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# Minerals Yearbook

## 1970

*Volume II*

AREA REPORTS: DOMESTIC



*Prepared by staff of the*  
BUREAU OF MINES



**UNITED STATES DEPARTMENT OF THE INTERIOR • Rogers C. B. Morton, Secretary**

**BUREAU ON MINES • Elburt F. Osborn, Director**

Created in 1849, the Department of the Interior—America's Department of Natural Resources—is concerned with the management, conservation, and development of the Nation's water, wildlife, mineral, forest, and park and recreational resources. It also has major responsibilities for Indian and Territorial affairs.

As the Nation's principal conservation agency, the Department works to assure that nonrenewable resources are developed and used wisely, that park and recreational resources are conserved for the future, and that renewable resources make their full contribution to the progress, prosperity, and security of the United States—now and in the future.

**U.S. GOVERNMENT PRINTING OFFICE**

**WASHINGTON : 1972**

## Foreword

The 1970 edition of the Minerals Yearbook marks the 89th year in which an annual report on the minerals industry has been published by the Federal Government. This edition provides a statistical record on global mineral industry performance during the year of review, and contains sufficient background information to interpret the year's developments. Although the same format has been followed as in previous editions, we direct the reader's attention to the change in numbering of the individual volumes. The former Volume I-II, Metals, Minerals, and Fuels, has been renumbered Volume I; Volume III, Area Reports: Domestic, has been changed to Volume II; and Volume IV, Area Reports: International, has been renumbered Volume III. The general content of the individual volumes is as follows:

Volume I, Metals, Minerals, and Fuels, contains chapters on virtually all metal, nonmetal, and mineral fuel commodities important to the domestic economy. In addition, it includes a general review chapter on these industries, a statistical summary, and chapters on employment and injuries and on technologic trends.

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

Volume III, Area Reports: International, presents the latest available mineral statistics for more than 130 foreign countries and discusses the importance of minerals to the economies of these nations. A separate chapter reviews minerals and their relationship to the world economy.

The continuous effort of the Bureau of Mines to enhance the value of the Yearbook for its readers can be aided by comments and suggestions. Toward that end, the constructive comments of readers will be welcomed.

ELBURT F. OSBORN, *Director*



# Acknowledgments

The chapters of this volume, except the statistical summary and injury experience and worktime, were prepared by the staffs of the Divisions of Ferrous Metals, Fossil Fuels, Nonferrous Metals, and Nonmetallic Minerals of the Assistant Directorate, Mineral Supply. The injury experience and work-time chapter was prepared in the Office of Accident Analysis of the Health and Safety Activity.

The Statistical Summary chapter and the tabular material covering total State mineral production, value of mineral production by county, and economic indicators were prepared in the Office of Technical Data Services. The Minerals Yearbook staff of that office reviewed the manuscripts upon which this volume was based, to insure statistical consistency among the tables, figures, and text between this volume and Volume I, and between this volume and those of former years.

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

Alabama: Geological Survey of Alabama.

Alaska: Division of Geological Survey, and the Division of Oil and Gas,

Alaska Department of Natural Resources.

Arizona: Arizona Bureau of Mines.

Arkansas: Arkansas Geological Commission.

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

Connecticut: Connecticut Geological and Natural History Survey.

Delaware: Delaware Geological Survey.

Florida: Florida Bureau of Geology.

Georgia: Georgia Department of Mines, Mining and Geology.

Hawaii: Hawaii Department of Land and Natural Resources.

Idaho: Idaho Bureau of Mines and Geology.

Illinois: Illinois Geological Survey.

Indiana: Geological Survey, Indiana Department of Natural Resources.

Iowa: Geological Survey of Iowa.

Kansas: State Geological Survey of Kansas.

Kentucky: Kentucky Geological Survey.

Louisiana: Louisiana Geological Survey.

Maine: Geological Survey of Maine.

Maryland: Maryland Geological Survey.

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

Minnesota: Minnesota Geological Survey.

Mississippi: Mississippi Geological, Economic, and Topographical Survey.

Missouri: Division of Geological Survey and Water Resources.

Montana: Montana Bureau of Mines and Geology.

Nebraska: Conservation and Survey Division of the University of Nebraska (Nebraska Geological Survey).

Nevada: Nevada Bureau of Mines.

New Hampshire: New Hampshire Department of Resources and Economic Development.

New Jersey: New Jersey Division of Resource Development, Bureau of Geology and Topography.  
New York: New York State Museum and Science Service.  
North Carolina: Division of Mineral Resources, North Carolina Department of Conservation and Development.  
North Dakota: State Geological Survey of North Dakota.  
Oklahoma: Oklahoma Geological Survey.  
Pennsylvania: Pennsylvania Bureau of Topographic and Geologic Survey.  
Puerto Rico: Mineralogy and Geology Section, Economic Development Administration, Commonwealth of Puerto Rico.  
South Carolina: South Carolina Division of Geology, State Development Board.  
South Dakota: South Dakota State Geological Survey.  
Tennessee: Tennessee Department of Conservation, Division of Geology.  
Texas: Bureau of Economic Geology, University of Texas at Austin.  
Utah: Utah Geological and Mineralogical Survey.  
Virginia: Virginia Division of Mineral Resources.  
Washington: Washington Division of Mines and Geology.  
West Virginia: West Virginia Geological and Economic Survey.  
Wisconsin: Wisconsin Geological Survey.  
Wyoming: Geological Survey of Wyoming.

Minerals Yearbook compilations are based largely on facts provided by the mineral industries. The willing contribution by both companies and individuals of these essential data is gratefully acknowledged.

ALBERT E. SCHRECK  
*Editor-In-Chief*

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# Statistical Summary

By Mary E. Daugherty <sup>1</sup> and Nellie W. Fahrney <sup>1</sup>

This chapter summarizes mineral production in the United States, its island possessions, the Canal Zone, and the Commonwealth of Puerto Rico. Tables showing the principal minerals exported from and imported into the United States, and comparing world and U.S. mineral production also are included. Further details are contained in the commodity chapters of volume I and the area chapters of volume II.

Mineral production may be measured at any of several stages of extraction and processing. The stage of measurement used in the chapter is normally what is termed "mine output." It usually refers to minerals in the form in which they are first extracted from the ground, but customarily includes for some minerals the product of auxiliary processing operations at or near mines.

Because of inadequacies in the statistics available, some series deviate from the foregoing definition. The quantities of gold, silver, copper, lead, zinc, and tin are recorded on a mine basis (as the recoverable content of ore sold or treated). The values assigned to these quantities, however, 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 metal.

The weight or volume units shown are those customary in the particular industries producing the respective commodities. No adjustment has been made in dollar values for changes in purchasing power of the dollar.

<sup>1</sup> Statistical assistant, Minerals Yearbook.

Table 1.—Value of mineral production <sup>1</sup> in the United States, by mineral groups

(Millions)				
Year	Mineral fuels	Nonmetals (except fuels)	Metals	Total <sup>2</sup>
1966.....	\$15,088	\$5,176	\$2,703	\$22,968
1967.....	16,195	5,200	2,333	23,729
1968.....	16,820	5,448	2,703	24,971
1969.....	17,965	5,624	3,332	26,921
1970.....	20,153	5,711	3,926	29,790

<sup>1</sup> Revised.

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

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



Table 2.—Mineral production<sup>1</sup> in the United States

Mineral	1967		1968		1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MINERAL FUELS								
Asphalt and related bitumens (native): Bituminous limestone	1,866,686	\$8,136	1,797,219	\$8,179	1,918,748	\$8,561	1,980,562	\$8,879
.....short tons	144	165	1,118,027	176	1,194,896	144	1,109,580	191
Carbon sandstone and gilsonite.....thousand cubic feet	1,142,374							
Coal	552,626	2,555,377	545,245	2,546,340	560,505	2,795,509	602,982	3,772,662
.....thousand short tons	12,256	96,160	11,461	97,245	10,473	100,769	9,729	105,941
.....do.								
Bituminous and lignite <sup>2</sup> .....thousand short tons	3,597	42,800	3,788	44,700	3,993	46,843	4,080	47,992
Pennsylvania anthracite.....do.	1,015	29,657	1,066	28,355	760	21,599	1,647	17,405
Grade A.....do.	18,171,325	2,898,741	19,322,493	3,168,693	20,698,240	3,455,615	21,920,642	3,745,680
Natural gas liquids:								
Natural gasoline and cycle products	187,840	546,927	199,049	571,679	201,784	608,084	206,305	603,024
.....thousand 42-gallon barrels	326,616	632,994	351,262	552,335	378,457	498,927	389,511	672,083
LP gases	620	6,768	619	7,230	566	7,055	526	3,986
.....thousand short tons	3,216,715	9,377,516	3,329,042	9,794,826	3,371,751	10,426,680	3,517,450	11,178,726
Peat.....thousand 42-gallon barrels								
Petroleum (crude)	XX 16,195,000		XX 16,820,000		XX 17,965,000		XX 20,153,000	
Total mineral fuels.....do.								
NONMETALS (EXCEPT FUELS)								
Abrasive stones <sup>3</sup> .....short tons	2,701	574	3,141	629	3,311	600	3,134	666
Asbestos.....do.	123,189	11,102	120,690	10,406	125,936	10,648	125,814	10,696
Barite.....thousand short tons	962	11,604	927	13,706	1,077	15,753	854	12,800
Boron minerals.....do.	349,757	69,819	963	76,535	1,020	81,261	1,041	86,827
.....thousand pounds	608,965	85,891	362,452	86,787	391,833	87,990	349,748	60,560
.....short tons		11,363	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	632,500	15,225
Calcium-magnesium chloride								
Cement:	965,570	1,148,208	938,525	1,227,942	400,883	1,284,600	381,001	1,268,718
.....thousand 376-pound barrels	21,700	62,168	23,167	66,259	23,253	67,106	21,275	67,587
Masonry.....do.	94	360	86	332	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )
Natural and slag.....thousand short tons	54,664	223,967	57,348	246,938	58,694	264,415	54,853	327,912
.....do.	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	598,482	36,435	597,636	32,649
Diatomite.....do.	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )
Emery.....do.	615,397	7,086	667,679	8,265	673,985	8,869	648,276	9,638
Feldspar.....long tons	295,643	13,164	292,411	11,656	182,567	8,411	269,221	13,923
Fluorspar.....short tons	20,494	1,849	22,186	1,922	20,458	1,874	18,897	2,396
Garnet (abrasive).....do.	NA	2,450	NA	2,497	NA	2,380	NA	35,182
Gem stones (estimate).....do.	9,393	34,563	9,905	36,775	9,905	38,354	9,436	35,182
Gypsum.....thousand short tons	17,985	240,216	18,687	249,639	20,209	280,736	19,747	286,155
Lime.....do.								
Magnesium compounds from sea water and brine (except for metals)	544,428	41,883	525,210	43,449	618,762	53,046	707,874	62,434
Mica.....do.								
Scrap.....short tons	118,503	2,876	125,323	3,014	133,058	2,893	118,843	2,827
Sheet.....pounds	20,500	175,000	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )
Perlite.....short tons	413,001	3,973	427,574	4,221	471,454	5,100	456,134	4,904
Phosphate rock.....thousand short tons	39,770	265,947	41,251	250,692	37,725	208,689	38,739	203,123
Potassium salts.....thousand short tons, K <sub>2</sub> O equivalent	3,299	105,313	3,725	75,664	2,804	73,572	2,729	98,128
Pumice.....thousand long tons	3,446	5,131	3,530	5,570	3,609	5,050	3,134	( <sup>4</sup> )
Pyrites.....thousand short tons	861	7,943	872	8,272	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )
Salt.....thousand short tons	38,946	251,210	41,274	272,275	44,245	287,680	45,804	303,528
Sand and gravel.....do.	905,899	980,619	917,468	1,020,107	937,169	1,069,667	943,941	1,115,320
Sodium carbonate (natural).....do.	1,726	40,539	2,043	42,104	2,513	50,922	2,688	56,320

STATISTICAL SUMMARY

Sulfur:	785,592	1,240,244	819,597	1,317,911	700	1,129	672	12,421	10,582	1,474,917	874,512	602
Frasch process mines.....	7,682	251,670	6,645	268,146	6,645	268,146	6,551	176,659	6,419	151,779	6,419	XX
Other mines.....	568	3	3,125	46	3,125	46						XX
Talc, soapstone, and pyrophyllite.....	902,512	6,371	958,262	6,656	1,029,238	7,773	7,508	1,027,929	7,773	7,773	68,105	XX
Tripoli.....	70,984	377	85,634	796	84,673	734	68,105	520	68,105	520	285	XX
Vermiculite.....	255	4,974	290	5,684	290	5,684	310	6,805	310	6,805	285	XX
Value of items that cannot be disclosed: Aplite, brucite, graphite, iodine, kyanite, lithium minerals, magnesite, green-sand marl, olivine, staurolite, wollastonite, and values indicated by footnote 4.....	XX	55,734	XX	79,309	XX	79,309	XX	46,941	XX	34,174	XX	XX
Total nonmetals.....	XX	5,200,000	XX	5,448,000	XX	5,448,000	XX	5,624,000	XX	5,710,815	XX	XX
METALS												
Antimony ore and concentrate.....	892	(6)	856	(6)	988	(6)	988	(6)	1,130	(6)	1,130	(6)
short tons, antimony content.....	1,654	19,079	1,665	23,752	1,843	23,752	1,843	25,725	2,082	30,070	2,082	(6)
Bauxite.....	(6)	(6)	168	81	(6)	81	(6)	(6)	(6)	(6)	(6)	(6)
thousand long tons, dried equivalent.....	954,064	729,401	1,008,195	1,544,579	1,468,400	1,719,657	1,719,657	1,743,322	1,984,484	1,984,484	1,743,322	(6)
short tons, gross weight.....	1,584,187	55,447	1,478,292	7,538,038	1,733,176	7,71,944	1,733,176	7,71,944	1,984,484	1,984,484	1,743,322	(6)
Copper (recoverable content of ores, etc.).....	82,415	81,934	836,433	89,854	929,293	87,176	941,789	87,176	941,789	87,176	941,789	(6)
short tons, gross weight.....	316,931	88,741	359,156	94,903	509,013	151,635	178,609	151,635	178,609	151,635	178,609	(6)
short tons.....	12,585	(6)	11,378	(6)	5,630	157	4,737	368,302	4,737	368,302	4,737	(6)
short tons, gross weight.....	23,784	11,639	244,590	14,464	430,637	14,969	11,134	27,303	11,134	27,303	11,134	(6)
76-pound flasks.....	81,596	133,604	98,245	151,000	103,009	178,819	110,381	190,077	110,381	190,077	110,381	(6)
thousand pounds.....	15,287	(6)	17,294	(6)	17,056	(6)	15,983	(6)	15,983	(6)	15,983	(6)
short tons.....	32,345	50,135	32,729	70,191	41,906	75,040	45,005	79,696	45,005	79,696	45,005	(6)
thousand Troy ounces.....	882,414	18,519	960,118	19,484	893,034	18,636	920,964	18,636	920,964	18,636	920,964	(6)
Titanium concentrate, ilmenite.....	9,088	165,239	24,139	182,698	23,748	142,161	24,682	149,464	24,682	149,464	24,682	(6)
short tons, 60-percent WO <sub>3</sub> basis.....	4,963	21,331	6,483	23,143	5,577	26,334	5,319	34,923	5,319	34,923	5,319	(6)
thousand pounds.....	549,413	151,562	529,446	142,950	553,124	161,512	534,136	161,512	534,136	161,512	534,136	(6)
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
Tungsten ore and concentrate.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons, gross weight.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
short tons, 60-percent WO <sub>3</sub> basis.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
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thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
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short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
short tons, 60-percent WO <sub>3</sub> basis.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
short tons, 60-percent WO <sub>3</sub> basis.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
short tons, 60-percent WO <sub>3</sub> basis.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
short tons, 60-percent WO <sub>3</sub> basis.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
short tons, 60-percent WO <sub>3</sub> basis.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	XX
short tons, 60-percent WO <sub>3</sub> basis.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
thousand pounds.....	XX	23,729,000	XX	24,971,000	XX	26,921,000	XX	29,790,000	XX	29,790,000	XX	XX
short tons.....	XX	50,190	XX	51,030	XX	54,180	XX	58,480	XX	58,480	XX	XX
thousand Troy ounces.....	XX	2,333,000	XX	2,703,000	XX	3,332,000	XX	3,926,000	XX	3,926,000	XX	

Table 3.—Minerals produced in the United States and principal producing States in 1970

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

Table 3.—Minerals produced in the United States and principal producing States in 1970—Continued

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

Table 4.—Value of mineral production in the United States and principal minerals produced in 1970

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	\$323,245	21	1.09	Coal, cement, stone, petroleum.
Alaska	338,271	20	1.14	Petroleum, sand and gravel, natural gas, stone.
Arizona	1,166,767	5	3.92	Copper, molybdenum, sand and gravel, cement.
Arkansas	225,622	27	.76	Petroleum, bromine and bromine compounds, natural gas, bauxite.
California	1,897,136	3	6.37	Petroleum, natural gas, sand and gravel, cement.
Colorado	389,789	18	1.31	Molybdenum, petroleum, coal, sand and gravel.
Connecticut	28,383	45	.10	Stone, sand and gravel, feldspar, lime.
Delaware	1,615	50	.01	Sand and gravel, clays, gem stones.
Florida	300,042	23	1.01	Phosphate rock, stone, cement, sand and gravel.
Georgia	203,225	29	.68	Clays, stone, cement, sand and gravel.
Hawaii	28,965	44	.10	Stone, cement, sand and gravel, pumice.
Idaho	119,748	32	.40	Silver, phosphate rock, lead, zinc.
Illinois	688,697	11	2.31	Coal, petroleum, stone, sand and gravel.
Indiana	255,786	25	.86	Coal, cement, stone, sand and gravel.
Iowa	120,822	31	.40	Cement, stone, sand and gravel, gypsum.
Kansas	586,161	16	1.97	Petroleum, natural gas, natural gas liquids, helium.
Kentucky	847,465	9	2.84	Coal, stone, petroleum, natural gas.
Louisiana	5,102,321	2	17.13	Petroleum, natural gas, natural gas liquids, sulfur.
Maine	23,780	47	.08	Cement, sand and gravel, stone, copper.
Maryland	88,216	37	.30	Stone, cement, sand and gravel, coal.
Massachusetts	50,360	43	.17	Stone, sand and gravel, lime, clays.
Michigan	670,729	12	2.25	Iron ore, cement, copper, sand and gravel.
Minnesota	633,006	13	2.12	Iron ore, sand and gravel, stone, cement.
Mississippi	249,973	26	.84	Petroleum, natural gas, sand and gravel, clays.
Missouri	392,996	17	1.32	Lead, cement, stone, iron ore.
Montana	313,016	22	1.05	Petroleum, copper, sand and gravel, cement.
Nebraska	72,657	39	.24	Petroleum, cement, sand and gravel, stone.
Nevada	186,349	30	.62	Copper, gold, sand and gravel, diatomite.
New Hampshire	8,730	48	.03	Sand and gravel, stone, clays, gem stones.
New Jersey	89,281	36	.30	Stone, sand and gravel, zinc, magnesium compounds.
New Mexico	1,060,358	8	3.56	Petroleum, copper, natural gas, potassium salts.
New York	299,564	24	1.01	Cement, stone, salt, sand and gravel.
North Carolina	98,365	33	.33	Stone, sand and gravel, cement, phosphate rock.
North Dakota	96,047	34	.32	Petroleum, coal, sand and gravel, natural gas.
Ohio	612,166	14	2.05	Coal, stone, lime, sand and gravel.
Oklahoma	1,137,267	6	3.82	Petroleum, natural gas, natural gas liquids, stone.
Oregon	68,101	40	.23	Sand and gravel, stone, cement, nickel.
Pennsylvania	1,095,743	7	3.68	Coal, cement, stone, sand and gravel.
Rhode Island	4,386	49	.01	Sand and gravel, stone, gem stones.
South Carolina	56,365	42	.19	Cement, stone, clays, sand and gravel.
South Dakota	61,576	41	.21	Gold, sand and gravel, stone, cement.
Tennessee	220,465	28	.74	Stone, coal, zinc, cement.
Texas	6,402,462	1	21.49	Petroleum, natural gas, natural gas liquids, cement.
Utah	601,997	15	2.02	Copper, petroleum, coal, molybdenum.
Vermont	27,843	46	.09	Stone, sand and gravel, asbestos, talc.
Virginia	374,321	19	1.26	Coal, stone, cement, sand and gravel.
Washington	90,922	35	.30	Sand and gravel, cement, stone, uranium.
West Virginia	1,285,364	4	4.31	Coal, natural gas, stone, cement.
Wisconsin	87,670	38	.29	Sand and gravel, stone, iron ore, zinc.
Wyoming	705,533	10	2.37	Petroleum, natural gas, sodium salts, uranium.
Total	29,789,668		100.00	

Table 5.—Mineral production in the United States, by State

Mineral	1967			1968			1969			1970		
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ALABAMA												
Cement: <sup>2</sup>												
Portland	15,364	\$46,510	15,514	\$48,147	16,527	\$51,251	16,053	\$51,114			16,053	\$51,114
Masonry	2,377	6,938	2,523	7,309	2,600	8,520	2,402	7,601			2,402	7,601
Clays	2,724	7,422	2,793	6,995	3,097	7,083	2,748	8,213			2,748	8,213
Coal (bituminous)	15,486	110,696	16,440	115,815	17,456	130,405	20,560	166,308			20,560	166,308
Iron ore (usable)	1,472	8,286	1,151	6,730	1,125	6,435	W	W			W	W
Lime	624	7,719	8,933	8,933	1,747	9,870	749	10,286			749	10,286
Natural gas	248	31	230	30	180	24	627	87			627	87
Petroleum (crude)	7,348	19,500	7,635	20,385	7,701	20,798	7,263	20,627			7,263	20,627
Sand and gravel	7,229	9,969	8,140	9,130	8,323	9,427	6,725	8,144			6,725	8,144
Stone	18,371	33,346	20,643	33,847	19,854	37,512	19,882	37,512			19,882	37,512
Value of items that cannot be disclosed: Native asphalt, bauxite, slag cement, scrap mica, natural gasoline 1969-70, liquefied petroleum gases 1969-70, phosphate rock 1969-70, salt, stone, dimension (1970), talc, and value indicated by symbol W	XX	2,974	XX	2,300	XX	3,416	XX	3,416			XX	13,699
Total	XX	261,391	XX	259,621	XX	284,736	XX	284,736			XX	323,245
ALASKA												
Antimony ore and coacaeate	10	W	3	W	12	\$13	63	\$109			63	\$109
Barite	W	W	91	W	W	W	134	835			134	835
Coal (bituminous)	925	\$7,296	750	\$4,502	667	4,366	549	4,059			549	4,059
Gold (recoverable content of ores, etc.)	22,948	803	21,262	4,835	21,227	4,881	34,776	41,265			34,776	41,265
Lead (recoverable content of ores, etc.)	---	---	---	---	---	---	---	---			---	---
Natural gas	14,438	3,610	17,343	4,388	50,864	12,665	111,576	27,448			111,576	27,448
Peat	2	---	12	---	---	---	---	---			---	---
Petroleum (crude)	29,126	91,164	66,204	186,695	73,953	214,464	83,616	251,684			83,616	251,684
Sand and gravel	22,370	26,248	18,013	20,366	16,205	18,615	25,825	41,092			25,825	41,092
Silver (recoverable content of ores, etc.)	6	W	4	W	2	---	---	---			---	---
Stone	W	---	W	---	1,954	3,902	6,470	10,014			6,470	10,014
Value of items that cannot be disclosed: Copper (1968), gem stones, liquefied petroleum gases (1969), mercury, platinum-group metals, tin, and values indicated by symbol W	XX	4,924	XX	4,923	XX	2,865	XX	1,761			XX	1,761
Total	XX	134,066	XX	221,717	XX	287,776	XX	287,776			XX	338,271
ARIZONA												
Clays	67	\$347	77	\$347	120	\$394	199	\$454			199	\$454
Coal (bituminous)	1	---	---	---	---	---	---	---			---	---
Copper (recoverable content of ores, etc.)	501,741	383,591	627,961	526,566	801,363	761,840	917,918	1,059,277			917,918	1,059,277

See footnotes at end of table.

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

Mineral	1967			1968			1969			1970		
	Quantity	Value (thousands)	W	Quantity	Value (thousands)	W	Quantity	Value (thousands)	W	Quantity	Value (thousands)	W
ARIZONA—Continued												
Diatomite.....			W			W			W			W
Fluorspar.....	10,000	\$280	NA		\$149	NA		\$153	NA		\$155	NA
Gem stones.....	150		W			W			W			W
Gold (recoverable content of ores, etc.).....	80,844	2,830	W	95,999	3,769	W	110,878	4,603	W	109,853	3,998	W
Gypsum.....			W			W			W			W
Helium, grade A.....	74	2,066	W	65	1,600	W	56	1,126	W	62	1,186	W
Iron ore (usable).....			W			W			W			W
Lead (recoverable content of ores, etc.).....	4,771	1,386	W	1,704	450	W	217	65	W	285	89	W
Lime.....	186	3,142	W	1,260	4,561	W	283	5,074	W	309	4,523	W
Mercury.....			W			W			W			W
Molybdenum (content of concentrate).....	9,261	15,385	W	12,127	19,207	W	12,699	20,947	W	15,672	26,700	W
Natural gas.....	1,255	193	W	881	142	W	1,136	199	W	1,101	188	W
Petroleum (crude).....	2,924	8,188	W	3,370	9,606	W	2,435	7,056	W	1,784	5,281	W
Pumice.....	1,064	904	W	1,083	974	W	910	814	W	824	627	W
Sand and gravel.....	17,317	17,280	W	18,981	14,423	W	16,744	18,224	W	17,822	19,804	W
Sliver (recoverable content of ores, etc.).....	4,588	7,112	W	4,958	10,633	W	6,141	10,997	W	7,330	12,981	W
Stone (recoverable content of ores, etc.).....	1,910	3,491	W	3,293	6,239	W	2,827	5,812	W	3,511	7,094	W
Tungsten ore and concentrate.....	83	656	W	295	1,923	W	3	1	W	2	2	W
Uranium (recoverable content of ores, etc.).....	14,330	3,967	W	5,441	1,469	W	9,089	2,639	W	9,618	2,947	W
Zinc (recoverable content of ores, etc.).....			W			W			W			W
Value of items that cannot be disclosed: Asbestos, cement, clays (bentonite 1967), feldspar, scrap mica, perlite, pyrites, vanadium (1967-69), vermiculite (1967-69), and values indicated by symbol W.....	XX	13,503	XX	XX	16,253	XX	XX	18,957	XX	XX	21,105	XX
Total.....	XX	464,126	XX	XX	617,541	XX	XX	859,462	XX	XX	1,166,767	XX
ARKANSAS												
Barite.....	229	\$2,266	W	166	\$3,839	W	210	\$4,616	W	168	\$3,721	W
Bauxite.....	1,571	18,269	W	1,582	23,058	W	1,755	24,706	W	1,869	26,293	W
Bromine and bromine in compounds.....	64,450	14,885	W	95,499	20,790	W	145,100	28,287	W	1,014	2,902	W
Clays.....	941	1,740	W	919	2,134	W	992	2,426	W	1,014	2,902	W
Coal (bituminous).....	189	1,427	W	211	1,576	W	228	1,802	W	268	2,225	W
Gem stones.....	NA	35	NA	NA	30	NA	NA	24	NA	NA	25	NA
Lime.....	187	2,723	W	206	3,058	W	184	2,748	W	186	2,680	W
Natural gas liquids.....	116,522	17,823	W	156,627	24,456	W	169,257	26,743	W	181,351	29,560	W
Natural gasoline and cycle products.....	656	1,780	W	763	2,192	W	692	2,049	W	643	1,824	W
LP gases.....	1,279	3,009	W	1,435	2,899	W	1,279	2,098	W	1,205	2,482	W
Petroleum (crude).....	21,075	56,902	W	19,464	53,137	W	18,049	51,079	W	18,035	51,760	W
Sand and gravel.....	14,239	15,531	W	12,997	14,643	W	12,674	14,949	W	13,301	16,036	W
Stone.....	17,454	23,236	W	16,322	22,256	W	16,463	23,134	W	15,284	22,786	W
Value of items that cannot be disclosed: Abrasive stones, cement, clays, gypsum, mercury (1967, 1970), soapstone, tripoli, vanadium (1968-70), and values indicated by symbol W.....	XX	19,822	XX	XX	24,655	XX	XX	23,465	XX	XX	63,331	XX
Total.....	XX	179,453	XX	XX	198,723	XX	XX	208,126	XX	XX	225,625	XX





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

Mineral	1967			1968			1969			1970		
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)		
COLORADO—Continued												
Gypsum	77	265	98	354	94	339	W	W	W	W	W	
Iron ore (usable)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Lead (recoverable content of ores, etc.)	21,923	6,138	19,778	5,226	21,767	6,484	W	W	21,855	6,827	W	
Lime	118	2,028	125	2,375	127	2,449	W	W	119	1,613	W	
Manganese ore (5 to 35 percent Mn)	321	3	3	3	3	3	W	W	3	3	W	
Molybdenum (content of concentrate)	52,040	84,728	61,684	100,296	62,411	105,346	W	W	105,804	15,553	W	
Natural gas	116,857	15,542	121,424	16,392	118,754	17,219	W	W	118,754	15,553	W	
Natural gas liquids	1,234	3,215	1,289	3,248	1,076	2,798	W	W	1,076	1,987	W	
Natural gasoline	1,703	3,649	1,987	3,338	1,782	2,762	W	W	1,542	2,529	W	
LP gases	22	204	28	250	26	160	W	W	34	210	W	
Peat	33,905	99,003	31,937	94,215	28,294	88,277	W	W	24,723	78,610	W	
Petroleum (crude)	18	105	28	234	42	232	W	W	50	263	W	
Pumice	W	W	23	97	24	120	W	W	22,261	24,190	W	
Pyrites	21,810	22,904	23,131	26,608	19,877	27,266	W	W	2,983	3,594	W	
Sand and gravel	1,818	2,317	1,646	3,531	2,599	4,653	W	W	3,552	8,076	W	
Silver (recoverable content of ores, etc.)	2,992	5,435	2,471	5,201	2,245	5,079	W	W	2,727	15,832	W	
Stone	31	59	33	64	44	119	W	W	56,694	17,370	W	
Tin (content of concentrate)	1,276	3,039	1,893	4,413	1,941	4,440	W	W	15,685	17,370	W	
Tungsten concentrate	2,537	20,299	2,706	20,009	2,736	16,935	W	W	2,727	15,832	W	
Uranium (recoverable content U <sub>3</sub> O <sub>8</sub> )	3,317	14,260	3,492	12,468	53,715	15,685	W	W	56,694	17,370	W	
Vanadium (recoverable in ore and concentrate)	52,442	14,519	50,258	13,570	53,715	15,685	W	W	56,694	17,370	W	
Zinc (recoverable content of ores, etc.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Value of items that cannot be disclosed: Cement, fluorapatite, scrap mica (1967, 1970), perlite, rare-earth metal concentrates (1967-68), salt, and values indicated by symbol W	XX	16,834	XX	15,630	XX	32,745	XX	XX	XX	169,025	XX	
Total	XX	346,235	XX	359,458	XX	368,494	XX	XX	XX	389,789	XX	
CONNECTICUT												
Clays	191	\$384	195	\$325	197	\$341	8	8	171	\$386	8	
Gemstones	NA	8	NA	8	NA	8	NA	8	NA	8	8	
Sand and gravel	8,320	8,710	8,752	9,320	8,857	10,359	W	W	6,765	9,202	W	
Stone	5,097	10,141	6,383	12,729	7,562	15,325	W	W	8,938	16,915	W	
Value of items that cannot be disclosed: Feldspar, lime, and scrap mica	XX	1,426	XX	1,493	XX	1,734	XX	XX	XX	1,872	XX	
Total	XX	20,619	XX	23,876	XX	27,767	XX	XX	XX	28,383	XX	
DELAWARE												
Clays	11	\$11	12	\$12	11	\$11	11	11	11	\$11	11	
Gem stones	NA	1	NA	1	NA	1	NA	1	NA	1	1	
Sand and gravel	1,966	1,846	1,596	1,483	2,267	2,074	W	W	1,565	1,603	W	
Stone	210	525	200	500	.....	.....	.....	.....	.....	.....	.....	
Value of items that cannot be disclosed: Feldspar, lime, and scrap mica	XX	2,383	XX	1,996	XX	2,086	XX	XX	XX	1,615	XX	
Total	XX	2,383	XX	1,996	XX	2,086	XX	XX	XX	1,615	XX	

FLORIDA

Clays.....	756	\$11,574	808	\$11,699	907	\$13,627	872	\$12,661
Lime.....	155	2,423	123	2,059	182	2,712	167	2,810
Natural gas.....	123	108	156	16	50	8		
Peat.....	22	150	150	277	55	359	46	304
Petroleum (crude).....	1,568	W	1,474	W	1,731	W	2,999	W
Sand and gravel.....	6,912	6,479	7,765	7,967	14,409	13,988	12,482	12,254
Stone.....	33,971	38,723	36,692	46,563	42,332	56,611	43,089	61,302
Value of items that cannot be disclosed: Cement, kyanite (1968-70), magnesium compounds, natural gas liquids, phosphate rock, rare-earth metal concentrates, staurolite, stone (dimension limestone 1967-70), titanium concentrate, zirconium concentrate, and values indicated by symbol W.....	XX	250,423	XX	236,042	XX	208,071	XX	210,711
Total.....	XX	309,797	XX	304,623	XX	295,376	XX	300,042

GEORGIA

Barite.....	W	W	140	\$2,874	124	\$3,116	W	W
Clays.....	4,933	\$77,314	5,111	88,692	5,670	98,462	5,684	\$110,149
Iron ore (usable).....	267	1,130	192	1,119	241	1,338	243	1,467
Mica: Scrap.....	17	4,201	W	W	W	W	W	W
Sand and gravel.....	3,787	4,201	3,803	4,314	3,824	4,709	3,667	4,437
Stone.....	23,418	49,953	26,303	56,177	27,755	59,451	26,695	59,200
Talc.....	46,160	292	45,600	288	47,790	301	45,900	289
Value of items that cannot be disclosed: Bauxite, cement, feldspar, kyanite, peat, rare-earth metal concentrates (1968-70), titanium concentrate, zirconium concentrate, and values indicated by symbol W.....	XX	19,952	XX	19,686	XX	23,525	XX	27,683
Total.....	XX	153,458	XX	173,090	XX	190,902	XX	203,225

HAWAII

Cement.....	1,395	\$7,360	1,841	\$9,254	2,075	\$10,544	2,162	\$10,334
Clays.....	W	W	3	4	2	9	2	11
Lime.....	8	265	8	268	9	287	9	338
Pumice.....	290	562	408	724	403	783	350	933
Sand and gravel.....	469	1,467	546	1,653	552	1,816	514	1,679
Stone.....	4,100	7,207	5,211	11,273	6,534	16,059	3,631	15,538
Value of items that cannot be disclosed: Other nonmetals and values indicated by symbol W.....	XX	75	XX	49	XX	41	XX	132
Total.....	XX	16,936	XX	23,225	XX	29,539	XX	28,965

IDAHO

Antimony ore and concentrate.....	823	W	853	W	922	W	993	W
Clays.....	19	\$16	12	\$14	23	\$51	13	\$28
Copper (recoverable content of ores, etc.).....	4,210	3,219	3,525	2,950	3,332	3,168	3,612	4,168
Gem stones.....	NA	180	NA	200	NA	NA	NA	NA
Gold (recoverable content of ores, etc.).....	4,838	169	3,227	417	3,403	4141	3,128	4,114
Gypsum.....			3	13				

See footnotes at end of table.

Table 5.—Mineral production 1 in the United States, by State—Continued

Mineral	1967		1968		1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
IDAHO—Continued								
Iron ore (usable).....	W	W	W	W	W	W	W	W
Lead (recoverable content of ores, etc.).....	61,387	17,188	54,790	14,478	65,597	19,541	61,211	19,121
Mercury.....	439	439	W	W	1,012	511	1,038	423
Peat.....	2	16	W	W	1	W	W	W
Phosphate rock.....	W	W	3,879	22,721	W	W	W	W
Pumice.....	W	W	135	259	21	62	41	83
Sand and gravel.....	11,246	11,490	8,224	9,133	8,555	7,588	12,953	10,022
Silver (recoverable content of ores, etc.).....	17,093	26,402	15,959	34,225	18,930	33,897	19,115	33,849
Stone.....	1,986	4,833	2,195	5,209	3,750	6,426	4,240	6,968
Tungsten concentrate.....	68	175	W	W	27	63	W	W
Zinc (recoverable content of ores, etc.).....	56,528	15,650	57,248	15,457	55,900	16,323	41,052	12,578
Value of items that cannot be disclosed: Cement, clays, (fire clay and kaolin), abrasive garnet, lime, perlite, stone (dimension 1970), vanadium, and values indicated by symbol W.....	XX	29,631	XX	9,467	XX	30,453	XX	32,904
Total.....	XX	109,408	XX	114,253	XX	118,309	XX	119,748
ILLINOIS								
Cement:.....	9,069	\$30,186	9,372	\$32,475	8,720	\$29,996	7,946	\$25,252
Portland.....	591	1,851	602	2,097	603	2,137	508	1,874
Masonry.....	1,881	3,799	2,327	4,813	1,863	4,321	1,676	3,862
Clays <sup>2</sup> .....	65,133	252,975	62,441	250,685	64,722	279,712	65,119	320,705
Coal (bituminous).....	210,207	9,859	188,325	9,134	88,400	4,676	148,208	8,687
Fluorspar.....	2,384	668	1,467	388	791	236	1,532	479
Natural gas.....	5,144	602	4,380	552	3,800	536	4,850	761
Lead (recoverable content of ores, etc.).....	60	697	62	867	67	958	63	711
Peat.....	60,115	181,581	56,391	173,120	50,724	161,302	43,747	141,994
Petroleum (crude).....	38,801	44,175	45,609	52,943	44,138	56,688	43,926	60,155
Sand and gravel.....	48,458	66,757	55,858	80,188	54,857	81,318	55,776	86,502
Stone.....	20,416	5,652	18,182	4,909	13,765	4,019	16,797	5,146
Zinc (recoverable content of ores, etc.).....	XX	37,999	XX	35,372	XX	33,916	XX	32,619
Value of items that cannot be disclosed: Clay (fuller's earth), gem stones, lime, natural gas liquids, and tripoli.....	XX	636,801	XX	647,543	XX	659,815	XX	688,697
Total.....	XX	1,081,304	XX	1,114,253	XX	1,118,309	XX	1,119,748
INDIANA								
Abrasive stones.....	5	\$16	5	\$16	5	\$17	W	W
Cement <sup>2</sup> .....	15,924	53,123	14,774	48,096	14,497	45,264	12,432	\$41,810
Clays.....	1,489	2,126	1,550	2,355	1,483	2,264	1,335	2,139
Coal (bituminous).....	18,772	73,419	18,486	71,680	20,086	82,902	22,263	102,371
Natural gas.....	198	46	234	55	171	40	153	36
Peat.....	43	441	39	557	38	515	W	W
Petroleum (crude).....	10,081	30,041	8,692	26,511	7,841	25,013	7,487	23,958

Sand and gravel.....	26,265	25,588	25,774	26,160	27,438	23,476	25,796
Stone.....	26,977	46,725	26,307	46,790	45,400	25,818	45,215
Value of items that cannot be disclosed; Cement (masonry), Gypsum, lime, and values indicated by symbol W.....	XX	13,396	XX	13,166	13,018	XX	14,461
Total.....	XX	244,921	XX	235,386	241,871	XX	255,786

IOWA

Cement:	13,712	\$45,394	13,900	\$47,275	14,084	\$47,265	12,744	\$45,432
Portland.....	612	1,853	624	1,986	606	1,912	520	1,758
Masonry.....	1,208	1,643	1,747	3,289	1,811	1,660	1,181	1,823
Clays.....	1,219	3,227	3,876	3,289	3,903	3,274	4,223	5,059
Coal (bituminous).....	1,219	5,186	1,351	5,838	1,169	5,274	1,136	4,223
Gypsum.....	17,734	16,564	16,332	15,192	18,391	17,867	21,058	20,642
Sand and gravel.....	26,133	37,912	26,150	40,397	26,233	40,895	41,119	41,119
Stone.....	XX	1,443	XX	1,573	XX	1,665	XX	1,766
Value of items that cannot be disclosed; Gem stones, lime, and peat.....	XX	113,222	XX	117,297	XX	119,930	XX	120,822
Total.....	XX	113,222	XX	117,297	XX	119,930	XX	120,822

KANSAS

Cement: <sup>2</sup>	8,833	\$25,545	9,680	\$29,898	9,764	\$29,365	9,197	\$28,177
Portland.....	850	1,000	333	1,177	348	1,023	328	1,029
Masonry.....	933	1,339	932	1,433	5,797	1,070	5,713	5,946
Clays.....	1,136	5,294	1,238	6,526	1,313	7,108	1,627	9,102
Coal (bituminous).....	1,136	5,294	1,238	6,526	1,313	7,108	1,627	9,102
Helium:	2,720	32,554	2,750	33,600	2,669	32,667	2,609	32,777
Crude.....	275	5,364	292	7,300	330	7,578	354	8,137
Grade A.....	1,031	289	1,227	324	395	118	80	25
Lime.....	871,971	116,844	885,555	115,307	883,156	122,759	899,955	125,994
Natural gas.....	4,623	10,703	4,824	10,977	4,855	11,848	6,549	14,617
Natural gas liquids:	15,335	31,923	15,748	25,227	19,574	26,229	20,814	30,597
Natural gasoline.....	99,200	297,600	94,505	285,405	88,716	283,891	84,853	277,469
LP gases.....	1,069	14,686	1,128	15,520	1,270	17,090	1,230	18,206
Petroleum (crude):	12,056	8,650	12,427	10,559	12,029	10,061	12,968	12,351
Pumice.....	13,251	17,806	14,372	20,650	15,828	22,645	15,161	22,406
Salt.....	4,165	1,319	3,012	813	1,900	555	1,186	364
Sand and gravel.....	XX	3,182	XX	3,811	XX	3,808	XX	3,964
Stone.....	XX	574,068	XX	568,637	XX	577,815	XX	586,161
Value of items that cannot be disclosed; Natural cement, clays (fire 1969-70), gypsum, salt (brine), and values indicated by symbol W.....	XX	574,068	XX	568,637	XX	577,815	XX	586,161
Total.....	XX	574,068	XX	568,637	XX	577,815	XX	586,161

KENTUCKY

Clays <sup>5</sup> .....	1,195	\$2,066	1,219	\$1,952	1,232	\$2,076	1,020	\$1,793
Coal (bituminous).....	100,294	396,833	101,156	395,039	109,049	450,950	125,305	711,163
Fluor spar.....	32,952	1,686	17,050	878	W	W	W	W
Lead (recoverable content of ores, etc.).....	845	287	W	W	W	W	W	W

See footnotes at end of table.

Table 5.—Mineral production 1 in the United States, by State—Continued

Mineral	1967		1968		1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
KENTUCKY—Continued								
Natural gas.....	89,168	21,400	89,024	22,256	81,304	20,407	77,892	19,161
Petroleum (crude).....	15,535	45,052	14,036	41,125	12,924	40,194	11,575	36,461
Sand and gravel.....	7,981	7,859	7,478	8,081	3,364	9,628	8,760	10,474
Sliver (recoverable content of ores, etc.).....	1	1						
Stone.....	24,812	35,481	30,155	43,266	30,158	44,644	29,310	45,358
Zinc (recoverable content of ores, etc.).....	6,317	1,749	W	W	W	W	4,189	1,288
Value of items that cannot be disclosed: Native asphalt (1967-68), cement, ball clay, natural gas liquids, stone (quartzite, 1969), and values indicated by symbol W.....	XX	23,291	XX	22,266	XX	23,149	XX	21,772
Total.....	XX	535,705	XX	584,863	XX	591,048	XX	847,465
LOUISIANA								
Clays.....	995	\$1,260	863	\$1,163	1,078	\$2,943	1,080	\$1,575
Lime.....	758	9,891	781	10,159	822	10,760	1,025	12,811
Natural gas.....	5,716,857	1,057,619	6,416,015	1,212,627	7,227,826	1,387,743	7,788,276	1,503,137
Natural gas liquids:								
Natural gasoline and cycle products.....	41,777	130,212	49,928	156,903	53,555	171,434	56,526	174,632
LP gases.....	43,921	92,234	57,165	91,484	71,867	96,302	80,385	138,262
Petroleum (crude).....	774,527	2,419,823	817,426	2,570,641	841,603	2,791,269	906,907	8,061,558
Salt.....	9,585	48,483	10,908	53,854	13,435	61,102	13,584	64,854
Sand and gravel.....	20,812	27,442	20,411	26,504	18,331	21,895	18,155	22,363
Stone <sup>1</sup> .....	7,599	11,174	9,387	11,785	8,237	11,882	9,059	11,680
Sulfur (Frasch process).....	4,233	139,739	4,074	162,664	3,999	108,289	3,618	89,489
Value of items that cannot be disclosed: Cement, gypsum, and stone (crushed miscellaneous).....	XX	23,873	XX	23,246	XX	21,697	XX	21,980
Total.....	XX	3,961,750	XX	4,321,010	XX	4,685,326	XX	5,102,321
MAINE								
Clays.....	42	\$54	542	\$65	542	\$56	541	\$55
Copper.....			W	W	W	W	2,703	3,120
Gem stones.....	NA	35	NA	35	NA	35	NA	35
Sand and gravel.....	11,627	5,368	11,866	5,978	11,215	6,026	12,971	6,888
Sliver.....							63	112
Stone.....	1,159	2,999	1,187	3,205	1,101	3,798	9,114	2,792
Zinc.....			W	W	W	W		
Value of items that cannot be disclosed: Beryllium (1969-70), cement, fire clay (1968-70), copper (1968-69), feldspar, peat, silver (1968-69), zinc (1968-69), and values indicated by symbol W.....	XX	6,426	XX	8,527	XX	10,273	XX	10,778
Total.....	XX	14,882	XX	17,810	XX	20,188	XX	23,780

MARYLAND		MASSACHUSETTS		MICHIGAN				
Clays.....	998	\$1,462	\$1,078	\$1,252	\$1,369	\$1,129	\$1,433	
Coal (bituminous).....	1,805	4,548	1,447	5,318	1,368	5,261	8,083	
Geo. stones.....	NA	W	NA	NA	NA	NA	W	
Lime.....	W	W	W	W	W	W	W	
Natural gas.....	621	169	864	221	978	248	202	
Sand and gravel.....	W	W	W	64	W	W	4	
Stone.....	12,868	17,724	11,719	17,157	14,280	21,226	20,484	
Value of items that cannot be disclosed: Cement, clays (ball clay 1968-70, fire clay 1968-70), distormite, 1969, greensand marl, potassium salts, talc and soapstone, and values indicated by symbol W.....	14,479	28,581	19,344	26,606	15,067	30,504	32,783	
Total.....	XX	20,342	XX	21,198	XX	24,794	XX	25,231
.....	XX	72,819	XX	71,844	XX	83,483	XX	88,216

Clays.....	W	257	\$314	332	\$624	284	\$582	
Geo. stones.....	NA	\$2	NA	2	NA	2	NA	
Lime.....	195	3,044	198	3,380	199	3,718	W	
Sand and gravel.....	17,881	19,504	17,799	20,106	19,456	17,925	W	
Stone.....	6,203	17,724	6,917	19,501	7,847	22,521	22,349	
Value of items that cannot be disclosed: Nonmetals and value indicated by symbol W.....	XX	338	XX	37	XX	28	XX	3,183
Total.....	XX	40,612	XX	49,340	XX	49,843	XX	50,360

Cement: 29,645 \$94,515 31,375 \$99,158 30,373 \$98,425 29,813 \$101,019

Masonry: 1,395 5,286 2,006 5,627 1,904 5,473 1,519 5,233

Clays (recoverable content of ores, etc.): 2,489 7,505 2,597 7,867 2,466 7,460 2,887 7,945

Copper..... 58,488 44,692 74,805 62,607 75,226 71,516 67,543 77,945

Gypsum..... 1,422 3,085 1,405 3,186 1,327 3,384 1,312 3,061

Iron ore (usable)..... 14,180 162,610 12,699 148,890 14,065 169,756 13,100 168,998

Lime..... 1,787 21,582 1,630 19,870 1,589 20,372 1,588 21,355

Magnesium compounds from sea water and brine (except for metal)..... 909,446 26,388 266,406 25,087 321,191 30,343 411,911 38,050

Natural gas..... 83,589 8,296 40,480 10,160 36,163 9,294 38,861 10,373

Natural gas liquids: 1,139 3,491 1,066 3,177 921 2,481 599 1,611

Natural gasoline..... 1,139 3,491 1,066 3,177 921 2,481 599 1,611

Peat..... 247 3,292 1,384 3,432 1,197 2,561 1,106 2,751

Petroleum (crude)..... 13,624 36,252 12,274 38,287 12,118 37,424 11,889 36,236

Salt..... 42,769 46,389 44,863 48,563 45,813 48,963 45,889 49,583

Sand and gravel..... 52,310 49,636 56,063 54,379 53,092 58,967 54,486 54,486

Silver (recoverable content of ores, etc.)..... 302 466 1,094 1,094 1,094 1,094 1,094 1,094

Stone..... 36,432 39,910 37,279 41,032 39,186 43,572 41,687 49,101

Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, gem stones, iodine, and potassium salts and values indicated by symbol W..... XX 58,089 XX 58,293 XX 58,818 XX 41,622

Total..... XX 610,204 XX 627,075 XX 667,986 XX 670,729

See footnotes at end of table.

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

Mineral	1967		1968		1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MINNESOTA								
Clays <sup>5</sup> .....	228	\$342	240	\$359	275	\$412	227	\$335
Iron ore (usable).....	49,471	468,623	51,275	508,814	56,367	570,446	54,791	571,488
Magnetiferous ore (5 to 85 percent Mn).....	236,793	257	191,846	96	381,491	W	321,436	W
Peat.....	4	257	4	249	13	249	13	835
Sand and gravel.....	41,212	88,132	44,674	36,414	48,121	40,121	46,851	58,802
Some items that cannot be disclosed: Abrasive stones, cement, fire clay, gem stones, lime, and values indicated by symbol W.....	4,160	11,442	4,427	13,045	5,035	14,253	4,879	7,000
Value of items that cannot be disclosed: Abrasive stones, cement, fire clay, gem stones, lime, and values indicated by symbol W.....	XX	9,530	XX	8,699	XX	10,085	XX	15,046
Total.....	XX	523,326	XX	567,427	XX	635,636	XX	633,006
MISSISSIPPI								
Clays.....	1,654	\$7,852	1,693	\$9,075	1,703	\$8,660	1,553	\$8,062
Natural gas.....	139,497	24,133	135,051	22,601	131,234	23,097	126,031	23,190
Natural gas liquids:.....								
Natural gasoline and cycle products.....	427	1,167	459	1,277	565	1,572	544	1,465
LP gases.....	424	1,085	518	958	538	799	428	964
Petroleum (crude).....	57,147	155,726	58,708	164,396	64,283	187,514	65,119	194,706
Sand and gravel.....	14,099	15,485	11,980	12,669	11,484	12,263	10,859	11,950
Stone.....	1,879	2,055	747	883	W	W	W	W
Value of items that cannot be disclosed: Cement, iron ore (1967), lime, magnesium compounds, stone, and values indicated by symbol W.....	XX	9,055	XX	9,146	XX	9,279	XX	9,636
Total.....	XX	216,558	XX	220,955	XX	243,184	XX	249,973
MISSOURI								
Barite.....	332	\$4,444	284	\$4,102	304	\$4,220	230	\$3,555
Cement:.....								
Portland.....	15,044	52,119	20,081	71,206	21,325	74,368	21,224	64,264
Masonry.....	372	1,172	405	1,312	427	1,319	402	1,234
Clays.....	2,305	6,220	2,433	6,158	2,251	6,405	2,128	6,480
Coal (bituminous).....	3,696	15,573	3,205	13,460	3,301	14,283	4,447	19,526
Copper (recoverable content of ores, etc.).....	3,215	2,458	5,494	4,598	12,664	12,039	12,134	14,003
Iron ore (usable).....	1,871	26,673	1,648	23,582	2,222	35,826	2,612	38,100
Lime (recoverable content of ores, etc.).....	152,649	42,742	212,611	56,180	355,452	105,889	421,764	131,751
Lead.....	W	W	W	W	W	W	W	W
Natural gas.....	121	30	107	14	126	17	87	21
Petroleum (crude).....	W	W	W	W	W	W	W	W
Sand and gravel.....	9,716	12,556	10,649	14,204	10,940	14,574	12,446	15,879
Silver (recoverable content of ores, etc.).....	226	341	231	341	1,442	2,582	1,817	3,218
Stone.....	36,585	53,953	38,988	58,743	41,977	63,251	39,726	57,285
Zinc (recoverable content of ores, etc.).....	7,430	2,057	12,301	3,321	41,099	12,001	50,721	15,540
Value of items that cannot be disclosed: Native asphalt, and values indicated by symbol W.....	XX	16,662	XX	18,624	XX	20,453	XX	22,643
Total.....	XX	237,010	XX	276,238	XX	367,232	XX	392,996

MONTANA									
Clays <sup>1</sup> .....	thousand short tons--	30	\$84	34	\$63	41	\$71		
Coal (bituminous and lignite).....	do.....	519	1,214	1,030	2,199	3,441	6,394		
Copper (recoverable content of ores, etc.).....	short tons--	65,483	50,063	69,480	98,219	120,412	138,955		
Gem stones.....	do.....	NA	109	NA	109	NA	NA		
Gold (recoverable content of ores, etc.).....	troy ounces--	9,786	343	13,385	4,525	24,189	4,817		
Iron ore (usable).....	thousand long tons, gross weight--	10	81	12	W	14	W		
Lead (recoverable content of ores, etc.).....	short tons--	898	1,765	1,870	494	996	311		
Lime.....	thousand short tons--	143	1,765	4,649	2,005	2,737	208		
Manganese ore (35 percent or more Mn).....	do.....	16	213	775	2,737	512	W		
Manganese ore (5 to 35 percent Mn).....	short tons, gross weight--	2,763	22	22	22	42,705	4,399		
Natural gas.....	million cubic feet--	25,866	2,173	19,313	1,757	41,229	118,359		
Petroleum (crude).....	thousand 42-gallon barrels--	34,959	87,543	48,460	124,488	43,954	37,879		
Pumice.....	thousand short tons--	12,339	98	98	327	102	102		
Sand and gravel.....	do.....	12,339	10,655	8,762	7,754	16,595	14,383		
Silver (recoverable content of ores, etc.).....	thousand troy ounces--	2,066	3,203	2,133	4,578	3,429	6,141		
Stone.....	thousand short tons--	4,762	6,037	3,314	4,874	7,667	10,579		
Tungsten ore and concentrate.....	short tons, 60-percent WO <sub>3</sub> basis--	W	W	W	W	W	9		
Zinc (recoverable content of ores, etc.).....	short tons--	3,341	925	3,778	1,020	6,143	1,457		
Value of items that cannot be disclosed: Antimony (1867, 1970), cement, clays (bentonite), fluorspar, gypsum, natural gas liquids, peat, phosphate rock, talc, vermiculite, and values indicated by symbol W.....									
Total.....		XX	22,314	XX	20,566	XX	22,189	XX	21,321
		XX	186,524	XX	228,131	XX	282,631	XX	313,016

NEBRASKA									
Clays.....	thousand short tons--	126	\$142	148	\$206	149	\$223	90	\$147
Gem stones.....	do.....	NA	5	NA	4	NA	5	NA	5
Lime.....	thousand short tons--	W	W	28	W	35	W	27	W
Natural gas.....	million cubic feet--	8,453	1,454	8,129	1,423	6,989	1,209	5,991	1,024
Natural gas liquids:									
Natural gasoline.....	thousand 42-gallon barrels--	186	578	153	456	128	387	W	W
LP gases.....	do.....	494	1,223	451	911	408	738	365	858
Petroleum (crude).....	do.....	13,373	36,775	13,183	36,775	12,106	36,075	11,451	35,384
Sand and gravel.....	thousand short tons--	11,739	10,878	12,742	12,946	12,758	12,232	12,232	12,974
Stone.....	do.....	4,846	7,483	4,416	7,435	4,665	9,494	4,265	7,378
Value of items that cannot be disclosed: Cement, pumice, and values indicated by symbol W.....									
Total.....		XX	12,330	XX	14,446	XX	16,307	XX	14,387
		XX	70,868	XX	74,608	XX	78,030	XX	72,657

NEVADA									
Antimony ore and concentrate.....	short tons, antimony content--	53	\$35	216	\$1,511	320	\$2,275	192	\$1,455
Barite.....	thousand short tons--	154	923	77,213	64,623	104,924	99,749	106,688	123,118
Copper (recoverable content of ores, etc.).....	do.....	50,771	38,815	NA	100	NA	100	NA	100
Gem stones.....	do.....	NA	100	NA	100	NA	100	NA	100
Gold (recoverable content of ores, etc.).....	troy ounces--	434,909	15,225	317,382	4,120	456,234	4,18,941	480,144	4,17,472
Gypsum.....	thousand short tons--	409	1,412	552	1,534	521	1,550	575	1,457
Iron ore (usable).....	thousand long tons, gross weight--	641	2,858	569	2,917	W	W	W	W
Lead (recoverable content of ores, etc.).....	do.....	1,500	420	863	228	1,420	423	364	114

See footnotes at end of table.





Feldspar.....	long tons.....	60	98	W	W	W	NA	W	NA	18
Gem stones.....	.....	NA	NA	59	NA	NA	8,952	4,326	8,719	317
Gold (recoverable content of ores, etc.).....	.....	5,188	6,630	4,260	8,952	4,326	8,719	4,326	8,719	317
Gypsum.....	.....	155	146	549	141	526	141	526	141	18
Helium.....	.....	NA	NA	NA	NA	NA	NA	NA	NA	NA
Crude.....	million cubic feet.....	2,492	39	1,355	13	260	(7)	260	(7)	18
Grade A.....	.....	W	17	1,113	13	W	W	W	W	W
Iron ore (usable).....	thousand long tons, gross weight.....	W	1,363	360	2,368	705	3,550	705	3,550	1,109
Lead (recoverable content of ores, etc.).....	.....	1,827	27	377	37	W	W	W	W	W
Lime.....	thousand short tons.....	243	6,729	W	4,855	181	4,225	181	4,225	W
Manganese ore (35 percent or more Mn).....	short tons, gross weight.....	W	50,681	379	49,146	340	46,166	340	46,166	W
Manganiferous ore (5 to 35 percent Mn).....	do.....	49,323	348	W	156,000	1,138,133	155,924	1,138,133	155,924	162,874
Natural gas.....	million cubic feet.....	1,067,510	138,776	1,164,182	1,164,182	156,000	1,138,133	155,924	1,138,133	162,874
Natural gas liquids.....	.....	8,050	20,730	8,868	8,868	24,388	9,606	24,388	9,606	25,548
Natural gasoline and cycle products.....	thousand 42-gallon barrels.....	21,647	40,003	34,989	24,920	30,402	25,999	30,402	25,999	37,179
LP gases.....	.....	21,647	40,003	34,989	24,920	30,402	25,999	30,402	25,999	37,179
Peat.....	thousand short tons.....	346,586	3,424	3,706	397,987	4,493	382,456	4,493	382,456	4,321
Pelite.....	do.....	126,144	368,340	378,708	129,227	404,441	128,184	404,441	128,184	410,320
Potassium (crude).....	thousand 42-gallon barrels.....	2,883	91,098	68,406	2,327	62,034	2,490	62,034	2,490	65,877
Potassium salts.....	thousand short tons, K <sub>2</sub> O equivalent.....	2,220	82	1,086	W	415	203	415	203	442
Pumice.....	thousand short tons.....	82	1,086	W	W	415	203	415	203	442
Sand and gravel.....	do.....	14,672	14,336	12,262	12,996	8,574	10,422	10,666	10,666	10,516
Silver (recoverable content of ores, etc.).....	thousand Troy ounces.....	14,672	14,336	12,262	12,996	8,574	10,422	10,666	10,666	10,516
Stone.....	thousand short tons.....	1,391	2,403	2,226	2,226	3,286	3,100	3,286	3,100	3,430
Uranium (recoverable content U <sub>3</sub> O <sub>8</sub> ).....	thousand short tons.....	11,202	89,615	95,144	11,811	69,887	11,574	69,887	11,574	69,870
Vanadium (recoverable in ore and concentrate).....	thousand pounds.....	W	W	W	W	W	W	W	W	W
Zinc (recoverable content of ores, etc.).....	short tons.....	21,380	5,919	5,045	18,686	24,308	7,098	24,308	7,098	5,086
Value of items that cannot be disclosed: Beryllium (1969), cement, fluorspar (1967-70), mica scrap, molybdenum, stone (other dimension 1970), tin (1969), and values indicated by symbol W.....	.....	XX	23,001	XX	XX	23,669	XX	29,150	XX	23,068
Total.....	.....	XX	874,106	XX	XX	893,775	XX	985,746	XX	1,060,358

NEW YORK

Clays.....	thousand short tons.....	1,506	\$1,814	1,675	1,623	\$1,783	1,707	\$1,897	1,707	\$1,897
Gem stones.....	.....	NA	NA	10	NA	NA	NA	NA	NA	10
Gypsum.....	thousand short tons.....	570	3,118	2,925	492	2,945	425	2,737	425	2,737
Lead (recoverable content of ores, etc.).....	.....	1,653	463	1,396	369	502	1,280	400	1,280	400
Lime.....	thousand short tons.....	1,139	10,570	1,086	10,154	10,224	10,224	10,224	10,224	10,224
Mercury.....	76-pound flasks.....	3,837	1,201	4,632	1,890	1,458	28	1,017	28	11
Natural gas.....	million cubic feet.....	23	252	15	153	14	178	15	15	145
Peat.....	thousand short tons.....	1,972	9,026	1,532	7,093	1,256	5,683	1,194	5,397	5,997
Petroleum (crude).....	thousand 42-gallon barrels.....	5,320	41,568	5,218	42,820	45,561	5,990	47,254	5,990	47,254
Salt.....	thousand short tons.....	43,500	44,499	43,439	45,812	39,806	42,518	35,637	42,518	38,839
Sand and gravel.....	do.....	31	48	28	59	32	24	24	24	42
Silver (recoverable content of ores, etc.).....	thousand Troy ounces.....	33,389	56,615	35,441	63,510	37,561	66,839	37,616	66,839	68,118
Stone.....	thousand short tons.....	70,555	19,534	66,194	17,872	17,149	58,577	17,149	58,577	17,947
Zinc (recoverable content of ores, etc.).....	short tons.....	XX	110,620	XX	XX	107,432	XX	115,750	XX	115,750
Value of items that cannot be disclosed: Cement, abrasive garnet, iron ore, talc, titanium concentrate, wollastonite, and values indicated by symbol W.....	.....	XX	299,318	XX	XX	302,480	XX	299,564	XX	299,564
Total.....	.....	XX	299,318	XX	XX	302,480	XX	299,564	XX	299,564

See footnotes at end of table.

Table 5.—Mineral production 1 in the United States, by State—Continued

Mineral	1967		1968		1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NORTH CAROLINA								
Clays <sup>s</sup> .....	2,977	\$2,012	3,310	\$2,148	3,342	\$2,610	3,918	\$3,102
Feldspar.....	265,690	3,113	316,862	4,940	338,149	4,615	345,186	5,173
Gem stones.....	NA	25	NA	20	NA	20	NA	20
Mica.....	70	1,751	69	1,640	67	1,513	64	1,457
Strap.....	4,500	W	15,000	W	W	3	W	3
Sheet.....	10,014	9,962	10,771	11,178	10,562	11,437	12,772	13,277
Sand and gravel.....	24,507	41,438	24,543	42,429	26,812	47,529	30,363	54,121
Stone.....	109,393	513	100,030	520	105,728	586	92,659	544
Talc and pyrophyllite.....								
Value of items that cannot be disclosed: Asbestos, barite (1967-68), cement, clay (kaolin), iron ore (1969-70), lithium minerals, olivine phosphate rock, tungsten (1970), and values indicated by symbol W	XX	18,230	XX	20,544	XX	21,843	XX	20,671
Total.....	XX	77,094	XX	82,819	XX	90,456	XX	98,365
NORTH DAKOTA								
Clays.....	W	W	W	W	W	W	W	W
Coal (lignite).....	4,156	\$7,967	4,487	\$7,986	4,704	\$8,696	5,639	\$11,009
Gem stones.....	NA	1	NA	1	NA	1	NA	1
Natural gas.....	40,462	6,636	41,023	6,769	33,587	5,441	34,889	5,722
Natural gas liquids:.....								
LP gases.....	554	1,443	558	1,479	508	1,346	504	1,376
Petroleum (crude).....	2,111	3,901	2,156	3,622	1,951	2,868	1,840	2,944
Sand and gravel.....	25,315	65,318	25,040	66,106	22,703	63,568	21,998	67,107
Stone.....	8,822	9,118	10,839	10,159	7,039	7,274	8,090	6,336
Value of items that cannot be disclosed: Lime, molybdenum (1967), peat (1968), (1970), salt, uranium (1968), and values indicated by symbol W	596	1,092	165	326	72	99	103	126
Total.....	XX	1,562	XX	1,588	XX	1,755	XX	1,426
OHIO								
Cement:	XX	97,538	XX	98,036	XX	91,048	XX	96,047
Portland.....	14,726	\$46,860	15,222	\$49,814	15,100	\$50,071	11,752	\$39,997
Masonry.....	3,946	1,730	1,063	3,155	1,123	3,527	3,116	3,116
Clays.....	4,670	15,185	4,760	15,216	5,242	11,693	3,920	10,100
Coal (bituminous).....	46,014	176,321	48,323	191,427	51,242	210,082	55,351	262,390
Gem stones.....	NA	3	NA	3	NA	3	NA	3
Lime.....	3,636	48,817	3,701	49,867	4,159	60,975	3,951	61,197
Natural gas.....	41,315	9,957	42,673	10,540	49,793	12,837	52,113	14,123
Peat.....	7	100	7	94	11	116	6	95
Petroleum (crude).....	9,924	31,427	11,204	35,722	10,972	36,098	9,864	32,914
Salt.....	5,407	39,549	5,713	43,172	5,844	43,519	5,329	47,498
Sand and gravel.....	43,196	52,888	46,734	57,671	50,029	64,562	42,069	57,506

Stone	45,458	72,534	348,054	378,772	51,792	86,570	47,244	81,506
Value of items that cannot be disclosed: Abrasive stone, gypsum, stone (dimension limestone and dolomite 1968)	XX	1,917	XX	1,945	XX	1,815	XX	1,721
Total	XX	498,888	XX	536,898	XX	581,868	XX	612,166

OKLAHOMA

Clays <sup>5</sup>	744	\$869	726	\$967	802	\$1,182	769	\$1,120
Coal (bituminous)	823	4,708	1,089	6,401	1,838	10,662	2,427	15,211
Gypsum	804	2,266	931	2,565	980	3,912	874	2,616
Helium:								
Grade A	309	9,835	309	8,700	221	7,717	149	5,214
Crude	2,727	764	2,387	631	133	1,123	245	1,985
Lead (recoverable content of ores, etc.)	1,412,952	202,952	1,890,884	197,506	1,528,715	233,128	1,594,948	248,811
Natural gas liquids:								
Natural gas	13,545	35,846	13,905	38,829	14,821	38,981	14,813	39,983
LP gases	23,944	49,276	25,497	49,202	27,304	34,403	28,029	52,975
Petroleum (crude)	230,749	676,095	223,623	668,202	224,759	701,155	223,574	712,419
Salt	10	76	7	44	9	51	13	78
Sand and gravel	4,540	5,280	5,041	6,288	5,262	7,156	5,675	7,258
Stone	16,355	18,932	17,230	21,950	18,799	23,650	18,177	23,701
Zinc (recoverable content of ores, etc.)	10,670	2,954	6,921	1,869	2,744	801	2,650	812
Value of items that cannot be disclosed: Cement, clay (bentonite), copper, lime, pumice, silver, and tripoli	XX	23,178	XX	23,360	XX	26,758	XX	24,985
Total	XX	1,032,126	XX	1,016,832	XX	1,090,809	XX	1,187,267

OREGON

Clays <sup>5</sup>	295	\$295	213	\$284	215	\$321	134	\$180
Diatomite	108	2	190	750	85	750	500	750
Gastromer	NA	750	NA	750	NA	750	NA	750
Gold (recoverable content of ores, etc.)	186	7	23	41	875	436	256	49
Lime	99	2,059	120	2,407	(7)	2,387	(7)	1,777
Lead	15,287	461	938	502	43	22	274	112
Mercury	W	W	17,294	W	17,056	W	15,983	W
Nickel (content of ore and concentrate)	W	W	(7)	11	---	---	---	---
Peat	W	W	---	---	---	---	---	---
Pearlite	(7)	(7)	---	---	---	---	---	---
Pumice	834	1,195	725	977	875	1,139	1,061	1,252
Sand and gravel	19,680	25,250	18,260	21,457	15,740	20,491	17,832	25,978
Silver (recoverable content of ores, etc.)	(7)	(7)	---	---	---	---	---	---
Stone	13,201	20,256	14,312	21,168	11,662	18,897	13,439	20,948
Talc and soapstone	13,201	W	3	1	W	W	W	W
Value of items that cannot be disclosed: Bauxite (1970), cement, clay (fire clay 1967-70), copper (1968-70), and values indicated by symbol	XX	16,285	XX	16,890	XX	16,162	XX	17,084
Total	XX	66,560	XX	64,449	XX	60,164	XX	68,101

See footnotes at end of table.

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

Mineral	1967		1968		1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
PENNSYLVANIA								
Cement:								
Portland.....	40,197	\$114,592	43,018	\$123,176	44,893	\$126,941	40,909	\$121,100
Masonry.....	2,929	7,948	3,151	8,706	3,955	8,504	2,804	8,324
Clays <sup>2</sup> .....	2,994	16,703	3,034	17,679	2,727	13,637	2,665	19,845
Coal:								
Anthracite.....	12,256	96,160	11,461	97,245	10,473	100,770	9,729	105,341
Bituminous.....	79,412	419,345	76,200	408,982	78,392	461,579	80,491	585,037
Copper (recoverable content of ores, etc.).....	4,401	3,365	4,850	4,059	3,952	3,215	2,339	2,930
Gem stones.....	NA	4	NA	4	NA	4	NA	4
Lime.....	1,719	24,715	1,702	24,272	2,008	28,952	1,887	29,279
Mica, scrap.....	W	W	W	W	W	W	W	W
Natural gas.....	89,966	25,280	87,987	24,460	79,134	21,841	76,841	21,439
Natural gas liquids:								
.....million cubic feet.....								
LP gases.....	28	77	27	73	22	61	19	50
.....thousand 42-gallon barrels.....	42	114	37	95	35	78	34	87
Peat.....	40	437	36	385	35	407	44	517
Petroleum (crude).....	4,387	19,701	4,160	18,698	4,448	20,086	4,093	18,500
Sand and gravel.....	17,479	29,614	18,101	31,076	18,105	31,451	18,504	33,915
Stone.....	60,155	103,157	62,812	108,151	66,992	117,726	66,241	120,187
Zinc (recoverable content of ores, etc.) <sup>3</sup> .....	35,067	9,468	30,382	8,203	33,035	9,646	29,554	9,055
Value of items that cannot be disclosed: Clays (kaolin), cobalt, gold, iron ore, scrap mica, pyrites, pyrophyllite, silver, tripoli, and values indicated by symbol W.....	XX	27,718	XX	28,780	XX	25,470	XX	24,053
Total.....	XX	898,398	XX	904,044	XX	976,368	XX	1,095,743
RHODE ISLAND								
Sand and gravel.....	2,334	\$2,416	2,291	\$2,546	2,480	\$3,015	2,387	\$2,913
Stone.....	481	1,618	W	W	W	1,417	W	W
Value of items that cannot be disclosed: Other nonmetals and values indicated by symbol W.....	XX	1	XX	1,676	XX	1	XX	1,473
Total.....	XX	4,035	XX	4,222	XX	4,433	XX	4,386
SOUTH CAROLINA								
Clays.....	1,733	\$8,048	1,936	\$8,923	2,444	\$10,911	1,974	\$9,878
Sand and gravel.....	5,248	7,178	5,662	8,074	5,992	8,229	5,864	7,766
Stone.....	3,830	32,366	8,942	13,717	8,846	13,506	9,710	34,734
Value of items that cannot be disclosed: Cement, feldspar, kyanite, scrap mica, peat, pyrites, stone (dimension granite (1967-70)), and vermiculite.....	XX	20,682	XX	21,144	XX	23,218	XX	23,987
Total.....	XX	48,274	XX	51,858	XX	55,864	XX	56,365

SOUTH DAKOTA

	W	W	75	\$35	46	\$23	W	W
Beryllium concentrate.....short tons, gross weight..								
Cement:								
Portland.....thousand 376-pound barrels..	1,406	\$4,815	1,826	6,228	1,566	5,715	W	W
Masonry.....thousand 280-pound barrels..	54	178	54	180	49	181	W	W
Clays.....thousand short tons..	199	799	226	1,119	187	1,171	165	\$946
Coal (lignite).....do..	5	27						
Feldspar.....long tons..	61,411	420	39,077	264	29,484	194	17,211	114
Gem stones.....troz ounces..	NA	30	NA	34	NA	36	NA	35
Gold (recoverable content of ores, etc.).....	601,785	21,062	593,052	428,283	593,146	424,621	578,716	421,059
Gypsum.....thousand short tons..	12	49	16	65	11	46	15	61
Lead (recoverable content of ores, etc.).....						( <sup>1</sup> )	3	1
Mica (scrap).....thousand short tons..	W	W	W	W	( <sup>1</sup> )	20	( <sup>1</sup> )	34
Petroleum (crude).....thousand 42-gallon barrels..	211	502	187	401	158	362	160	374
Sand and gravel.....thousand short tons..	13,463	13,737	11,558	11,578	11,158	10,807	16,556	16,656
Silver (recoverable content of ores, etc.).....	121	188	138	295	124	223	120	212
Stone.....thousand short tons..	1,866	9,694	1,860	9,687	2,092	10,839	1,979	13,375
Zinc (recoverable content of ores, etc.).....								( <sup>1</sup> )
Value of items that cannot be disclosed: Columblum-tantalum concen- trates (1967-69), lime, molybdenum (1967), tin (1969), uranium, vanadium (1967, 1970), and values indicated by symbol W.....	XX	1,117	XX	917	XX	683	XX	8,709
Total.....	XX	52,618	XX	54,086	XX	54,921	XX	61,576

TENNESSEE

	15	\$235	21	\$362	16	\$295	19	\$286
Barite.....thousand short tons..								
Cement:								
Portland.....thousand 376-pound barrels..	8,062	25,548	8,488	27,691	9,159	29,403	8,878	29,832
Masonry.....thousand 280-pound barrels..	1,092	2,982	1,370	3,536	1,331	3,587	969	2,749
Clays.....thousand short tons..	1,574	5,152	1,562	5,772	1,719	6,064	1,401	5,723
Coal (bituminous).....do..	6,882	26,974	8,148	29,647	8,082	30,682	8,237	40,372
Copper (recoverable content of ores, etc.).....	14,600	11,162	14,196	11,881	15,353	14,596	18,535	17,928
Gold (recoverable content of ores, etc.).....	181	6	140	45	126	45	124	45
Lead (recoverable content of ores, etc.).....								
Natural gas.....million cubic feet..	58	11	48	9	57	11	64	13
Petroleum (crude).....thousand 42-gallon barrels..	7	W	6	W	32	W	309	W
Phosphate rock.....thousand short tons..	2,992	22,571	3,149	23,628	6,175	9,709	6,715	10,639
Sand and gravel.....do..	7,975	10,679	7,344	11,140	79	141	95	168
Silver (recoverable content of ores, etc.).....	180	202	90	192	89	141	35,374	50,013
Stone.....thousand short tons..	31,463	41,964	32,083	43,864	39,265	46,192	50,013	50,013
Zinc (recoverable content of ores, etc.).....	113,065	31,303	124,039	33,491	124,582	36,363	118,260	36,233
Value of items that cannot be disclosed: Clay (fuller's earth) 1969, lime, pyrites, stone (crushed sandstone 1968), dimension sandstone 1967), and values indicated by symbol W.....	XX	10,779	XX	9,826	XX	27,402	XX	25,104
Total.....	XX	189,572	XX	201,334	XX	205,450	XX	220,465

See footnotes at end of table.



Stone.....	1,831	4,108	1,953	4,812	2,582	4,434	1,650	4,920
Tungsten concentrates.....			W	W	3	6	W	W
Uranium (recoverable content U <sub>3</sub> O <sub>8</sub> ).....	1,287	10,300	1,712	13,175	1,140	6,824	1,635	10,023
Vanadium (recoverable in ore and concentrate).....	471	2,024	563	2,010	W	W	257	W
Zinc (recoverable content of ores, etc.).....	34,251	9,483	33,153	8,951	34,902	10,191	34,688	10,628
Value of items that cannot be disclosed: Asphalt (gilsonite), cement, clays (fire clay 1967, kaolin (1967-68), epsom, magnesium compounds, olivudenum, natural gas liquids, perlite (1967, 1969-70), phosphate rock, potassium salts, pyrites (1967-68), and values indicated by symbol W.....	XX	45,349	XX	44,774	XX	57,507	XX	55,899
Total.....	XX	354,477	XX	423,951	XX	542,489	XX	601,997

VERMONT

Lime.....	W	W	W	W	1,500	\$25		
Peat.....	(?)	\$4	W	W	(?)	4	(?)	\$6
Sand and gravel.....	3,718	2,178	3,587	\$2,806	3,336	3,028	4,046	4,122
Stone.....	2,761	20,520	2,536	21,401	2,151	19,810	1,514	19,088
Value of items that cannot be disclosed: Asbestos, clays, gem stones, lime, talc, and values indicated by symbol W.....	XX	4,566	XX	4,508	XX	4,892	XX	4,627
Total.....	XX	27,268	XX	28,715	XX	27,759	XX	27,843

VIRGINIA

Clays.....	1,382	\$1,623	1,462	\$1,714	1,677	\$1,504	1,693	\$1,672
Coal (bituminous).....	36,721	171,183	36,966	178,946	35,555	192,802	35,016	246,181
Gem stones.....	NA	7	NA	7	NA	7	NA	7
Lime.....	3,430	960	3,573	944	3,358	1,000	3,356	1,048
Lead (recoverable content of ores, etc.).....	829	10,345	919	11,138	1,072	13,653	1,046	14,090
Natural gas.....	3,818	1,149	3,389	1,013	2,846	845	2,805	864
Petroleum (crude).....	3	W	3	W	1	W	1	W
Sand and gravel.....	9,863	12,494	10,859	13,644	12,140	15,954	11,126	15,229
Soapstone.....	W	W	3,928	10	4,600	12	3,760	9
Stone.....	31,324	52,470	31,217	53,533	33,461	58,713	35,415	60,477
Zinc (recoverable content of ores, etc.).....	18,846	5,088	19,257	5,199	18,704	5,462	18,063	5,594
Value of items that cannot be disclosed: Aplite, cement, feldspar, epsom, iron ore (pigment materials 1967-69), kyanite, salt, titanium concentrate, and values indicated by symbol W.....	XX	28,366	XX	29,515	XX	27,575	XX	29,210
Total.....	XX	283,685	XX	295,663	XX	317,527	XX	374,321

WASHINGTON

Barite.....	(?)	\$1						
Cement.....	5,614	20,581	6,928	\$23,030	6,356	\$22,724	6,495	\$24,892
Masonry.....	65	200	56	175	58	204	41	158
Clays.....	139	203	255	263	230	434	240	436
Coal (bituminous).....	59	517	178	823	58	480	37	470
Copper (recoverable content of ores, etc.).....	21	16	22	18	17	9	9	11
Gem stones.....	NA	75	NA	100	NA	150	NA	150
Lead (recoverable content of ores, etc.).....	2,762	773	5,655	1,494	8,649	2,577	6,734	2,119

See footnotes at end of table.



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

Mineral	1967		1968		1969		1970	
	Quantity (thousands)	Value (thousands)	Quantity (thousands)	Value (thousands)	Quantity (thousands)	Value (thousands)	Quantity (thousands)	Value (thousands)
WASHINGTON—Continued								
Peat.....	41	181	40	159	33	134	17	71
Sand and gravel.....	28,164	27,520	31,432	27,839	34,245	31,046	25,089	27,902
Stone.....	14,454	19,099	14,331	15,690	15,742	21,069	13,701	19,100
Talc and soapstone.....	4,916	26	W	W	4,228	W	W	W
Zinc (recoverable content of ores, etc.).....	21,540	5,964	13,884	3,749	9,738	2,843	11,956	3,663
Value of items that cannot be disclosed: Bauxite (1970), carbon dioxide (1967), clays (fire clay, bentonite, diatomite, gold, gypsum (1967-69), lime, magnesite (1967-68), mercury (1968), olivine, pumice, silver, tungsten (1967), uranium (1970), and values indicated by symbol W.....	XX	6,911	XX	7,095	XX	6,948	XX	12,010
Total.....	XX	82,067	XX	81,425	XX	88,626	XX	90,922
WEST VIRGINIA								
Clays <sup>5</sup> .....	245	\$254	193	\$219	247	\$348	191	\$238
Coal (bituminous).....	153,749	800,683	145,921	775,720	141,011	807,811	144,072	1,142,245
Lime.....	217	3,099	207	2,848	269	3,648	262	3,757
Natural gas.....	211,460	50,962	286,971	62,086	231,759	62,575	242,052	61,583
Petroleum (crude).....	3,951	14,244	3,312	13,149	3,104	11,888	3,124	11,871
Salt.....	1,127	5,137	1,308	4,971	1,309	4,978	1,190	5,171
Sand and gravel.....	5,827	12,167	5,657	11,900	r 5,021	r 11,475	4,396	11,473
Stone <sup>5</sup> .....	9,445	16,447	9,011	16,789	9,031	15,801	9,740	16,722
Value of items that cannot be disclosed: Calcium-magnesium chloride (1967), cement, clay (fire clay), gem stones, natural gas liquids, and stone (dimension sandstone).....	XX	34,865	XX	30,026	XX	28,715	XX	32,304
Total.....	XX	937,858	XX	917,708	XX	r 947,239	XX	1,285,364
WISCONSIN								
Clays.....	89	\$112	17	\$34	12	\$24	8	\$14
Iron ore (usable).....	1,596	447	1,126	298	1,102	328	806	W
Lead (recoverable content of ores, etc.).....	212	3,414	254	3,620	244	4,080	761	238
Lime.....	2	W	2	153	2	155	247	4,503
Peat.....	42,542	32,955	39,807	30,903	42,815	35,414	41,103	35,107
Sand and gravel.....	17,122	24,863	17,000	25,223	18,954	27,571	17,577	25,167
Stone.....	23,953	8,016	25,711	6,942	22,901	6,687	20,634	6,322
Zinc (recoverable content of ores, etc.).....	XX	9,805	XX	4,522	XX	5,583	XX	16,319
Value of items that cannot be disclosed: Abrasive stones, cement, gem stones, and values indicated by symbol W.....	XX	79,612	XX	71,695	XX	79,792	XX	87,670

WYOMING

Clays	1,495	\$14,313	1,828	\$17,275	1,982	\$18,970	1,950	\$18,829
Coal (bituminous)	3,588	11,876	3,829	12,117	4,602	15,443	7,222	24,423
do.	NA	125	NA	127	NA	129	NA	130
Gem stones	W	W	W	W	W	W	216	868
Gypsum	1,854	19,186	1,967	19,452	2,048	20,751	22	W
Iron ore (usable)	W	W	28	W	27	W	338,520	49,762
Lime	240,074	35,051	248,481	36,278	303,517	44,617	W	W
Natural gas liquids:								
thousand cubic feet	2,361	6,447	2,381	6,501	2,523	7,051	2,597	7,085
thousand 42-gallon barrels	4,139	7,648	3,917	7,090	4,428	7,085	4,556	7,472
LP gases	136,312	851,686	144,250	380,589	154,845	432,846	160,345	469,811
Petroleum (crude)	8,181	8,253	9,350	8,973	7,588	7,988	9,447	9,298
Sand and gravel	1,246	2,375	1,434	2,764	1,584	3,012	1,268	2,758
Uranium	4,655	37,243	5,928	44,343	6,716	40,318	6,346	38,768
Value of items that cannot be disclosed: Cement, copper (1969), feldspar (1967-68 and 70), gold (1969), gypsum, phosphate rock, pumice (1967), silver (1969), sodium carbonates and sulfates, vanadium (1967), vermiculite (1967), and values indicated by symbol W	XX	36,494	XX	40,691	XX	48,983	XX	76,329
Total	XX	530,696	XX	576,190	XX	647,443	XX	705,533

<sup>c</sup> Estimate. <sup>r</sup> Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data. 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 cement, included with "Value of items that cannot be disclosed."  
<sup>3</sup> Excludes certain stone, included with "Value of items that cannot be disclosed."  
<sup>4</sup> Based on average U.S. Treasury price (\$35.00) Jan. 1, 1968 through Mar. 19, 1968; and Engelhard selling quotations Mar. 20, 1968 through 1970.  
<sup>5</sup> Excludes certain clays, included with "Value of items that cannot be disclosed."  
<sup>6</sup> Excludes salt in brine, included with "Value of items that cannot be disclosed."  
<sup>7</sup> Less than 1/2 unit.  
<sup>8</sup> Recoverable zinc valued at the yearly average price of Prime Western slab, East St. Louis market. Represents value established after transportation, smelting and manufacturing charges have been added to the value of ore at mine.

Table 6.—Mineral production <sup>1</sup> in the Canal Zone and islands administered by the United States <sup>2</sup>

Mineral	1967		1968		1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
American Samoa:								
Pumice.....	28	\$24	21	\$51	2	\$5	2	\$6
Sand and gravel.....	7	20	20	19	7	7	26	25
Stone.....	28	50	53	79	54	108	49	69
Total.....	XX	81	XX	149	XX	120	XX	100
Canal Zone:								
Sand and gravel.....	56	94	55	77	60	97	60	97
Stone (crushed).....	100	245	106	290	74	231	85	265
Total.....	XX	339	XX	367	XX	328	XX	362
Guam: Stone.....	511	820	560	998	654	1,399	626	1,289
Virgin Islands: Stone (crushed).....	183	851	366	1,555	411	1,682	514	2,226
Wake: Stone (crushed).....	31	150	41	132	9	45	4	18

XX. Not applicable.

<sup>1</sup> Production as measured by mine shipments, sales, or marketable production (including consumption by producers).<sup>2</sup> Production data for Wake furnished by U.S. Department of Transportation, Federal Aviation Administration; Guam, by the Government of Guam; American Samoa, by the Government of American Samoa.Table 7.—Mineral production <sup>1</sup> in the Commonwealth of Puerto Rico

Mineral	1967		1968		1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement.....	8,447	\$27,397	8,923	\$27,577	8,943	\$27,920	9,460	\$29,515
Clays.....	291	244	512	481	438	454	429	486
Lime.....	35	1,106	39	1,187	41	1,505	41	W
Salt.....	12	195	32	395	32	395	32	395
Sand and gravel.....	14,101	21,633	16,146	24,723	9,432	23,296	* 9,432	* 23,296
Stone.....	7,269	12,795	7,367	13,580	6,985	13,550	7,296	13,947
Total.....	XX	63,370	XX	67,943	XX	67,120	XX	* 67,639

\* Estimate. 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 withheld.

Table 8.—U.S. exports of principal minerals and products

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>METALS</b>				
<b>Aluminum:</b>				
Ingots, slabs, crude.....short tons..	344,414	\$172,137	408,452	\$214,780
Scrap.....do.....	86,255	33,827	57,159	20,945
Plates, sheets, bars, etc.....do.....	185,707	99,596	137,675	106,913
Castings and forgings.....do.....	4,360	10,473	3,438	9,068
<b>Antimony: Metals and alloys, crude.....do.....</b>	<b>207</b>	<b>216</b>	<b>544</b>	<b>634</b>
<b>Bauxite, including bauxite concentrates</b>				
.....thousand long tons..	r 5	456	3	245
Aluminum sulfate.....short tons..	12,274	367	17,726	578
Other aluminum compounds.....do.....	1,038,680	85,850	1,134,707	92,633
<b>Beryllium.....pounds.....</b>	<b>28,951</b>	<b>630</b>	<b>41,853</b>	<b>1,021</b>
<b>Bismuth: Metals and alloys.....do.....</b>	<b>447,931</b>	<b>1,515</b>	<b>910,275</b>	<b>2,332</b>
<b>Cadmium.....thousand pounds.....</b>	<b>1,085</b>	<b>3,254</b>	<b>373</b>	<b>997</b>
<b>Chrome:</b>				
<b>Ore and concentrates:</b>				
Exports.....thousand short tons..	49	1,915	41	2,582
Reexports.....do.....	150	5,806	73	2,572
Ferrocrome.....do.....	25	5,679	28	8,259
<b>Cobalt.....thousand pounds.....</b>	<b>3,257</b>	<b>5,951</b>	<b>2,699</b>	<b>5,798</b>
<b>Columbium metals, alloys and other forms.....do.....</b>	<b>41</b>	<b>601</b>	<b>46</b>	<b>562</b>
<b>Copper:</b>				
<b>Ore, concentrate, composition metal and unrefined (copper content).....short tons..</b>	<b>5,517</b>	<b>5,113</b>	<b>69,343</b>	<b>65,869</b>
<b>Refined copper and semimanufactures.....short tons..</b>	<b>236,914</b>	<b>303,386</b>	<b>249,217</b>	<b>370,388</b>
Other copper manufactures.....do.....	4,602	6,160	6,057	8,568
Copper sulfate or blue vitriol.....short tons..	3,127	2,385	2,485	1,543
Copper base alloys.....do.....	94,803	111,048	127,593	138,327
<b>Ferroalloys:</b>				
Ferrosilicon.....do.....	6,487	1,666	44,694	11,887
Ferrophosphorous.....do.....	37,351	912	33,106	1,199
<b>Gold:</b>				
Ore and base bullion.....troy ounces..	58,867	2,434	106,117	3,903
Bullion, refined.....do.....	279,434	9,853	968,108	33,887
<b>Iron ore.....thousand long tons.....</b>	<b>5,160</b>	<b>62,310</b>	<b>5,492</b>	<b>67,898</b>
<b>Iron and steel:</b>				
Pig iron.....short tons.....	43,961	2,647	309,746	18,339
<b>Iron and steel products (major):</b>				
Semimanufactures.....do.....	r 4,809,469	r 641,559	6,584,610	846,518
Manufactured steel mill products.....do.....	705,579	322,826	767,140	381,695
Iron and steel scrap: Ferrous scrap, including re-rolling materials.....thousand short tons..	r 9,177	r 302,707	10,364	447,369
<b>Lead:</b>				
Pigs, bars, anodes.....short tons..	4,968	3,913	7,747	4,757
Scrap.....do.....	2,340	505	4,214	1,056
<b>Magnesium: Metal and alloys and semimanufactured forms, n.e.c.....short tons.....</b>	<b>27,372</b>	<b>17,961</b>	<b>35,732</b>	<b>22,542</b>
<b>Manganese:</b>				
Ore and concentrate.....do.....	r 19,796	r 1,589	20,294	2,461
Ferromanganese.....do.....	1,759	483	21,747	4,356
<b>Mercury:</b>				
Exports.....76-pound flasks..	507	294	4,653	2,133
Reexports.....do.....	108	57	50	19
<b>Molybdenum:</b>				
<b>Ore and concentrates (molybdenum content)</b>				
Metals and alloys, crude and scrap.....thousand pounds..	r 57,575	99,055	55,737	95,246
Wire.....do.....	21	70	671	802
Semifabricated forms, n.e.c.....do.....	61	1,083	107	1,252
Powder.....do.....	229	682	133	643
Ferromolybdenum.....do.....	r 44	r 168	329	528
.....do.....	1,455	2,381	2,014	3,088
<b>Nickel:</b>				
Alloys and scrap (including monel metal), ingots, bars, sheets, etc.....short tons..	29,240	64,420	26,007	64,830
Catalysts.....do.....	3,592	7,531	2,524	6,451
Nickel-chrome electric resistance wire.....do.....	746	3,630	870	5,642
Semifabricated forms, n.e.c.....do.....	1,180	6,487	2,055	9,001
<b>Platinum:</b>				
<b>Ore, concentrate, metal and alloys in ingots, bars, sheets, anodes, and other forms, including scrap</b>				
.....troy ounces..	223,569	30,356	270,584	32,978
Palladium, rhodium, iridium, osmiridium, ruthenium, and osmium (metal and alloys including scrap).....troy ounces..	277,495	16,355	143,182	10,034
Platinum group manufactures, except jewelry.....do.....	NA	4,310	NA	5,727
<b>Rare-earths: Cerium ore, metal, alloys and lighter flints.....pounds..</b>	<b>103,169</b>	<b>351</b>	<b>77,523</b>	<b>275</b>

See footnotes at end of table.

Table 8.—U.S. exports of principal minerals and products—Continued

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued				
Silver:				
Ore, concentrates, waste and sweepings thousand troy ounces..	30,952	53,334	10,375	18,102
Bullion, refined.....do....	57,957	103,386	17,239	31,037
Tantalum:				
Ore, metal, and other forms.....thousand pounds..	209	2,652	762	3,884
Powder.....do....	100	2,952	139	4,367
Tin:				
Ingots, pigs, bars, etc:				
Exports.....long tons..	2,362	8,459	4,009	15,222
Reexports.....do....	541	1,927	443	1,701
Tin scrap and other tin-bearing material except tin- plate scrap.....long tons..	5,369	4,825	2,756	2,466
Titanium:				
Ore and concentrate.....short tons..	1,424	183	1,100	297
Sponge (including iodide titanium and scrap) do....	2,802	1,936	2,892	2,583
Intermediate mill shapes and mill products, n.e.c do....	1,773	9,206	1,740	10,435
Dioxide and pigments.....do....	24,507	7,510	26,183	7,944
Tungsten ore and concentrates:				
Exports.....thousand pounds..	7,151	19,829	19,470	61,131
Reexports.....do....			188	341
Vanadium ore and concentrate, pentoxide, etc. (vanadium content).....thousand pounds..	516	1,300	1,946	5,808
Zinc:				
Slabs, pigs, or blocks.....short tons..	9,298	2,612	288	114
Sheets, plates, strips, or other forms, n.e.c do....	2,714	1,746	1,412	1,173
Scrap (zinc content).....do....	1,989	716	3,112	1,049
Semifabricated forms, n.e.c.....do....	28,810	6,321	25,528	5,635
Zirconium:				
Ore and concentrate.....do....	2,698	295	4,380	591
Metals and alloys and other forms.....pounds..	443,462	5,911	600,035	6,284
NONMETALS				
Abrasives:				
Dust and powder of precious or semiprecious stones, including diamond dust and powder thousand carats..	8,122	21,599	7,258	18,711
Crushing bort.....do....	45	265	33	154
Industrial diamonds.....do....	345	1,634	339	1,838
Diamond grinding wheels.....do....	699	3,560	614	3,117
Other natural and artificial, metallic abrasives and products.....do....	NA	43,596	NA	40,518
Asbestos, unmanufactured:				
Exports.....short tons..	34,522	4,626	38,235	5,340
Reexports.....do....	1,651	353	8,350	1,656
Boron: Boric acid, borates, crude and refined.....do....	233,650	24,004	233,200	25,680
Cement.....thousand 376-pound barrels..	589	3,189	847	5,211
Clays:				
Kaolin or china clay.....short tons..	477,674	14,789	816,284	27,294
Fire clay.....do....	162,557	2,621	167,308	3,464
Other clays.....do....	930,237	28,256	1,071,087	35,358
Fluorspar.....do....	3,605	213	14,952	1,145
Graphite.....do....	5,655	682	5,783	701
Gypsum:				
Crude, crushed or calcined.....thousand short tons..	40	2,003	41	1,915
Manufactures, n.e.c.....do....	NA	1,443	NA	1,560
Kyanite and allied minerals.....short tons..	19,696	1,353	24,024	1,622
Lime.....do....	51,006	1,153	53,876	1,391
Mica sheet, waste and scrap and ground.....pounds..	11,810,008	1,274	17,459,607	1,422
Mica, manufactured.....do....	638,830	1,834	1,260,780	3,310
Mineral-earth pigments: Iron oxide, natural and manu- factured.....short tons..	3,992	1,439	4,565	1,621
Nitrogen compounds (major).....thousand short tons..	4,009	184,098	3,421	150,735
Phosphate rock.....do....	11,369	87,418	11,738	89,838
Phosphatic fertilizers (superphosphates) do....	847	33,922	774	28,645
Pigments and compounds (lead and zinc):				
Lead pigments.....short tons..	1,688	686	1,516	649
Zinc pigments.....do....	4,865	1,641	7,867	2,866
Potash:				
Fertilizer.....do....	1,232,636	33,061	966,410	28,490
Chemical.....do....	26,620	4,712	80,377	8,450
Quartz, natural, quartzite, cryolite and chiolite do....	794	165	671	108

See footnotes at end of table.

Table 8.—U.S. exports of principal minerals and products—Continued

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
NONMETALS—Continued				
Salt:				
Crude and refined..... thousand short tons..	716	4,486	423	3,657
Shipments to noncontiguous Territories				
do.....	14	1,200	16	969
Sodium and sodium compounds:				
Sodium sulfate..... do.....	91	2,644	55	1,668
Sodium carbonate..... do.....	324	10,326	336	12,007
Stone:				
Dolomite, block..... do.....	93	1,809	77	1,454
Limestone, crushed, ground, broken				
do.....	1,382	3,189	1,755	3,459
Marble and other building and monumental				
thousand cubic feet..	NA	863	NA	877
Stone, crushed, ground, broken..... thousand short tons..	284	3,569	388	3,288
Manufactures of stone.....	NA	793	NA	1,318
Sulfur:				
Crude..... thousand long tons..	1,549	57,449	1,429	33,096
Crushed, ground, flowers of..... do.....	2	334	4	955
Talc, crude and ground..... short tons..	69,022	3,713	104,946	5,738
MINERAL FUELS				
Carbon black..... thousand pounds..	196,203	22,915	192,636	24,505
Coal:				
Anthracite..... thousand short tons..	627	8,420	789	11,215
Bituminous..... do.....	56,234	585,452	70,908	950,232
Briquets..... do.....	73	3,952	69	3,736
Coke..... do.....	1,629	38,510	2,514	78,885
Petroleum:				
Crude..... thousand barrels..	1,436	3,694	4,991	17,225
Gasoline..... do.....	1,874	14,475	1,049	10,362
Jet..... do.....	326	1,323	63	228
Naphtha..... do.....	3,224	24,638	2,052	19,249
Kerosine..... do.....	151	1,312	118	973
Distillate oil..... do.....	2,403	8,849	1,631	5,555
Residual oil..... do.....	16,766	34,005	19,801	45,734
Lubricating oil..... do.....	16,089	186,814	15,712	189,374
Asphalt..... do.....	413	3,615	399	4,668
Liquefied petroleum gases..... do.....	12,781	34,297	9,932	31,674
Wax..... do.....	1,616	32,724	1,783	40,862
Coke..... do.....	23,028	74,176	30,515	97,654
Petrochemical feedstocks..... do.....	3,829	18,170	3,754	19,856
Miscellaneous..... do.....	908	18,651	1,061	21,331
Total.....	XX	4,412,016	XX	5,455,967

† Revised. NA Not available. XX Not applicable.

Table 9.—U.S. imports for consumption of principal minerals and products

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>METALS</b>				
<b>Aluminum:</b>				
Metal..... short tons..	468,236	\$214,845	350,060	\$164,227
Scrap..... do.....	28,850	11,003	36,779	12,979
Plates, sheets, bars, etc..... do.....	r 57,168	r 38,437	78,660	53,836
Aluminum oxide (alumina)..... do.....	1,912,474	106,333	2,554,807	152,537
<b>Antimony:</b>				
Ore (antimony content)..... do.....	12,098	5,248	13,820	12,733
Needle or liquated..... do.....	62	51	18	54
Metal..... do.....	980	888	1,290	3,493
Oxide..... do.....	4,715	3,852	4,256	10,023
Arsenic: White (As <sub>2</sub> O <sub>3</sub> content)..... do.....	18,171	2,064	18,763	2,089
Bauxite: Crude..... thousand long tons..	r 12,160	r 165,639	12,620	156,362
Beryllium ore..... short tons.....	6,422	2,648	4,942	1,912
Bismuth..... pounds.....	r 894,804	r 3,712	997,924	5,636
Boron carbide..... do.....	422,133	883	52,652	166
<b>Cadmium:</b>				
Metal..... thousand pounds.....	1,078	3,166	2,492	7,800
Flue dust (cadmium content)..... do.....	1,115	1,495	1,111	2,438
<b>Calcium:</b>				
Metal..... pounds.....	r 662,200	r 619	164,769	141
Chloride..... short tons.....	9,226	350	8,280	359
<b>Chromate:</b>				
Ore and concentrates (Cr <sub>2</sub> O <sub>3</sub> content)..... thousand short tons..	506	20,030	647	31,805
Ferrochrome..... do.....	r 37	r 12,394	26	9,620
Metal..... do.....	1	2,072	2	3,052
<b>Cobalt:</b>				
Metal..... thousand pounds.....	12,037	21,725	11,873	26,020
Oxide (gross weight)..... do.....	1,175	2,023	710	1,394
Salts and compounds (gross weight)..... thousand pounds.....	131	67	157	92
Columbium ore..... do.....	4,161	2,681	5,719	4,345
<b>Copper: (copper content):</b>				
Ore and concentrates..... short tons.....	3,588	3,274	64,540	77,367
Regulus, black, coarse..... do.....	6	17	247	346
Unrefined, black, blister..... do.....	241,712	233,265	224,289	245,778
Refined in ingots, etc..... do.....	131,171	132,573	132,143	146,093
Old and scrap..... do.....	r 5,692	r 5,183	2,308	2,044
<b>Ferrous alloys: Ferrosilicon (silicon content)..... do.....</b>	16,944	4,577	10,060	4,117
<b>Gold:</b>				
Ore and base bullion..... troy ounces.....	236,738	9,064	286,988	9,992
Bullion..... do.....	5,624,649	227,842	6,365,380	227,472
Iron ore..... thousand long tons.....	r 40,732	r 402,178	44,876	479,380
<b>Iron and steel:</b>				
Pig iron..... short tons.....	r 404,888	r 18,445	249,241	13,729
Iron and steel products (major):				
Iron products..... do.....	35,012	9,604	28,609	9,886
Steel products..... do.....	13,983,804	1,758,171	13,809,116	2,362,493
Scrap..... do.....	311,350	r 12,571	279,586	10,609
Tinplate..... do.....	23,849	917	21,707	591
<b>Lead:</b>				
Ore, flue dust, matte (lead content)..... do.....	115,286	22,697	42,606	8,360
Base bullion (lead content)..... do.....	1,993	699	1,177	448
Pigs and bars (lead content)..... do.....	278,873	72,104	244,623	73,397
Reclaimed scrap, etc. (lead content)..... do.....	6,682	1,513	2,981	798
Sheets, pipe and shot..... do.....	518	174	513	241
<b>Magnesium:</b>				
Metallic and scrap..... do.....	3,515	1,913	2,948	1,566
Alloys (magnesium content)..... do.....	467	1,175	122	306
Sheets, tubing, ribbons, wire, other forms (magnesium content)..... short tons.....	r 334	r 1,168	225	637
<b>Manganese:</b>				
Ore (35 percent or more manganese) (manganese content)..... short tons.....	r 979,708	r 39,136	846,706	34,263
Ferromanganese (manganese content)..... do.....	r 239,144	r 32,281	226,979	31,563
<b>Mercury:</b>				
Compounds..... pounds.....	r 13,510	r 16	196	3
Metal..... 76-pound flasks.....	31,924	15,207	21,972	9,101
<b>Minor metals: Selenium and salts..... pounds.....</b>	r 564,266	r 3,380	461,974	4,329
<b>Nickel:</b>				
Pigs, ingots, shot, cathodes..... short tons.....	r 99,656	r 209,476	117,371	302,821
Scrap..... do.....	r 3,184	r 8,077	2,149	4,485
Oxide..... do.....	4,013	6,524	6,423	12,611

See footnotes at end of table.

Table 9.—U.S. imports for consumption of principal minerals and products—Continued

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued				
Platinum group:				
Unwrought:				
Grains and nuggets (platinum)				
troy ounces.....	67,560	9,741	28,937	3,828
Sponge (platinum).....do.....	272,794	33,665	346,069	39,585
Sweepings, waste and scrap				
troy ounces.....	127,053	5,422	64,096	6,578
Iridium.....do.....	5,938	1,027	8,459	1,239
Palladium.....do.....	249,389	10,410	270,134	9,896
Rhodium.....do.....	38,077	8,615	38,626	7,541
Ruthenium.....do.....	7,566	391	20,816	984
Other platinum group metals				
do.....	11,602	1,696	9,242	495
Semimanufactured:				
Platinum.....do.....	58,249	8,018	124,867	16,323
Palladium.....do.....	382,783	14,280	503,822	17,532
Rhodium.....do.....	3,387	444	4,986	428
Other platinum group metals				
do.....	1,453	190	3,036	442
Radium: Radioactive substitutes.....	NA	4,697	NA	3,472
Rare-earths: Ferrocerium and other cerium alloys				
pounds.....	17,328	91	9,373	54
Silver:				
Ore and base bullion.....thousand troy ounces.....	32,332	48,115	29,246	45,040
Bullion.....do.....	39,544	71,247	29,569	52,637
Tantalum ore.....thousand pounds.....	975	3,196	1,046	3,231
Tin:				
Ore (tin content).....long tons.....			4,667	13,987
Blocks, pigs, grains, etc.....do.....	54,950	185,037	50,554	187,662
Dross, skimmings, scrap, residues and tin alloys, n.s.p.f.....long tons.....	948	1,052	776	275
Tin foil, powder, flitters, etc.....do.....	NA	3,458	NA	4,311
Titanium:				
Ilmenite.....short tons.....	398,903	9,453	261,683	6,812
Rutile.....do.....	204,907	16,207	243,269	19,813
Metal.....pounds.....	13,211,214	11,735	14,190,209	13,480
Ferrotitanium.....do.....	1,103,148	259	146,300	48
Compounds and mixtures.....do.....	107,157,550	19,410	121,000,983	22,566
Tungsten: (tungsten content):				
Ore and concentrates.....thousand pounds.....	1,503	3,445	1,284	3,176
Metal.....do.....	33	65	35	173
Other alloys.....do.....	30	552	190	1,560
Zinc:				
Ore (zinc content).....short tons.....	565,234	79,242	450,770	67,164
Blocks, pigs, slabs.....do.....	324,758	84,617	260,132	73,695
Sheets.....do.....	840	380	692	419
Old, dross, skimmings.....do.....	2,486	322	1,915	284
Dust.....do.....	8,251	2,652	9,359	3,161
Manufactures.....do.....	NA	489	NA	1,276
Zirconium: Ore, including zirconium sand				
do.....	95,414	3,858	94,759	3,704
NONMETALS				
Abrasives: Diamonds (industrial)				
thousand carats.....	14,076	52,821	13,365	49,037
Asbestos.....short tons.....	694,558	76,422	649,402	75,146
Barite:				
Crude and ground.....do.....	616,573	5,783	707,028	6,360
Witherite.....do.....	459	22	182	35
Chemicals.....do.....	6,952	1,154	7,238	1,173
Cement.....thousand 376-pound barrels.....	9,687	24,376	13,812	34,176
Clays:				
Raw.....short tons.....	76,698	1,541	81,393	1,610
Manufactured.....do.....	5,190	209	5,147	192
Cryolite.....do.....	20,406	4,251	21,377	4,666
Feldspar: Crude.....long tons.....	46	7	225	23
Fluorspar.....short tons.....	1,149,546	32,818	1,092,318	32,758
Gem stones:				
Diamonds.....thousand carats.....	4,690	504,647	4,275	424,897
Emeralds.....do.....	309	9,175	326	7,715
Other.....do.....	NA	52,871	NA	53,431
Graphite.....short tons.....	58,459	2,419	66,449	3,027
Gypsum:				
Crude, ground, calcined				
thousand short tons.....	5,860	12,481	6,130	13,829
Manufactures.....do.....	NA	2,121	NA	2,684
Iodine, crude.....thousand pounds.....	5,705	5,753	5,905	6,819
Kyanite.....short tons.....	2,088	88	1,179	56

See footnotes at end of table.



Table 9.—U.S. imports for consumption of principal minerals and products—Continued

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
NONMETALS—Continued				
Lime:				
Hydrated.....short tons..	39,270	\$542	34,158	\$479
Other.....do.....	144,471	1,911	167,432	1,946
Magnesium compounds:				
Crude magnesite.....do.....	r 18	r (2)	21	(2)
Lump, ground, caustic calcined magnesia short tons..	15,238	983	11,476	702
Refractory magnesia, dead-burned, fused mag- nesite, dead-burned dolomite.....short tons..	r 97,335	6,481	128,193	9,032
Compounds.....do.....	48,719	1,251	39,876	1,336
Mica:				
Uncut sheet and punch.....thousand pounds..	1,601	1,695	875	966
Scrap.....do.....	3,078	74	6,048	136
Manufactures.....do.....	5,520	3,060	4,530	2,549
Mineral-earth pigments, Iron oxide pigments:				
Natural.....short tons..	2,736	225	2,115	155
Synthetic.....do.....	22,555	4,390	24,138	5,264
Ocher, crude and refined.....do.....	87	6	62	4
Siennas, crude and refined.....do.....	1,341	146	1,051	115
Umber, crude and refined.....do.....	6,240	235	4,833	171
Vandyke brown.....do.....	472	42	435	50
Nitrogen compounds (major), including urea thousand short tons..	r 1,803	r 88,733	2,495	119,176
Phosphate, crude.....do.....	140	3,554	136	3,790
Phosphatic fertilizers.....do.....	83	3,976	110	5,679
Pigments and salts:				
Lead pigments and compounds.....short tons..	32,473	7,984	22,591	5,845
Zinc pigments and compounds.....do.....	23,518	4,476	20,766	4,106
Potash.....do.....	r 3,978,422	r 67,094	4,418,064	101,337
Pumice:				
Crude or unmanufactured.....do.....	8,424	r 60	10,639	74
Wholly or partly manufactured.....do.....	375,861	819	354,681	902
Manufactures, n.s.p.f.....do.....	NA	61	NA	29
Quartz crystal (Brazilian pebble).....pounds..	1,291,003	477	975,679	421
Salt.....thousand short tons..	3,302	11,990	3,536	13,329
Sand and gravel:				
Glass sand.....do.....	43	194	64	262
Other sand and gravel.....do.....	r 855	1,253	815	1,338
Sodium sulfate.....do.....	236	4,808	269	4,753
Stone and whiting.....do.....	NA	r 30,543	NA	35,674
Strontium: Mineral.....short tons..	27,803	595	37,254	827
Sulfur and pyrites:				
Sulfur ore and other forms n.e.s. thousand long tons..	r 1,675	57,222	1,537	34,149
Pyrites.....do.....	99	322	197	662
Talc: Unmanufactured.....short tons..	20,358	749	29,988	1,294
MINERAL FUELS				
Carbon black:				
Acetylene.....pounds..	7,097,186	1,220	5,876,221	1,103
Gas black and carbon black.....do.....	1,129,280	165	168,997	39
Coal:				
Bituminous, slack, culm, lignite.....short tons..	r 108,904	1,081	36,441	457
Briquets.....do.....	1,351	18	3,208	93
Coke.....do.....	173,052	3,354	152,879	3,531
Peat:				
Fertilizer grade.....do.....	297,364	13,631	281,429	13,398
Poultry and stable grade.....do.....	2,633	121	1,782	104
Petroleum:				
Crude oil.....thousand barrels..	r 514,114	1,120,191	483,293	1,048,746
Gasoline.....do.....	22,709	87,203	24,320	101,658
Special naphtha.....do.....	3,191	8,233	2,111	5,193
Kerosine.....do.....	965	2,567	1,451	4,614
Distillate fuel oil.....do.....	78,275	223,867	79,510	218,653
Residual fuel oil.....do.....	461,611	987,843	557,845	1,227,259
Military jet fuel.....do.....	5,134	15,813	7,060	21,745
Commercial jet fuel.....do.....	40,405	124,447	44,992	163,771
Liquefied gases.....do.....	12,651	20,373	21,419	39,625
Asphalt.....do.....	4,761	10,284	6,201	13,394
Unfinished oil.....do.....	r 38,766	87,798	39,261	110,323
Lubricants.....do.....	163	1,535	224	2,110
Wax.....do.....	158	799	117	591
Petrochemical feed stocks.....do.....	40	106	5,195	13,766
Total.....	XX	r 8,304,493	XX	9,435,163

r Revised. NA Not available. XX Not applicable.

1 Includes titanium slag averaging about 70 percent TiO<sub>2</sub>. For detail see Titanium Chapter, table 9.

2 Less than 1/2 unit.

Table 10.—Comparison of world and United States production of principal metals and minerals

Mineral	1969			1970 <sup>p</sup>		
	World <sup>r 1</sup>		United States Percent of world	World <sup>1</sup>		United States Percent of world
	Thousand short tons (unless otherwise stated)			Thousand short tons (unless otherwise stated)		
<b>MINERAL FUELS</b>						
Carbon black... thousand pounds..	5,703,294	2,968,261	52	5,878,769	2,931,153	50
Coal:						
Bituminous.....	<sup>2</sup> 2,134,471	555,493	26	<sup>2</sup> 2,218,464	596,970	27
Lignite.....	837,472	5,012	1	867,984	5,963	1
Pennsylvania anthracite.....	199,020	10,473	5	201,622	9,729	5
Coke (excluding breeze):						
Gashouse <sup>3</sup> .....	29,857	-----	NA	27,619	-----	-----
Oven and beehive.....	366,210	64,757	18	382,510	66,525	17
Natural gas (marketable)						
million cubic feet.....	34,325,102	20,698,240	60	37,820,609	21,920,642	58
Peat.....	203,536	572	( <sup>4</sup> )	217,471	517	( <sup>4</sup> )
Petroleum (crude)						
thousand barrels.....	15,214,038	3,371,752	22	16,689,617	3,517,450	21
<b>NONMETALS</b>						
Asbestos.....	3,640	126	3	3,826	125	3
Barite.....	4,235	1,077	25	4,221	854	20
Cement						
thousand 376-pound barrels..	3,179,863	<sup>5</sup> 416,652	13	3,350,142	<sup>5</sup> 406,721	12
China clay.....	13,847	<sup>6</sup> 4,739	34	14,390	<sup>6</sup> 4,926	34
Corundum.....	7	-----	-----	8	-----	-----
Diamonds..... thousand carats..	40,863	-----	-----	42,355	-----	-----
Diatomite.....	1,785	598	34	1,783	598	34
Feldspar..... thousand long tons..	2,345	674	29	2,298	648	28
Fluorspar.....	4,229	183	4	4,600	269	6
Graphite.....	424	W	NA	417	W	NA
Gypsum.....	56,481	9,905	18	55,551	9,436	17
Lime (sold or used by producers)...	99,067	<sup>5</sup> 20,250	20	105,829	<sup>5</sup> 19,788	19
Magnesite.....	12,670	W	NA	13,847	W	NA
Mica (including scrap)						
thousand pounds.....	351,655	266,115	76	347,426	238,000	69
Nitrogen, agricultural <sup>7</sup> .....	31,649	<sup>5</sup> 7,869	25	33,730	<sup>5</sup> 8,413	25
Phosphate rock.....	90,062	37,725	42	93,858	38,739	41
Potash (K <sub>2</sub> O equivalent).....	18,810	2,804	15	20,443	2,729	13
Pumice <sup>8</sup> .....	16,279	3,609	22	16,036	3,134	20
Pyrites..... thousand long tons..	20,599	W	NA	21,810	W	NA
Salt.....	148,789	<sup>5</sup> 44,277	30	156,365	<sup>5</sup> 45,836	29
Strontium <sup>8</sup> .....	31	-----	-----	39	-----	-----
Sulfur, elemental						
thousand long tons.....	20,771	8,560	41	21,748	8,531	39
Talc, pyrophyllite, and soapstone..	5,137	1,029	20	5,306	1,028	19
Vermiculite <sup>8</sup> .....	466	310	67	432	285	66
<b>METALS, MINE BASIS</b>						
Antimony (content of ore and concentrate)..... short tons..	73,044	938	1	73,152	1,130	2
Arsenic, white <sup>8</sup> .....	56	W	NA	56	W	NA
Bauxite..... thousand long tons..	51,803	<sup>9</sup> 1,843	4	57,072	2,082	4
Beryllium concentrate..... short tons..	8,834	W	NA	8,197	W	NA
Bismuth..... thousand pounds..	8,460	W	NA	8,918	W	NA
Cadmium..... do.....	38,653	<sup>10</sup> 12,646	33	35,245	<sup>10</sup> 9,465	27
Chromite.....	5,896	-----	-----	6,527	-----	-----
Cobalt (contained).....	22	W	NA	26	W	NA
Columbium-tantalum concentrates <sup>8</sup>						
thousand pounds.....	34,557	W	NA	43,898	W	NA
Copper (content of ore and concentrate).....	6,213	<sup>11</sup> 1,545	25	6,527	<sup>11</sup> 1,720	26
Gold..... thousand troy ounces..	46,526	1,733	4	47,356	1,743	4
Iron ore..... thousand long tons..	707,183	<sup>12</sup> 88,328	12	754,299	<sup>12</sup> 89,760	12
Lead (content of ore and concentrate).....	3,569	<sup>11</sup> 509	14	3,751	<sup>11</sup> 572	15
Manganese ore (35 percent or more Mn).....	19,196	6	( <sup>4</sup> )	20,390	5	( <sup>4</sup> )
Mercury						
thousand 76-pound flasks.....	290	30	10	284	27	10
Molybdenum (content of ore and concentrate)..... thousand pounds..	142,639	99,807	70	163,648	111,352	68
Nickel (content of ore and concentrate).....	533	16	3	685	15	2
Platinum groups (Pt, Pd, etc.)						
thousand troy ounces.....	3,431	22	( <sup>4</sup> )	4,216	17	( <sup>4</sup> )
do.....	290,469	41,906	14	301,740	45,006	15
Tin (content of ore and concentrate)..... long tons..	224,079	W	NA	226,569	W	NA
Titanium concentrates:						
Ilmenite <sup>8</sup> .....	3,542	931	26	3,942	868	22
Rutile <sup>8</sup> .....	437	-----	NA	460	-----	NA

See footnotes at end of table.

Table 10.—Comparison of world and United States production of principal metals and minerals—Continued

Mineral	1969			1970 <sup>⒅</sup>		
	World <sup>Ⓐ</sup>	United States		World <sup>Ⓐ</sup>	United States	
	Thousand short tons (unless otherwise stated)	Percent of world		Thousand short tons (unless otherwise stated)	Percent of world	
<b>METALS, MINE BASIS—Continued</b>						
Tungsten concentrate (contained tungsten)-----short tons	35,375	3,452	10	37,009	4,053	11
Vanadium (content of ore and concentrate) <sup>Ⓒ</sup> -----short tons	14,830	5,577	38	16,448	5,319	32
Zinc (content of ore and concentrate)-----	5,892	553	9	6,061	534	9
<b>METALS, SMELTER BASIS</b>						
Aluminum-----	9,932	3,793	38	10,655	3,976	37
Copper-----	6,622	<sup>13</sup> 1,585	24	6,877	<sup>13</sup> 1,641	24
Iron, pig (including ferroalloys)-----	456,577	97,632	21	479,151	94,808	20
Lead-----	3,561	<sup>14</sup> 639	18	3,637	667	18
Magnesium-----short tons	221,748	99,887	45	243,250	112,007	46
Selenium <sup>Ⓒ</sup> -----thousand pounds	2,789	1,247	45	2,392	1,005	42
Steel ingots and castings-----	632,010	<sup>15</sup> 41,262	22	652,735	<sup>15</sup> 131,514	20
Tellurium <sup>Ⓒ</sup> -----thousand pounds	395	234	59	357	158	44
Tin <sup>16</sup> -----long tons	223,426	345	( <sup>4</sup> )	222,296	NA	NA
Uranium oxide (U <sub>3</sub> O <sub>8</sub> ) <sup>Ⓒ</sup> -----						
Zinc-----short tons	23,056	12,281	53	23,707	12,768	54
Zinc-----	5,472	1,041	19	5,407	878	16

<sup>⒅</sup> Preliminary. <sup>Ⓐ</sup> Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data.

<sup>1</sup> Total is not strictly comparable with previous years because it does not represent total world production. Confidential U.S. data are excluded. The data include reported figures and reasonable estimates in some instances where data were not available, no reasonable estimate could be made and none has been included except for gold, silver, and pyrites.

<sup>2</sup> Includes small quantities of lignite for mainland China, Mongolia, North Korea, and Pakistan, and anthracite for Colombia.

<sup>3</sup> Includes low- and medium-temperature and gashouse coke.

<sup>4</sup> Less than 1/2 unit.

<sup>5</sup> Includes Puerto Rico.

<sup>6</sup> Kaolin sold or used by producers.

<sup>7</sup> Year ended June 30 of year stated (United Nations).

<sup>8</sup> World total exclusive of U.S.S.R.

<sup>9</sup> Dry bauxite equivalent of crude ore.

<sup>10</sup> Includes secondary.

<sup>11</sup> Recoverable.

<sup>12</sup> Iron-nickel ore.

<sup>13</sup> Smelter output from domestic and foreign ores, exclusive of scrap. Production from domestic ores only, exclusive of scrap, was as follows: 1968, 1,233,951; 1969, 1,547,494.

<sup>14</sup> Lead refined from domestic and foreign ores, excludes lead refined from imported base bullion.

<sup>15</sup> Data from American Iron and Steel Institute. Excludes production of castings by companies that do not produce steel ingots.

<sup>16</sup> Includes tin content of alloys made directly from ores.

# Injury Experience and Worktime in the Mineral Industries By States

By Forrest T. Moyer<sup>1</sup>

The overall safety record of the mineral mining and processing industries in 1970 worsened in all general measures of injury experience. There were more disabling injuries, both fatal and nonfatal, than in 1969. The frequency rate of 18.17 injuries per million man-hours and the severity rate of 2,593 days lost per million man-hours in 1970 were, respectively, 5 and 7 percent higher than in 1969. Operating activity, as measured by man-hours worked, was 2 percent higher in 1970.

These data comprise the injury and work experience of all personnel engaged in production, exploration, development, maintenance, repair, and force-account construction work, including supervisory and technical personnel and working partners and owners, at mineral-producing and mineral-processing establishments in the United States. Data concerning officeworkers are excluded except for the oil and gas industry, for which such information is not

separable. All injury rates and totals are calculated from data before rounding. The data for 1970 are preliminary except for the coke, oil and natural gas, peat, and slag industries, which are final. The figures represent full coverage for all industries except oil and gas, for which coverage is not complete particularly with respect to small companies.

Injury and worktime data were collected from coal producers as required by the Federal Coal Mine Health and Safety Act of 1969 (Public Law 91-173; 30 U.S.C. 801-960). Similar information was collected as required by the Federal Metal and Nonmetallic Mine Safety Act (Public Law 89-577; 30 U.S.C. 721-740, Supp. III (1968)) from metal, nonmetal, stone, and sand and gravel producers. Mineral and mineral-fuel producers and processors, not covered under either of the acts, voluntarily reported the requested injury and worktime data.

## INJURY EXPERIENCE

The rate of occurrence for all injuries, 18.17 per million man-hours, comprised frequency rates of 0.30 for fatal and 17.88 for nonfatal injuries in 1970. The fatality rate retrogressed by 11 percent from that of 0.27 in 1969. For nonfatal injuries, the frequency rate worsened by 5 percent from the corresponding rate of 17.10 in 1969.

The 7-percent increase in the injury-severity rate to 2,593 in 1970 resulted largely from the higher number of fatal injuries. The total of 573 work fatalities was 63 more than in 1969. The worsened fatality experience resulted principally from four major disasters (a single accident which results in the death of five or more persons) in 1970, whereas there were no

major disasters in 1969. In the coal industry in 1970, a dust explosion in the underground workings of a bituminous coal mine in Kentucky killed 38 men. In the oil-gas industries, a premature detonation of experimental explosives at a research department site in Oklahoma claimed the lives of five company employees (in addition, four employees from other industries were killed), an oil-well blowout at a drilling department site in Texas killed five men, and the rupturing of a liquid-full vessel at the base of a fractionator tower at a refinery in Pennsylvania killed seven men.

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Nonfatal injuries for all mineral mining and processing industries totaled 34,515 in 1970, or 2,275 more than in 1969; as a result, the frequency rate for these injuries retrogressed.

**Industry Data.**—The safety records of the separate mineral industries displayed varying trends in 1970, as shown in the summary section at the end of table 1. Information on the major mineral industry segments in this chapter is broken down to specific component industries in a companion chapter in Volume I of the Minerals Yearbook.

In the coal-mining industry, the frequency rate of 42.55 per million man-hours for all injuries was virtually the same as in 1969. However, the injury-severity rate of 7,963 days lost per million man-hours was appreciably worse than in 1969, owing to the increased number of fatalities. For the metal-mining industry, the rate of injury occurrence retrogressed to 25.60 in 1970, but the severity rate of 3,514 was better because of the reduced number of fatal injuries. Both the frequency (26.12) and severity (2,855) rates of injuries at nonmetal mines and mills in 1970 worsened from the corresponding data in 1969. At sand and gravel operations, the injury-frequency rate of 20.81 remained at the same level as in 1969, and with the lower number of fatal injuries, the severity rate was moderately better in 1970. There were 10 fewer fatalities in 1970 at stone operations, as a result, the injury-severity rate of 2,300 was appreciably better than in 1969. However, the injury-frequency rate for the stone industries worsened to 19.77 in 1970.

Injury experience in the oil and natural gas industries worsened appreciably in 1970, and the injury rates increased to 10.41 for frequency and 1,281 for severity, 7 and 30 percent worse, respectively, than in 1969. At coal-coking plants in 1970, the injury-frequency rate increased to 6.78, but the severity rate of 1,562 was markedly better than in 1969. All general measures of injury experience for the primary nonferrous smelting and refining industries were better than in 1969, and the injury frequency and severity rates were lowered, respectively, to 12.34 and 1,036 in 1970.

**Mine Data.**—All general measures of injury experience at underground mines and at mill activities of the solid mineral area worsened appreciably in 1970. At surface

mines fatality experience was improved, but the nonfatal injury record was worse than in 1969.

At all underground mines (including the associated surface shops and yards), the total of 280 fatal injuries with a frequency rate of 1.08 was sharply worse than the 227 fatalities at a rate of 0.92 in 1969. One major disaster in 1970 claimed 38 lives, whereas there were no disasters in 1969. Owing to the regression in fatality experience, the severity rate for all injuries increased to 8,619 from 8,081 in 1969. The total of 12,330 nonfatal injuries was 834 more than in 1969, and the frequency rate for these injuries increased to 47.63 from 46.76.

General measures of injury experience for surface mines were mixed. The totals of 103 fatal and 5,555 nonfatal injuries were, respectively, 12 percent lower and 3 percent higher than in 1969. The frequency rate of 0.36 for fatal injuries was 12 percent below that of 0.41 in 1969. The nonfatal-injury-frequency rate for 1970 was 3 percent higher than in 1969. The overall severity rate of 3,106 for surface mines was 10 percent better than in 1969.

All general measures of safety performance in milling and cleaning activities in the solid mineral area worsened in 1970. The totals of 39 fatal and 4,780 nonfatal injuries were, respectively, 3 and 7 percent higher than in 1969. Similarly, the frequency rates of 0.16 for fatalities and 0.16 for nonfatal injuries, as well as the overall severity rate of 1,824, were higher than the corresponding data for 1969.

**State Data.**—In States with large mineral industry activity (more than 5 million man-hours of worktime), the mineral industry of Idaho, in which metal mining is dominant, had the highest injury-frequency rate in any State during 1970. The rate of 57.43 injuries per million man-hours was 3 percent higher than that reported in 1969. Mineral mines and processing or cleaning plants in West Virginia, where coal mining predominates, ranked second highest in injury frequency, with a rate of 55.79. In Virginia and Colorado, the mineral industries had frequency rates of 41.15 and 39.72, respectively, the third and fourth highest of any State.

Mineral mines and processing plants in Kentucky in 1970 had a higher injury-severity rate, 13,530 days lost per million man-hours, than these industries in any

other State. This high severity rate resulted largely from a coal mine disaster which killed 38 men in December. The next highest injury-severity rates in States with more than 5 million man-hours of work in 1970 were experienced by mineral operations in Virginia (8,176), West Virginia (7,478), Illinois (5,140), and Colorado (5,059).

The mineral industries of Kentucky had a higher total of work fatalities, 89, in 1970 than these industries in any other State. States ranking next in number of mineral industry fatalities during 1970 were West Virginia (67), Pennsylvania (44), Virginia (31), and Illinois (19). States ranked by number of nonfatal injuries in mines and processing plants during 1970 were West Virginia (4,450), Pennsylvania (2,112), Kentucky (1,626), Virginia (1,186), and Illinois (1,039).

Of the States with major mineral industry activity (more than 5 million man-

hours of worktime) in 1970, mines and plants had the lowest injury-frequency rates in Minnesota (8.49), Alabama (12.24), Florida (12.81), Wyoming (13.95), and Louisiana (17.28). Similarly, the most favorable injury-severity rates were for the mineral industries in Kansas (496), Arkansas (1,364), Iowa (1,432), Florida (1,791), and Wyoming (1,679).

In 1970, the relative size of the mineral mining and milling activity in the ranking States, as measured by worktime in millions of man-hours, was as follows: West Virginia (81.0), Pennsylvania (80.7), Kentucky (44.2), Ohio (37.2), and Arizona (36.7). States with the largest number of man-hours worked (in millions) within major groupings of the mineral industries were as follows: Coal—West Virginia (77.7), metal—Arizona (32.7), nonmetals—California (9.1), stone—Pennsylvania (18.1), and sand and gravel—California (11.0).

## ACTIVE OPERATIONS

The active mineral extractive and processing establishments in the United States during 1969 are shown in table 1 by States for each of the general groupings except the oil and gas industries. Similar data for 1970 are not yet available.

Producers and processors of minerals reported 25,148 active mines, quarries, pits,

dredges, brine, well, and other types of mineral-extractive operations in 1969. The largest numbers of mining establishments were in Pennsylvania (1,733), Kentucky (1,576), West Virginia (1,507), and California (1,380). Active mineral cleaning and processing plants totaled 5,168 in 1969.

## WORKTIME AND WORK STOPPAGES

Total worktime of 1,931 million man-hours in the mineral industries during 1970 was 2 percent higher than in 1969. Operating activity, as gaged by man-hours worked, was higher than in 1969 in the mineral fuels and the metal-mining industries, and these gains more than offset the decreased activity in the other industries.

The 567 work stoppages in the mineral industries in 1970 resulted in a time loss of 918,400 man-days of work, according to

the Bureau of Labor Statistics, U.S. Department of Labor. In 1969, there were 531 stoppages with a time loss of 2,387,800 man-days. The average time loss per stoppage was 1,620 man-days in 1970, compared with 4,497 man-days in 1969.

Most of the work stoppages in 1970 were at bituminous coal and lignite mines where there were 500 stoppages with a time loss of 627,000 man-days of work (table 3).

## SAFETY COMPETITIONS

The annual safety competitions conducted by the Bureau of Mines have been recognized as effective tools to promote accident-prevention work in the mineral in-

dustries. They are used at the enrolled operations to arouse and maintain the interest of employees in daily safe working practices, as well as to provide recognition

for outstanding work in safety. A total of 1,528 mineral operations participated in these contests during 1970.

In 1970, a total of 965 mines, open pits, and quarries competed in the 46th National Safety Competition (the Sentinels of Safety contest) cosponsored by the Bureau and the American Mining Congress. Of the participants, 435, or 45 percent of the total, operated throughout 1970 without a disabling work injury. The aggregate worktime of these injury-free plants was 24.1 million man-hours, or 15 percent of the total man-hours of exposure at all enrolled operations. The National Safety Competition comprises six groupings of plants so as to assure equality of competition among operations with relatively similar working conditions. The winning operation in each group is awarded the Sentinels of Safety trophy and a plant flag. In addition, each employee and official at the winning plant receives a personal Certificate of Accomplishment in Safety from the Bureau in recognition of his daily contribution to the winning record.

**Underground Coal Mines.**—Robena No. 1 mine, United States Steel Corp., Frick district, Carmichaels, Pa., 671,438 man-hours.

**Surface Coal Mines.**—West Farm No. 22 mine, Hanna Coal Co., Div. Consolidation Coal Co., Smithfield, Ohio, 213,637 man-hours.

**Underground Metal Mines.**—Jefferson City mine, United States Steel Corp., Southern district, Jefferson, Tenn., 374,711 man-hours.

**Underground Nonmetal Mines.**—Carls-

bad Potash Properties mine, Duval Corp., Carlsbad, N. Mex., 692,131 man-hours.

**Open-Pit Mines (Metal and Nonmetal).**—Thunderbird mine, Eveleth Taconite Co., Eveleth, Minn., 383,045 man-hours.

**Quarries.**—Port Inland quarry, Inland Steel Co., Inland Lime and Stone Division, Gulliver, Mich., 535,429 man-hours.

A total of 246 operations participated in the National Sand and Gravel Safety Competition sponsored by the Bureau. There were 134 injury-free plants, 54 percent of the total number enrolled in the 1970 contest. These plants were operated 4.4 million man-hours without injuries, or 38 percent of the total worktime of all participating operations.

The following plants won top safety honors for injury-free records in 1970 in the bank or pit and the dredge groups into which the contest is divided:

**Bank or Pit.**—Marlboro mine, Becker County Sand and Gravel Co., Barrettsville, S.C., 223,443 man-hours.

**Dredge.**—Whitehead Brothers Co., at Florham Park, N.J., 107,009 man-hours.

Three other annual safety competitions cosponsored with the Bureau by the National Lime Association, the National Limestone Institute, and the National Slag Association were conducted in 1970. A total of 317 operations were enrolled in these contests. Of these, 155 plants, 49 percent of all participants, had no disabling work injuries throughout 1970. The injury-free plants were operated 6.3 million man-hours, or 26 percent of the total worktime at all enrolled operations.

Table 1.—Worktime and injury experience in the mineral industries (mines and mills) in the United States, by States<sup>1</sup>

State and industry group	Average men working daily				Man-days worked (thousands)				Man-hours worked (thousands)				Number of injuries				Injury rates per million man-hours				Count of operations 1969
	1969		1970		1969		1970		1969		1970		Fatal		Nonfatal		Frequency		Severity		
	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	
<b>Alabama:</b>																					
Coal	4,899	5,080	1,120	1,195	8,875	9,473	5	7	125	123	14.65	13.72	4.180	5.109	140	23					
Metal	1,141	925	270	281	2,210	2,802	1	--	20	27	9.50	11.73	3.323	8.04	19	4					
Nonmetal and native asphalt <sup>2</sup>	798	720	202	193	1,621	1,557	--	--	20	15	12.34	9.63	104	287	42	26					
Sand and gravel	586	550	151	133	1,327	1,246	--	--	20	21	15.07	16.85	264	3,990	65	55					
Stone <sup>2</sup>	2,507	2,445	699	674	5,722	5,597	1	1	78	53	13.81	9.65	2,337	1,367	60	55					
Total or average	9,931	9,725	2,442	2,475	19,755	20,176	7	8	263	239	13.67	12.24	2,953	3,138	326	108					
<b>Alaska:</b>																					
Coal	62	70	18	21	158	177	--	--	6	7	38.06	50.90	165	204	3	--					
Metal	200	205	29	29	256	260	--	--	7	22	27.33	84.60	437	4,818	76	1					
Nonmetal	15	15	3	3	20	26	--	--	--	--	--	--	--	--	1	1					
Sand and gravel	885	900	145	129	1,157	1,110	--	--	26	26	22.47	23.43	521	536	81	--					
Stone	137	115	22	14	197	124	--	1	3	1	15.24	16.11	437	48,766	22	19					
Total or average	1,299	1,300	217	196	1,788	1,697	--	1	42	58	23.49	34.77	463	4,678	183	21					
<b>Arizona:</b>																					
Coal	3	5	(3)	(3)	3	4	--	8	549	768	18.45	23.76	3,412	2,433	1	25					
Metal	12,309	12,260	3,805	4,076	30,408	32,664	12	12	4	4	10.76	9.06	91	52	58	17					
Nonmetal	251	240	55	52	465	442	--	5	5	59	20.13	24.73	2,943	14,725	137	36					
Sand and gravel	1,349	1,390	325	328	2,633	2,629	1	6	52	6	9.92	6.17	498	1,78	65	36					
Stone	1,409	430	113	122	907	973	--	--	9	9	--	--	--	--	--	--					
Total or average	14,321	14,320	4,299	4,578	34,417	36,711	13	14	615	837	18.25	23.18	3,254	3,222	518	78					
<b>Arkansas:</b>																					
Coal	108	130	22	26	174	208	--	--	9	13	51.84	62.51	1,613	1,938	12	--					
Metal	2,135	1,515	608	382	4,861	3,056	1	--	54	51	11.31	16.69	2,012	1,224	6	6					
Nonmetal	962	900	239	225	1,916	1,801	1	--	67	55	35.49	30.54	4,935	715	61	16					
Sand and gravel	772	740	185	184	1,642	1,702	--	--	36	29	21.93	17.04	522	1,163	293	64					
Stone	1,337	1,370	381	384	3,300	3,274	--	--	88	83	26.67	25.35	1,294	1,919	116	64					
Total or average	5,314	4,650	1,485	1,201	11,892	10,040	2	--	254	231	21.53	23.01	2,072	1,364	438	86					
<b>California:</b>																					
Coal	6	5	1	1	5	6	--	3	188	145	40.52	29.68	3,757	5,507	1	21					
Metal	2,367	2,180	585	628	4,689	5,020	2	2	225	271	23.00	30.05	2,583	1,532	192	71					
Nonmetal and native asphalt <sup>2</sup>	4,422	4,010	1,230	1,126	9,868	9,051	3	1	238	270	23.06	25.00	2,388	5,000	678	--					
Sand and gravel	5,359	5,675	1,275	1,358	10,453	11,039	3	6	145	120	13.89	11.14	1,606	2,160	276	124					
Stone <sup>2</sup>	4,230	4,465	1,313	1,372	10,585	11,039	2	3	--	--	--	--	--	--	--	--					
Peat	14	12	2	1	14	11	--	--	--	--	--	--	--	--	3	--					
Total or average	16,398	16,350	4,405	4,486	35,614	36,165	9	13	796	807	22.60	22.67	2,389	3,333	1,380	216					

See footnotes at end of table.



Table 1.—Worktime and injury experience in the mineral industries (mines and mills) in the United States, by States 1.—Continued

State and industry group	Average men working daily			Man-days worked (thousands)			Man-hours worked (thousands)			Number of injuries						Injury rates per million man-hours			Count of operations 1969		
	1969		1970	1969		1970	1969		1970	Fatal		Nonfatal		Frequency		Severity					
	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970		Mines	Mills
<b>Colorado:</b>																					
Coal.....	1,325	1,470	298	337	2,339	2,624	4	68	97	30.78	36.97	11.332	1.368	66	4						
Metal.....	4,416	4,515	1,131	1,201	9,010	9,618	13	6	392	44.95	47.31	10.405	6,020	540	26						
Nonmetal.....	459	515	95	114	762	908	2	20	56	26.23	63.85	1,507	17,525	100	16						
Sand and gravel.....	1,494	1,410	310	286	2,530	2,369	1	1	49	39.76	16.88	2,835	3,039	306	30						
Stone.....	525	590	119	149	973	1,232	--	9	16	9.25	12.99	2,882	188	130	26						
Peat.....	25	22	3	3	17	18	--	1	--	58.28	--	466	--	15	--						
Total or average.....	8,244	8,525	1,955	2,089	15,633	16,769	18	9	539	657	35.63	39.72	8,243	5,059	1,157	72					
<b>Connecticut:</b>																					
Nonmetal.....	86	75	22	19	182	145	--	1	4	6	21.99	48.31	896	45,136	5	2					
Sand and gravel.....	505	450	112	97	912	783	--	19	19	20.84	15.32	280	232	82	21						
Stone.....	399	350	106	91	894	748	--	17	35	19.02	46.89	616	1,568	26	21						
Total or average.....	990	875	240	207	1,987	1,675	--	1	40	53	20.13	32.24	488	4,721	113	23					
<b>Delaware:</b>																					
Nonmetal.....	2	(4)	1	1	5	5	--	1	--	--	--	--	--	1	1						
Sand and gravel.....	44	45	10	9	87	81	--	1	--	11.53	--	427	--	14	--						
Total or average.....	46	50	11	10	92	86	--	1	--	10.90	--	403	--	15	1						
<b>Florida:</b>																					
Metal.....	149	150	53	53	422	427	--	1	61	40	6.86	4.86	1,728	901	2	32					
Nonmetal.....	3,713	3,330	1,153	1,054	9,186	8,435	2	23	39	26.35	33.03	11,925	440	41	41						
Sand and gravel.....	337	470	102	120	1,181	1,181	1	1	11	10	19.95	20.37	437	11,284	66	71					
Stone.....	2,337	2,350	676	710	5,959	6,278	4	3	104	126	18.12	20.55	5,560	3,382	95	71					
Peat.....	45	38	11	9	85	73	--	1	1	11.82	13.66	496	96	11	--						
Total or average.....	6,631	6,340	1,995	1,947	16,563	16,394	7	4	189	206	11.83	12.81	3,617	1,791	215	103					
<b>Georgia:</b>																					
Metal.....	125	120	39	37	330	309	--	1	2	3.03	6.48	27	55	6	3						
Nonmetal and peat.....	3,363	3,365	1,004	1,055	8,076	8,492	1	2	212	191	26.38	22.73	1,776	2,409	75	42					
Sand and gravel.....	230	230	61	61	551	540	--	1	11	10	19.95	20.37	437	11,284	28	--					
Stone.....	2,855	2,715	746	701	6,614	6,202	3	1	125	145	19.35	23.54	4,400	1,760	91	81					
Total or average.....	6,513	6,425	1,850	1,853	15,572	15,543	4	4	349	348	22.67	22.65	2,806	2,412	200	126					
<b>Hawaii:</b>																					
Nonmetal.....	97	85	12	11	91	88	--	4	5	43.94	56.87	538	1,194	27	6						
Sand and gravel.....	33	50	3	5	26	42	--	4	7	38.58	44.50	869	1,543	41	28						
Stone.....	587	545	156	156	1,310	1,281	--	44	7	38.58	44.50	869	1,543	41	28						
Total or average.....	717	685	171	172	1,427	1,410	--	48	66	38.64	46.80	833	1,530	80	34						

<b>Idaho:</b>	2,314	2,260	572	580	4,576	4,688	5	1	347	362	76.92	78.26	12,561	8,876	15
Metal.....	466	425	168	192	903	792	1	1	15	10	17.72	14.62	6,856	8,097	8
Nonmetal and peat.....	813	750	183	143	1,066	1,132	--	--	19	24	17.82	20.83	356	482	135
Sand and gravel.....	312	340	63	63	513	509	--	--	6	7	11.69	13.74	479	469	47
Stone.....															20
Total or average.....	3,925	3,770	877	880	7,059	7,052	6	2	387	403	55.68	57.43	9,110	3,625	382
<b>Illinois:</b>															43
Coal.....	8,566	9,100	2,283	2,428	17,832	18,982	12	15	699	730	39.87	39.20	5,793	6,470	63
Metal.....	52	55	14	15	115	117	--	1	7	8	60.85	76.88	1,852	69,271	3
Nonmetal.....	1,068	1,000	257	266	2,984	2,189	--	49	74	74	23.51	34.27	962	3,992	51
Sand and gravel.....	3,541	3,640	378	381	3,240	3,285	--	50	54	15.43	16.39	1,018	714	332	
Stone.....	3,541	3,475	963	938	7,983	7,794	2	3	170	172	21.55	22.45	2,501	3,145	267
Peat.....	41	49	3	3	23	29	--	--	1	--	--	34.60	--	104	177
Total or average.....	14,936	15,350	3,897	4,030	31,277	32,376	14	19	975	1,039	31.62	32.68	4,117	5,140	715
<b>Indiana:</b>															243
Coal.....	2,178	2,365	603	645	4,652	4,988	--	2	194	206	41.70	41.70	2,128	3,893	39
Nonmetal.....	666	560	177	162	1,412	1,282	--	20	20	8	14.17	6.24	789	290	34
Sand and gravel.....	982	875	230	221	2,009	1,871	1	2	37	16	18.91	9.62	4,460	8,153	209
Stone.....	3,039	3,095	830	850	6,644	7,016	2	1	102	114	15.65	16.39	2,892	1,637	136
Peat.....	26	26	5	6	44	45	--	--	1	1	22.91	22.09	641	751	6
Total or average.....	6,841	6,920	1,845	1,883	14,761	15,202	3	5	354	345	24.19	23.02	2,432	3,063	424
<b>Iowa:</b>															138
Coal and Peat.....	175	190	43	46	364	391	--	--	7	8	19.22	20.46	868	1,514	17
Nonmetal.....	535	505	134	133	1,075	1,068	1	--	33	44	31.62	41.22	6,171	693	24
Sand and gravel.....	953	950	193	191	1,781	1,787	1	--	28	40	16.28	22.38	5,268	1,263	294
Stone.....	2,472	2,475	676	670	5,844	5,782	1	1	87	109	15.06	19.03	2,429	1,615	269
Total or average.....	4,115	4,120	1,046	1,040	9,065	9,027	3	1	155	201	17.43	22.38	3,368	1,432	604
<b>Kansas:</b>															146
Coal.....	213	260	63	75	457	547	--	--	7	10	15.32	18.27	85	110	6
Metal.....	28	30	7	8	57	60	--	--	4	67	69.69	43.75	2,230	905	5
Nonmetal.....	932	780	238	193	1,899	1,531	--	--	65	67	34.23	43.75	516	35	18
Sand and gravel.....	637	645	146	143	1,289	1,276	1	--	22	21	17.85	16.46	8,018	492	198
Stone.....	1,611	1,545	424	412	3,509	3,414	--	--	35	47	9.97	13.77	366	385	160
Total or average.....	3,421	3,260	878	830	7,211	6,829	1	--	133	145	18.58	21.23	1,770	496	404
<b>Kentucky:</b>															107
Coal.....	22,447	23,100	4,604	4,788	36,489	38,079	34	88	1,535	1,450	43.00	40.36	8,286	15,350	1,366
Metal.....	46	35	11	9	92	74	--	--	11	7	119.88	94.12	5,166	417	1
Nonmetal.....	234	250	55	55	440	443	--	--	19	20	43.19	45.16	10,925	1,635	51
Sand and gravel.....	303	380	79	100	755	879	--	--	14	22	18.53	25.02	716	544	40
Stone.....	2,198	2,220	562	560	4,608	4,677	6	1	125	127	28.43	27.37	9,244	2,490	118
Total or average.....	25,228	26,025	5,302	5,512	42,384	44,152	40	89	1,704	1,626	41.15	38.84	8,276	13,630	1,576

See footnotes at end of table.

Table I.—Worktime and injury experience in the mineral industries (mines and mills) in the United States, by States 1—Continued

State and industry group	Average men working daily			Man-days worked (thousands)			Man-hours worked (thousands)			Number of injuries						Injury rates per million man-hours			Count of operations 1969		
	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	Fatal		Nonfatal		1969	1970	1969	1970		Mines	Mills
											1969	1970	1969	1970							
Louisiana:																					
Metal.....	1,099	1,235	401	451	3,057	3,609	--	1	14	17	4.58	4.99	169	1,908	3						
Nonmetal.....	2,103	1,995	621	578	5,062	4,674	2	6	118	99	23.71	22.46	3,759	8,219	34						
Sand and gravel.....	1,214	1,170	295	282	2,590	2,590	2	1	51	49	20.43	19.30	5,080	3,015	102						
Stone.....	584	545	190	172	1,759	1,684	--	--	24	44	13.65	26.13	331	1,051	11						
Total or average.....	5,000	4,945	1,507	1,483	12,472	12,558	4	8	207	209	16.92	17.28	2,670	4,368	147						
Maine:																					
Metal and peat.....	103	100	28	26	222	206	--	1	5	15	22.55	77.52	433	82,189	4						
Nonmetal.....	74	50	15	10	122	79	--	--	3	3	40.98	38.20	772	739	12						
Sand and gravel.....	625	690	124	124	1,105	1,121	--	--	23	19	20.82	16.95	386	74	16						
Stone.....	201	200	63	61	521	506	--	--	12	6	23.05	11.86	311	79	16						
Total or average.....	1,003	1,045	230	221	1,969	1,912	--	1	45	43	22.85	23.02	358	3,576	192						
Maryland and District of Columbia:																					
Coal and peat.....	349	375	69	74	552	591	--	1	6	6	10.88	11.84	832	10,931	77						
Nonmetal.....	187	155	47	37	372	296	--	--	17	19	45.67	64.21	768	987	12						
Sand and gravel.....	775	790	196	204	1,750	1,852	--	--	30	32	17.14	17.28	679	2,200	74						
Stone.....	1,282	1,248	358	350	2,976	2,911	1	--	52	76	17.81	26.11	3,046	632	46						
Total or average.....	2,598	2,565	669	665	5,650	5,650	1	1	105	133	18.76	23.72	1,947	2,242	209						
Massachusetts:																					
Nonmetal and peat.....	64	55	19	17	150	135	--	--	8	7	52.93	51.77	927	2,640	4						
Sand and gravel.....	1,053	1,010	240	233	2,029	1,938	--	--	45	29	22.17	14.51	417	334	175						
Stone.....	787	815	196	200	1,641	1,636	--	1	49	56	29.87	34.84	628	4,617	37						
Total or average.....	1,904	1,875	454	450	3,820	3,769	--	1	102	92	26.70	24.67	528	2,275	216						
Michigan:																					
Metal.....	5,170	4,635	1,393	1,416	11,147	11,328	5	3	310	314	28.26	27.98	4,159	2,548	19						
Nonmetal.....	1,826	1,730	503	514	4,023	4,197	--	2	96	111	23.56	26.93	4,475	3,525	85						
Sand and gravel.....	2,636	2,620	577	569	4,968	4,820	3	1	100	124	20.73	23.94	4,924	2,136	593						
Stone.....	3,435	2,970	993	892	7,941	7,247	2	--	59	64	7.63	8.83	1,980	305	62						
Peat.....	183	173	35	34	332	311	--	--	1	5	3.01	16.10	84	280	23						
Total or average.....	13,250	12,125	3,501	3,425	28,412	27,902	10	6	566	618	20.27	22.36	3,114	2,016	782						
Minnesota:																					
Metal.....	8,729	8,535	2,763	2,803	22,102	22,425	--	--	8	92	4.16	4.37	343	2,402	48						
Nonmetal.....	154	150	40	36	324	291	--	--	11	11	33.99	37.83	578	213	5						
Sand and gravel.....	2,653	2,670	456	445	4,095	3,976	1	1	70	60	17.34	15.34	1,973	2,006	705						

Stone.....	1,391	1,305	361	311	2,960	2,735	2	--	83	79	28.72	28.88	4,845	1,123	92	
Peat.....	32	85	2	3	17	20	--	--	1	1	57.33	49.52	229	446	7	
Total or average.....	12,959	12,695	3,622	3,598	29,498	29,448	3	9	257	241	8.81	8.49	1,023	2,207	857	
Mississippi:																
Nonmetal.....	915	745	231	182	1,846	1,465	--	--	47	24	25.45	16.39	595	807	22	
Sand and gravel.....	584	545	182	135	1,195	1,249	--	--	23	28	19.25	22.41	3,682	344	77	
Stone.....	151	120	39	25	313	200	--	--	1	--	3.19	--	77	--	5	
Total or average.....	1,600	1,415	402	340	3,355	2,914	--	--	71	52	21.17	17.84	1,646	302	119	
Missouri:																
Coal.....	397	480	119	142	874	1,047	--	1	28	42	32.03	41.07	690	6,613	12	
Metal.....	3,043	3,045	818	892	6,547	7,154	--	2	4	305	386	46.89	54.52	4,104	4,767	18
Nonmetal and native asphalt.....	841	675	194	164	1,587	1,330	--	--	52	60	32.76	45.11	810	4,777	146	
Sand and gravel.....	832	805	198	182	1,687	1,681	--	--	29	22	17.19	13.09	507	345	81	
Stone.....	4,279	4,070	1,157	1,114	9,510	9,171	4	1	179	188	19.24	20.61	3,727	2,086	231	
Total or average.....	9,392	9,080	2,487	2,494	20,205	20,384	6	6	593	698	29.65	34.54	3,220	3,291	488	
Montana:																
Coal and peat.....	81	90	13	15	101	118	--	--	1	1	9.91	8.88	30	27	18	
Metal.....	2,966	3,425	838	1,097	6,699	8,300	2	2	128	174	19.41	21.20	3,084	3,020	107	
Nonmetal.....	562	420	139	102	1,226	828	1	--	23	28	21.32	33.82	5,793	6,551	122	
Sand and gravel.....	831	830	129	133	1,124	1,088	--	--	24	20	21.35	18.38	461	663	173	
Stone.....	490	470	119	118	975	962	--	--	12	16	12.31	16.63	481	513	73	
Total or average.....	4,950	5,230	1,237	1,404	10,025	11,291	3	2	188	239	19.05	21.34	2,810	2,808	393	
Nebraska:																
Nonmetal.....	15	15	3	3	25	23	--	--	1	1	39.46	9.88	592	204	5	
Sand and gravel.....	925	845	197	194	1,829	1,823	--	--	26	18	14.21	9.88	3,783	340	285	
Stone.....	501	570	148	165	1,257	1,411	--	--	21	31	16.70	21.98	309	340	36	
Total or average.....	1,441	1,425	348	361	3,112	3,256	--	--	48	49	15.42	15.05	2,353	262	326	
Nevada:																
Metal.....	2,127	1,915	660	582	5,298	4,694	4	4	115	78	22.46	17.47	5,135	5,950	166	
Nonmetal.....	740	735	188	184	1,526	1,484	1	--	49	50	32.76	33.70	5,024	2,355	52	
Sand and gravel.....	620	655	113	140	907	1,174	--	--	22	16	24.26	13.63	1,045	588	92	
Stone.....	198	225	55	63	453	509	--	--	7	13	15.46	25.55	660	1,189	20	
Total or average.....	3,685	3,530	1,017	968	8,184	7,860	5	4	193	157	24.19	20.48	4,413	4,162	330	
New Hampshire:																
Nonmetal.....	49	35	11	8	85	60	--	--	1	--	11.76	9.71	235	104	6	
Sand and gravel.....	409	385	78	69	725	618	--	--	14	6	19.32	9.71	1,037	104	49	
Stone.....	144	150	35	36	281	293	--	--	12	12	42.69	41.01	1,131	369	6	
Total or average.....	602	570	123	113	1,091	971	--	--	27	18	24.75	18.54	998	177	61	

See footnotes at end of table.

Table 1.—Worktime and injury experience in the mineral industries (mines and mills) in the United States, by States 1.—Continued

State and industry group	Average men working daily				Man-days worked (thousands)				Man-hours worked (thousands)				Number of injuries				Injury rates per million man-hours				Count of operations 1969		
	1969		1970		1969		1970		1969		1970		Fatal		Nonfatal		Frequency		Severity		Mines	Mills	
	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	
New Jersey:																							
Metal.....	176	160	47	47	379	380			1	26	19	68.66	52.66	2,345	21,748					2	2		
Nonmetal.....	290	300	79	83	634	666			--	17	24	26.00	36.05	910	12					9	9		
Sand and gravel.....	1,131	990	271	243	2,009	2,009			--	63	56	28.22	27.87	2,855	770					117	117		
Stone.....	935	915	252	225	2,146	1,897			1	77	89	36.36	36.92	4,173	744					33	34		
Peat.....	21	25	4	6	35	44			--	1	1	28.60	22.75	343	227					5	5		
Total or average.....	2,553	2,395	653	604	5,426	4,996			1	184	189	34.09	38.03	3,095	2,370					169	169		
New Mexico:																							
Coal and peat.....	865	405	90	102	714	801			5	22	31	30.83	38.72	7,157	1,123					13	13		
Metal.....	4,370	4,515	1,198	1,276	9,606	10,207			10	5	409	402	43.62	39.87	7,356	4,363					14	14	
Nonmetal.....	2,112	2,165	704	703	5,666	5,629			4	2	161	183	29.12	32.87	5,217	3,295					37	24	
Sand and gravel.....	911	920	162	163	1,323	1,347			--	35	35	23.01	26.45	1,684	358					164	164		
Stone.....	252	245	58	53	471	453			--	7	8	14.86	17.66	289	474					63	43		
Total or average.....	8,010	8,255	2,212	2,298	17,804	18,413			14	7	630	659	36.17	36.17	6,074	3,512					448	82	
New York:																							
Metal.....	1,303	1,345	358	362	2,862	2,898			--	1	57	50	19.92	17.60	1,947	2,709					5	5	
Nonmetal.....	2,049	2,085	545	555	4,429	4,440			1	1	146	130	33.19	29.50	2,390	2,149					35	31	
Sand and gravel.....	2,219	2,115	477	459	3,969	3,918			--	79	69	19.90	17.61	559	588					369	369		
Stone.....	3,210	3,075	863	840	7,070	6,869			1	3	80	131	11.46	19.51	1,264	3,654					107	106	
Peat.....	13	14	2	2	17	20			--	1	--	--	57.53	--	805	--					5	--	
Total or average.....	8,794	8,635	2,244	2,219	18,347	18,146			2	5	363	380	19.89	21.22	1,490	2,468					511	142	
North Carolina:																							
Metal.....	16	165	5	46	37	369			--	2	53	53.77	143.53	2,016	3,512					2	2		
Nonmetal.....	1,924	1,685	503	439	4,060	3,531			2	1	103	105	25.86	30.02	3,737	5,518					75	40	
Sand and gravel.....	1,927	1,745	177	174	1,646	1,614			2	33	31	21.26	19.20	7,690	363					134	134		
Stone.....	1,927	1,950	484	499	4,116	4,192			2	1	64	58	16.03	14.07	3,754	1,862					100	75	
Total or average.....	4,628	4,545	1,168	1,159	9,859	9,707			6	2	202	247	21.10	25.65	4,398	3,006					311	115	
North Dakota:																							
Coal.....	258	285	61	69	488	548			--	1	9	13	18.43	25.55	340	11,378					20	5	
Nonmetal.....	61	50	12	9	92	75			1	20	1	227.18	13.25	69,627	225					7	3		
Sand and gravel.....	664	670	113	117	1,032	1,071			--	18	12	18.41	11.21	6,139	448					249	7		
Stone.....	4	5	1	1	7	7			--	--	--	--	--	--	--	--					7	1	
Total or average.....	987	1,010	187	196	1,620	1,701			2	1	47	26	30.25	15.87	7,986	3,956					283	9	
Ohio:																							
Coal.....	7,706	8,300	1,954	2,124	15,564	16,888			13	8	515	560	33.92	33.69	6,844	3,905					335	23	
Nonmetal.....	2,101	2,090	568	550	4,581	4,377			1	--	96	112	21.17	25.59	1,843	779					145	41	

Sand and gravel.....	2,327	2,060	555	482	4,655	4,093	7	--	87	64	20.19	15.64	9,646	1,131	399	
Stone.....	5,589	5,245	1,433	1,433	12,941	11,781	4	--	205	227	16.15	19.27	2,968	581	203	
Peat.....	18	21	2	2	15	16	4	--	--	--	--	--	--	--	11	
Total or average.....	17,741	17,695	4,655	4,591	37,757	37,155	25	8	908	963	24.58	26.16	5,251	2,175	1,093	
Oklahoma:																
Coal.....	349	425	92	110	715	857	3	2	26	39	40.53	47.84	27,045	16,968	12	
Metal.....	222	195	61	54	492	429	1	1	15	21	30.47	48.95	886	1,867	1	
Nonmetal.....	520	540	137	137	1,007	1,076	1	1	46	34	46.69	32.52	6,750	7,911	27	
Sand and gravel.....	296	310	76	80	657	679	1	1	19	17	28.93	25.05	6,621	1,048	100	
Stone.....	1,354	1,375	366	364	3,054	3,009	--	--	74	88	24.23	29.25	790	785	107	
Total or average.....	2,741	2,845	723	745	5,926	6,050	4	3	180	199	31.05	33.39	4,962	4,235	260	
Oregon:																
Coal and peat <sup>s</sup> .....	5	5	( <sup>4</sup> )	( <sup>3</sup> )	2	1	--	--	1	3	6	18.34	41.07	134	41	121
Metal.....	112	110	20	21	164	170	--	--	1	3	5	20.81	14.92	357	504	58
Nonmetal.....	158	180	31	33	246	268	1	1	5	4	20.31	14.92	3,854	7,677	225	
Sand and gravel.....	1,210	1,010	230	228	1,847	1,811	1	2	32	59	17.87	33.67	3,782	7,252	278	
Stone.....	1,066	900	250	200	2,020	1,607	--	1	66	54	32.67	34.23	782	7,252	278	
Total or average.....	2,551	2,205	532	483	4,280	3,858	1	4	106	123	25.00	32.92	2,034	8,478	597	
Pennsylvania:																
Bituminous coal.....	21,139	22,000	5,169	5,507	41,424	44,143	26	31	1,073	1,170	26.53	27.16	5,690	5,854	819	
Anthracite.....	5,927	6,000	1,377	1,447	10,073	10,533	13	5	492	485	50.14	46.71	9,090	4,123	419	
Metal.....	1,363	1,350	419	409	3,348	3,273	1	1	29	20	8.96	6.42	2,044	2,172	3	
Nonmetal.....	1,344	1,100	342	278	2,772	2,240	1	--	73	82	26.69	36.61	4,935	1,997	95	
Sand and gravel.....	1,127	1,125	282	270	2,426	2,360	2	2	55	84	22.67	36.45	739	8,443	105	
Stone.....	8,470	7,900	2,354	2,177	18,709	18,079	2	5	296	267	15.93	15.04	1,705	2,714	282	
Peat.....	56	55	13	13	106	90	--	--	1	4	9.43	44.34	160	3,303	10	
Total or average.....	39,446	39,580	9,955	10,100	78,858	80,717	43	44	2,019	2,112	26.15	26.71	4,837	4,741	1,733	
Rhode Island:																
Sand and gravel.....	182	150	34	27	281	216	--	--	6	3	21.38	13.87	884	920	19	
Stone.....	78	45	19	11	160	89	--	--	3	2	18.80	22.45	1,579	202	5	
Total or average.....	260	195	53	38	440	305	--	--	9	5	20.44	16.37	1,136	710	24	
South Carolina:																
Nonmetal and peat.....	925	900	236	226	1,919	1,824	--	--	41	94	21.37	51.52	460	1,215	61	
Sand and gravel.....	532	355	84	89	781	828	1	--	17	5	23.05	6.04	10,428	140	30	
Stone.....	761	810	200	235	1,584	2,012	--	2	28	21	17.68	11.43	527	6,327	21	
Total or average.....	2,038	2,065	521	551	4,283	4,664	1	2	86	120	20.31	26.16	2,302	3,229	112	
South Dakota:																
Metal.....	1,677	1,600	522	500	4,176	4,002	2	3	87	96	21.31	24.74	4,505	5,885	30	
Nonmetal.....	754	775	37	43	315	345	1	--	10	14	34.90	40.57	19,860	1,516	34	
Sand and gravel.....	758	725	130	133	1,190	1,198	--	--	26	25	21.86	20.87	581	1,623	350	
Stone.....	495	535	116	129	984	1,093	1	1	19	31	20.32	29.28	8,140	6,020	35	
Total or average.....	3,104	3,035	805	804	6,665	6,638	4	4	142	166	21.91	25.61	5,068	4,911	449	

See footnotes at end of table.

Table 1.—Worktime and injury experience in the mineral industries (mines and mills) in the United States, by States 1.—Continued

State and industry group	Average men working daily			Man-days worked (thousands)			Man-hours worked (thousands)			Number of injuries			Injury rates per million man-hours			Count of operations 1969	
	1969		1970		1969		1970		1969		1970		1969		1970		
	Fatal	Nonfatal	Fatal	Nonfatal	Fatal	Nonfatal	Fatal	Nonfatal	Frequency	Severity	Frequency	Severity	Frequency	Severity			
<b>Tennessee:</b>																	
Coal.....	2,099	2,180	404	430	3,276	3,496	3	1	69	68	21.98	19.73	9,012	2,630	193	2	
Metal.....	1,697	1,720	453	467	3,624	3,740	2	95	103	26.49	28.08	3,593	5,717	14	6		
Nonmetal.....	644	640	170	161	1,349	1,349	--	37	35	25.65	25.95	446	735	62	23		
Sand and gravel.....	548	535	146	142	1,280	1,196	--	1	30	27	23.44	23.42	3,341	6,065	82	115	
Stone.....	2,832	2,695	751	690	6,727	5,921	--	4	112	130	16.95	22.63	2,351	6,138	136	115	
Total or average.....	7,820	7,770	1,924	1,890	16,349	15,701	6	8	343	363	21.35	23.63	3,870	4,787	487	146	
<b>Texas:</b>																	
Coal.....	116	140	37	44	298	357	--	2	61	45	15.76	10.59	4,036	3,737	21	7	
Metal.....	1,448	1,665	495	553	3,998	4,439	--	2	2	146	26.46	22.28	1,797	4,429	138	66	
Nonmetal and native asphalt.....	3,305	2,850	942	837	7,634	6,732	1	4	201	117	29.33	28.69	2,241	1,879	290	178	
Sand and gravel.....	1,879	1,870	488	481	4,482	4,497	1	--	117	129	26.33	23.13	1,272	2,215	228	178	
Stone.....	4,487	4,390	1,316	1,329	10,999	11,373	1	--	234	261	21.37	23.18	1,272	2,215	228	178	
Total or average.....	11,235	10,910	3,278	3,244	27,412	27,397	5	8	613	581	22.54	21.50	1,966	2,922	679	251	
<b>Utah:</b>																	
Coal.....	1,193	1,325	281	318	2,207	2,476	1	5	123	175	56.17	72.69	4,847	14,801	24	7	
Metal.....	5,278	5,180	1,598	1,632	12,790	13,058	2	3	221	239	17.44	18.53	1,726	2,351	232	11	
Nonmetal.....	869	1,065	239	276	2,200	2,200	1	1	70	80	27.10	36.82	4,133	4,716	139	20	
Sand and gravel.....	723	710	140	147	1,146	1,205	2	1	21	20	30.08	17.43	10,868	5,143	187	17	
Stone.....	443	445	118	116	959	946	--	14	14	12	14.61	12.68	628	630	37	17	
Native asphalt (gilsonite).....	262	(*)	72	(*)	578	(*)	--	(*)	23	(*)	39.80	(*)	744	(*)	18	3	
Total or average.....	8,768	8,725	2,449	2,439	19,593	19,885	6	10	472	526	24.40	26.95	2,764	4,250	540	58	
<b>Vermont:</b>																	
Nonmetal and peat.....	322	335	91	92	734	743	--	--	19	22	25.87	29.63	296	815	6	5	
Sand and gravel.....	189	185	33	32	300	299	--	--	5	9	16.66	30.06	777	155	65	5	
Stone.....	1,313	1,280	335	324	2,780	2,679	2	--	101	78	37.05	29.11	7,352	1,037	43	34	
Total or average.....	1,824	1,800	459	448	3,814	3,721	2	--	125	109	33.29	29.29	5,429	921	114	39	
<b>Virginia:</b>																	
Coal.....	10,429	11,405	2,154	2,349	17,177	18,763	16	27	988	945	58.45	51.80	8,374	10,749	857	30	
Metal.....	285	290	73	75	587	598	1	--	45	37	18.37	31.90	1,266	1,476	2	2	
Nonmetal.....	599	580	160	158	1,273	1,263	--	--	35	39	27.49	30.88	1,031	3,330	35	20	
Sand and gravel.....	559	550	139	129	1,275	1,190	--	1	23	23	28.04	20.17	1,988	6,935	83	83	
Stone.....	3,742	3,580	985	937	8,053	7,758	5	3	190	142	24.21	18.69	4,581	3,448	152	131	
Total or average.....	15,614	16,405	3,511	3,648	28,365	29,572	22	31	1,281	1,186	45.94	41.15	6,668	8,176	1,129	183	
<b>Washington:</b>																	
Coal.....	39	45	9	10	68	76	--	--	3	25	60.67	75.16	3,110	32,412	17	4	
Metal.....	220	280	54	73	429	585	--	--	41	41	60.67	75.16	3,110	32,412	17	4	
Nonmetal.....	85	55	12	9	98	72	--	--	1	--	10.18	--	244	--	33	3	

Sand and gravel.....	1,479	1,360	306	265	2,462	2,121	--	1	54	55	21.93	26.40	604	3,734	306	
Stone.....	1,127	1,110	242	264	1,943	2,114	--	--	29	28	14.93	13.25	794	979	188	
Peat.....	21	15	3	2	23	11	--	--	--	--	--	--	--	--	10	
Total or average.....	2,971	2,865	626	622	5,022	4,980	--	4	110	124	21.90	25.70	873	5,816	560	
West Virginia:																
Coal.....	42,501	44,400	9,081	9,801	71,929	77,738	70	66	3,904	4,380	55.25	57.20	8,423	7,686	1,424	
Nonmetal.....	283	165	57	43	457	340	--	--	10	7	21.86	20.58	490	121	13	
Sand and gravel.....	182	215	46	45	416	431	--	--	17	13	40.56	30.16	1,322	278	14	
Stone.....	1,126	1,115	299	305	2,330	2,471	--	1	40	50	17.16	20.64	291	3,179	56	
Total or average.....	44,052	45,930	9,484	10,194	75,133	80,981	70	67	3,971	4,450	53.78	55.79	8,083	7,478	1,507	
Wisconsin:																
Metal.....	217	325	60	90	482	726	2	--	21	37	47.73	50.97	26,426	1,991	12	
Nonmetal.....	22	25	4	4	36	35	--	--	--	--	--	--	--	--	2	
Sand and gravel.....	1,856	1,870	370	352	3,251	3,051	1	1	70	62	21.64	20.65	3,357	3,076	461	
Stone.....	1,775	1,675	397	394	3,179	3,046	2	2	81	91	24.56	30.53	4,215	4,715	386	
Peat.....	8	9	1	2	11	15	--	--	--	--	--	--	--	--	2	
Total or average.....	3,872	3,895	833	811	7,188	6,874	5	3	172	190	24.62	28.08	5,285	3,665	863	
Wyoming:																
Coal.....	391	435	94	106	715	802	3	--	11	16	19.59	19.95	25,850	858	15	
Metal.....	1,845	1,715	441	458	3,740	4,034	--	--	85	78	22.73	18.98	486	2,132	145	
Nonmetal.....	1,496	1,485	448	443	3,618	3,595	1	--	36	32	21.24	21.04	1,861	335	12	
Sand and gravel.....	777	790	131	129	1,141	1,034	--	--	24	4	21.64	21.04	2,404	322	18	
Stone.....	224	215	52	52	1,420	1,426	--	1	11	4	26.18	11.74	483	14,341	45	
Total or average.....	4,733	4,640	1,166	1,139	9,633	9,890	4	2	167	136	17.75	13.95	3,077	1,679	429	
U.S. totals: 7																
Coal.....	133,302	140,100	30,053	32,207	237,484	254,678	203	260	9,917	10,575	42.61	42.55	7,359	7,963	5,955	
Peat.....	567	542	98	93	881	763	--	--	8	14	9.62	18.36	184	587	132	
Native asphalt.....	445	(9)	117	(8)	949	(8)	--	(9)	36	(8)	37.93	(8)	733	(8)	23	
Metal.....	68,765	67,700	19,824	20,567	158,773	165,152	68	65	3,731	4,165	23.93	25.60	3,760	3,514	2,332	
Nonmetal.....	44,602	42,000	12,255	11,667	98,799	93,836	27	26	2,861	2,425	24.17	25.12	2,587	2,855	2,440	
Sand and gravel.....	50,161	49,400	10,964	10,787	94,223	83,117	31	28	1,929	1,910	20.80	20.81	3,024	2,849	9,410	
Stone.....	83,149	80,800	22,586	21,919	187,003	183,026	53	43	3,389	3,575	18.41	19.77	2,634	2,300	5,056	
Total or average.....	380,991	380,600	95,896	97,240	778,063	790,572	382	422	21,371	22,655	27.96	29.20	4,342	4,507	25,148	
Oil and natural gas.....	449,606	462,468	NA	NA	939,385	972,278	95	134	9,023	9,989	9.71	10.41	983	1,251	NA	
Coke.....	13,617	13,997	4,824	4,937	38,520	39,554	15	8	231	260	6.39	6.78	2,533	1,562	71	
Blast-furnace slag.....	1,610	1,647	442	441	3,573	3,602	3	1	49	72	14.55	20.27	6,061	2,072	--	
Primary nonferrous smelting and refining.....	45,244	44,700	15,683	15,587	125,348	124,692	15	8	1,566	1,530	12.61	12.34	1,293	1,036	--	
Grand total or average.....	891,068	903,400	NA	NA	1,884,890	1,930,698	510	573	32,240	34,515	17.38	18.17	2,431	2,593	NA	

NA Not available.  
 1 All data for 1969 are final. Data for 1970 are preliminary, except for peat, oil and natural gas, coke, and slag.  
 2 Beginning in 1970, data on asphaltic stone operations, which formerly were included in "Native Asphalt," have been included in "Stone," on a continuing basis.  
 3 Less than 500.  
 4  
 5 No employment reported in the peat mining industry in Oregon during 1970.  
 6 Beginning in 1970, data on gilsonite operations, which formerly were included in "Native Asphalt," have been included in "Nonmetal," on a continuing basis.  
 7 Data may not add to totals shown because of independent rounding.  
 8 Beginning in 1970, data on asphaltic stone and gilsonite operations, which comprised the Native Asphalt industry, have been separated and included, respectively, in the Stone industry and the Nonmetal industry.  
 9 Officeworker data not separable.



Table 2.—Worktime and injury experience in the mineral industries

Year	Average men working daily	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours		
			Fatal	Nonfatal	Frequency		Severity (all injuries)
					Fatal	Nonfatal	
1966-----	915,964	1,925,695	544	32,823	0.28	17.04	2,539
1967-----	900,240	1,863,349	512	31,360	.27	16.83	2,468
1968-----	904,436	1,901,322	607	31,254	.32	16.44	2,741
1969-----	891,068	1,884,890	510	32,240	.27	17.10	2,431
1970 <sup>p</sup> -----	903,400	1,930,698	573	34,515	.30	17.88	2,593

<sup>p</sup> Preliminary.

Table 3.—Work stoppages in certain mineral industries in the United States

Industry and year	Work stoppages		Industry and year	Work stoppages	
	Number	Man-days lost (thousands)		Number	Man-days lost (thousands)
<b>COAL MINING</b>			<b>Miscellaneous metal ores:</b>		
Anthracite:			1966	--	--
1966	4	8.3	1967	1	1.0
1967	3	1.4	1968	--	--
1968	2	4.2	1969	--	--
1969	7	13.1	1970	1	1.7
1970	3	11.4	<b>Metal mining services:</b>		
Bituminous and lignite:			1966	--	--
1966	160	629.0	1967	--	--
1967	207	<sup>1</sup> 158.0	1968	--	--
1968	266	<sup>1</sup> 956.6	1969	--	--
1969	457	900.6	1970	1	1.5
1970	500	627.0	<b>Primary smelting and refining of nonferrous metals:</b>		
<b>OIL AND NATURAL GAS</b>			1966	15	182.0
Crude petroleum and natural gas:			1967	12	1,420.0
1966	1	50.7	1968	11	<sup>1</sup> 915.0
1967	2	( <sup>2</sup> )	1969	7	<sup>1</sup> 108.2
1968	--	--	1970	14	54.0
1969	3	40.3	<b>MINING AND QUARRYING OF NONMETALLIC MINERALS (EXCEPT FUELS)</b>		
1970	--	--	<b>Dimension stone:</b>		
Natural gas liquids:			1966	1	( <sup>2</sup> )
1966	--	--	1967	--	--
1967	--	--	1968	1	3.4
1968	--	--	1969	2	5.9
1969	1	25.1	1970	--	--
1970	--	--	<b>Crushed and broken stone:</b>		
Oil and gas field services:			1966	7	9.2
1966	1	2.6	1967	1	9.0
1967	3	( <sup>2</sup> )	1968	11	17.1
1968	3	3.0	1969	7	14.7
1969	1	.2	1970	11	8.1
1970	1	91.3	<b>Sand and gravel:</b>		
Petroleum refining:			1966	7	1.9
1966	5	5.6	1967	15	<sup>1</sup> 26.8
1967	15	103.0	1968	6	6.3
1968	6	50.8	1969	3	1.4
1969	16	992.7	1970	9	71.6
1970	7	8.5	<b>Clay, ceramic, and refractory minerals:</b>		
<b>METAL MINING</b>			1966	--	--
Iron:			1967	--	--
1966	--	--	1968	2	6.2
1967	--	--	1969	1	.2
1968	2	32.7	1970	--	--
1969	--	<sup>3</sup> 1.5	<b>Chemical and fertilizer mineral mining:</b>		
1970	--	--	1966	2	( <sup>2</sup> )
Copper:			1967	10	38.9
1966	6	25.2	1968	1	7.0
1967	7	2,660.0	1969	1	38.5
1968	6	<sup>1</sup> 1,453.1	1970	6	16.8
1969	6	<sup>1</sup> 97.4	<b>Miscellaneous nonmetallic minerals (except fuels):</b>		
1970	5	3.2	1966	--	--
Lead-zinc:			1967	1	( <sup>2</sup> )
1966	4	166.0	1968	--	--
1967	3	93.4	1969	1	.5
1968	1	<sup>1</sup> 31.1	1970	2	8.6
1969	5	9.4	<b>Cement, hydraulic:</b>		
1970	4	8.0	1966	2	1.7
Gold-silver:			1967	9	67.4
1966	--	--	1968	2	4.7
1967	2	26.9	1969	12	130.0
1968	--	<sup>1</sup> 31.1	1970	2	6.2
1969	--	--			
1970	1	.5			
Ferroalloy metal ores:					
1966	1	( <sup>2</sup> )			
1967	1	( <sup>2</sup> )			
1968	--	--			
1969	1	5.4			
1970	--	--			

<sup>1</sup> Includes idleness from stoppages that began in the previous year.<sup>2</sup> Less than 100 man-days.<sup>3</sup> Idleness from a stoppage that began in the previous year.

Source: U.S. Department of Labor, Bureau of Labor Statistics.



# The Mineral Industry of Alabama

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

By William B. Harper <sup>1</sup> and W. Everett Smith <sup>2</sup>

Business activity in Alabama tapered off in 1970. The decline, however, was not as severe as the average for the country as a whole. The index of industrial production in Alabama receded about 2 percent, and the national average, based on the Federal Reserve Index (1957-59 = 100), dropped about 5 percent. Likewise, the decline in the production of steel ingots in the State was not as sharp as the national average. The national steel index reflected the 10-week strike against General Motors. Unlike the steel mills in the Great Lakes region, which are closely associated with the automobile industry, the Alabama steel industry felt very little impact from the strike. On the brighter side, coal production rose to 20.6 million tons in 1970, an increase of 17.8 percent over the preceding year, and early indications point to more sizable gains in 1971 as newly started strip mines gather production momentum.

Mineral production in Alabama rose sharply in terms of both volume and value. Value rose to \$323 million in 1970, or 13.5 percent as increases in the prices and production of coal more than offset decreases in output of other minerals such as cement, sand and gravel, iron ore, clays, and petroleum.

Coal, cement, petroleum, and stone accounted for 88 percent of the total value of the mineral production; coal alone accounted for 58 percent of the aggregate values.

Alabama ranked second, exceeded only by Arkansas, in the production of bauxite, and third in kaolin.

The number of persons employed in the nonagricultural sector in 1970 averaged 1,000,800 per month, which is a shade (.1 percent) higher than in 1969. Slight gains in nonmanufacturing employment more than offset a decrease in manufacturing employment.

The value of exports from the Mobile Customs District, increased 2.3 percent, to \$466.7 million; imports were valued at \$254.2 million, or 1 percent higher than in 1969.

**Consumption, Trade, and Markets.**—Increasing concern about air pollution caused by sulfur-containing fuels has created a strong demand for low-sulfur coal from Alabama in both domestic and foreign markets. Coal exports from the Mobile Customs District in 1970 aggregated 342,000 short tons, compared with only 630 short tons in 1969. Six ports—three in Florida, two in Mississippi, and one in Alabama—are included in the Mobile Customs District. Virtually all of the coal, however, is shipped from the port of Mobile.

Belgium provided the largest market for coal sent out from the Mobile Customs District in 1970 with 99,127 tons shipped. Japan, with 69,199 short tons, ranked second. It is interesting to note that not one of the major export markets for U.S. coal in 1970 shown in the following table was in evidence in 1969.

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<sup>2</sup> Chief, Economic Geology Division, Geological Survey of Alabama, Tuscaloosa, Ala.

**Exports of Coal from Mobile  
Customs District #19**  
(Short tons)

Country	1969	1970
Belgium.....	--	99,127
Japan.....	--	69,199
West Germany.....	--	60,841
Spain.....	--	55,653
Argentina.....	--	32,480
Uruguay.....	--	24,750
Honduras.....	117	28
Dominican Republic.....	--	43
El Salvador.....	114	--
Peru.....	89	60
Venezuela.....	310	154
Total.....	630	342,335

Source: Bureau of the Census, Department of Commerce.

**Trends and Developments.**—One significant development in the State was the expansion in bituminous coal production to a level of 20,560,000 tons. Equally significant was the transition in coal mining operations. There were 74 underground mines operating in 1969, most of which were located in Jefferson and Marion Counties. By the end of 1970, however, 39 of the 74 had ceased operations; 17 mines shut down in Jefferson County; Marion County felt the impact of a drastic cut—from 24 to six; Walker County lost two of its six underground mines. On the positive side, there was a net increase of 27 strip mines in 1970; coal production from strip

operations jumped 39.4 percent to 11,339,000 tons. Production from underground mines declined 2.2 percent, to 9,078,000 tons, which was 20 percent less than the coal produced from the strip mines.

Coal production in Alabama will receive added stimulus from the opening of new strip mines. Arch Minerals Corp. with one operation in Jackson County, was developing another strip mine in Walker County. This 1 million-ton-per-year mine will supply coal to the Georgia Power and Light Co. The Ramsey Coal Co., also with one mine in Jackson County, was developing another strip operation in northern Alabama near the Tennessee border.

Still another coal development in 1970 was the construction of a new underground coal mine near Gorgas. The new mine was being developed by the Alabama By-Products Corp. to provide fuel for a steam-generating unit being built near Gorgas. When fully developed, the mine is expected to have an output of 1.7 million tons per year.

Virtually all of the stimulation in coal production was attributable, in some degree, to the air pollution regulations enacted by States and cities all over the Nation on the sulfur content of fuels. Also intensifying demand for low-sulfur coal

**Table 1.—Mineral production in Alabama <sup>1</sup>**

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement: <sup>2</sup>				
Masonry.....thousand 230-pound barrels..	2,600	\$8,520	2,402	\$7,601
Portland.....thousand 376-pound barrels..	16,527	51,251	16,053	51,114
Clays.....thousand short tons..	3,097	7,083	2,748	8,213
Coal (bituminous).....do.....	17,456	130,405	20,560	166,308
Iron ore (usable).....thousand long tons, gross weight..	1,125	6,435	W	W
Lime.....thousand short tons..	747	9,870	749	10,286
Natural gas.....million cubic feet..	180	24	627	87
Petroleum (crude).....thousand 42-gallon barrels..	7,701	20,793	7,263	20,627
Phosphate rock.....thousand short tons..	W	W	90	452
Sand and gravel.....do.....	8,323	9,427	6,725	8,144
Stone.....do.....	19,854	37,512	19,882	37,166
Value of items that cannot be disclosed:				
Asphalt (native), bauxite, cement (slag), gasoline (natural), liquefied petroleum gases, mica (scrap), salt, talc, and values indicated by "W".....	XX	3,416	XX	13,247
Total.....	XX	284,736	XX	323,245
Total 1967 constant dollars.....	XX	268,876	XX	P 292,537

<sup>1</sup> Preliminary. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

<sup>3</sup> Excludes slag cement; included with "Value of items that cannot be disclosed."

<sup>4</sup> Excludes certain dimension stones; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Alabama, by counties <sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Autauga	\$171	\$171	Sand and gravel.
Baldwin	W	W	Sand and gravel, petroleum, miscellaneous clay.
Barbour	767	1,725	Bauxite, kaolin, sand and gravel.
Bibb	4,404	7,057	Coal, limestone, dolomite, sand and gravel, miscellaneous clay.
Blount	1,865	2,253	Coal, cement, fire clay, sandstone.
Calhoun	2,140	2,942	Fire clay, limestone, miscellaneous clay.
Chilton	W	W	Sand and gravel.
Choctaw	2,381	2,501	Petroleum.
Clarke	W	W	Sand and gravel, petroleum.
Coffee	163	40	Sand and gravel.
Colbert	W	W	Limestone, native asphalt.
Covington	W	W	Limestone.
Crenshaw	W	W	Sand and gravel.
Cullman	W	W	Coal.
Dale	W	W	Sand and gravel.
Dallas	W	W	Sand and gravel, stone.
De Kalb	W	W	Limestone.
Elmore	W	W	Sand and gravel, miscellaneous clay.
Escambia	W	W	Petroleum, sand and gravel, miscellaneous clay.
Etowah	1,189	W	Limestone, coal.
Fayette	W	W	Sand and gravel.
Franklin	4,463	4,157	Iron ore, limestone, sand and gravel, fire clay.
Geneva	W	W	Sand and gravel.
Hale	W	W	Do.
Henry	W	W	Bauxite, kaolin.
Houston	W	W	Sand and gravel.
Jackson	W	W	Coal, limestone.
Jefferson	111,878	133,878	Coal, cement, iron ore, dolomite, limestone, miscellaneous clay, sandstone.
Lee	W	W	Limestone.
Limestone	W	W	Phosphate rock, limestone.
Lowndes	W	W	Bentonite, sand and gravel.
Macon	1,126	W	Sand and gravel.
Madison	W	W	Limestone, miscellaneous clay.
Marengo	W	W	Cement, limestone.
Marion	W	W	Coal, kaolin.
Marshall	W	W	Limestone, sand and gravel, miscellaneous clay.
Mobile	W	29,838	Petroleum, cement, oystershell, sand and gravel, miscellaneous clay.
Monroe	52	84	Sand and gravel, petroleum.
Montgomery	1,999	1,634	Sand and gravel, miscellaneous clay.
Morgan	1,599	2,140	Limestone, sand and gravel.
Pike	W	W	Iron ore.
Randolph	W	W	Mica (scrap).
Russell	W	W	Miscellaneous clay, sand and gravel.
St. Clair	W	W	Cement, limestone, miscellaneous clay, coal.
Shelby	31,804	32,425	Lime, cement, coal, limestone, dolomite, miscellaneous clay.
Sumter	W	W	Miscellaneous clay, sand and gravel.
Talladega	11,525	11,997	Marble, limestone, talc.
Tuscaloosa	10,503	12,339	Coal, sand and gravel.
Walker	W	38,744	Coal, fire clay, miscellaneous clay.
Washington	W	W	Salt, limestone, petroleum.
Winston	W	W	Coal.
Undistributed <sup>2</sup>	96,708	39,319	
Total <sup>3</sup>	284,736	323,245	

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

<sup>1</sup> The following counties are not listed because no production was reported: Bullock, Butler, Chambers, Cherokee, Clay, Cleburne, Conecuh, Coosa, Greene, Lamar, Lauderdale, Lawrence, Perry, Pickens, Tallapoosa, and Wilcox.

<sup>2</sup> Includes value of natural gas, natural gas liquids, and values indicated by symbol W.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

was the strong demand in the export market.

Another promising development was the discovery of five new oilfields and gasfields during 1970. Included were the Uriah field, the first in Monroe County, the Little Escambia Creek field in Escambia County; the Womack Hill field in Choctaw County; the East Detroit field in Lamar

County; and the Chatom field in Washington County.

Relative to a stimulus for oil and natural gas production in Alabama, Humble Oil and Refining Co. announced that a contract has been awarded to the Hudson Engineering Corp. to construct a 35-million-cubic-foot-per-day natural-gas-treating and sulfur-recovery plant. The plant is to

Table 3.—Selected indicators of Alabama business activity

	1969	1970 <sup>p</sup>	Change, percent
Monthly average employment:			
Total nonagricultural..... thousands..	r 999.4	1,000.8	+ .1
Manufacturing..... do.....	r 323.7	319.6	-1.3
Nonmanufacturing..... do.....	r 675.7	681.2	+ .8
Personal income:			
Total..... millions..	\$9,116	\$9,752	+7.0
Per capita.....	\$2,650	\$2,828	+6.7
Construction activity:			
Housing units authorized..... thousands..	14.6	20.3	+39.0
Value of construction..... millions..	\$130.3	\$251.6	+39.5
Value of construction..... do.....	\$722.6	\$734.5	+1.6
Farm marketing, cash receipts..... do.....	\$234.7	\$323.2	+13.5
Mineral production.....			
Utility consumption:			
Total consumption of electric energy..... billion kilowatt hours..	33.2	34.0	+2.4
Consumption for industrial purposes..... do.....	18.9	19.0	+ .5
Foreign trade, Mobile Customs District:			
Value of exports..... millions..	\$456.0	\$466.7	+2.3
Value of imports..... do.....	\$251.7	\$254.2	+1.0

<sup>p</sup> Preliminary. <sup>r</sup> Revised.  
Sources: Alabama Business, Center for Business and Economic Research, University of Alabama; Survey of Current Business; Construction Review; and Bureau of the Census, U.S. Department of Commerce.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1969:								
Coal.....	4,899	229	1,120	8,875	5	125	14.65	4,180
Metal.....	1,141	236	270	2,210	1	20	9.50	3,323
Nonmetal and native asphalt.....	798	253	202	1,621	--	20	12.34	104
Sand and gravel.....	586	258	151	1,327	--	20	15.07	264
Stone.....	2,507	279	699	5,722	1	78	13.81	2,337
Total.....	9,931	246	2,442	19,755	7	263	13.67	2,953
1970: <sup>p</sup>								
Coal.....	5,080	235	1,195	9,473	7	123	13.72	5,109
Metal.....	925	304	281	2,302	--	27	11.73	804
Nonmetal and native asphalt.....	720	267	193	1,557	--	15	9.63	287
Sand and gravel.....	550	242	133	1,246	--	21	16.85	3,990
Stone <sup>1</sup> .....	2,445	276	674	5,597	1	53	9.65	1,367
Total <sup>2</sup> .....	9,725	255	2,475	20,176	8	239	12.24	3,138

<sup>p</sup> Preliminary.  
<sup>1</sup> Beginning in 1970, data on asphaltic stone operations which formerly were included in "Native Asphalt," have been included in "Stone."  
<sup>2</sup> Data may not add to totals shown because of independent rounding.

be constructed in the Flomaton field in Escambia County, and the project will cost \$6.9 million. Humble plans to sell the residue gas to the Florida Gas Transmission Co.

An impressive expansion in electric power generation capacity was under way in the State, and most of the new plants were being designed to burn coal. At year-end 1970, the Alabama Power Co. had under construction three steam-electric-generating units, each of which will have at least twice the capacity of the largest unit now in the company's service. The expansion of the Barry Steam Plant near Mobile

will add a 700,000-kilowatt, coal-fired unit. Under construction at the Gorgas Steam Plant is another 700,000-kilowatt, coal-fired unit. The largest unit under construction is an 850,000-kilowatt, coal-fired turbine generator near Wilsonville. In addition, Alabama Power Co. is expanding nuclear generating capacity.

In 1969 Alabama Power Co. awarded one contract for a 820,000-kilowatt nuclear generating station to be erected near Dothan. The plant is scheduled for commercial operation in 1975. In June 1970, plans for a second generating unit, similar to the first a year earlier, were released.

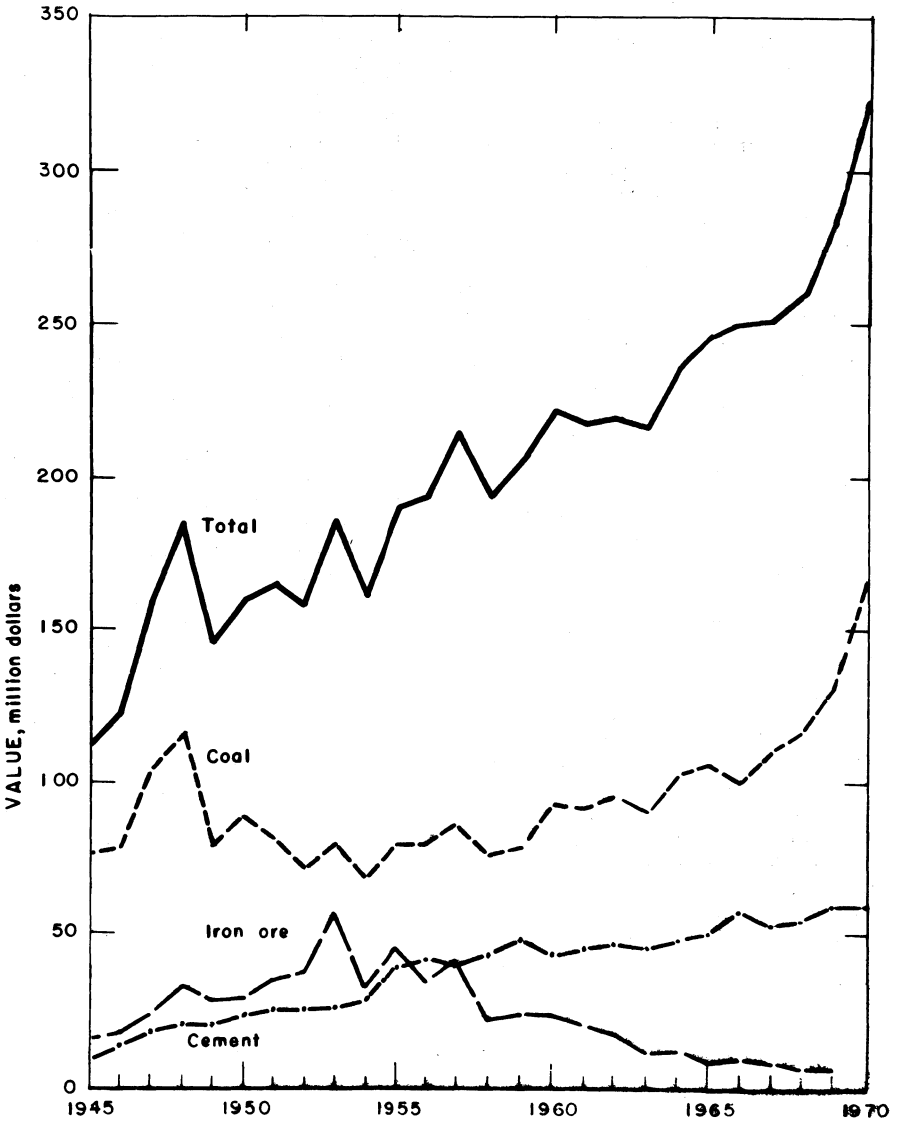


Figure 1.—Value of coal, cement, and iron ore, and total value of mineral production in Alabama.

The total estimated cost for both units is \$506 million.

The Tennessee Valley Authority (TVA) has under construction at the Browns Ferry Nuclear Plant in northern Alabama three electric-generating units of 1,152,000-kilowatt-capacity each.

Exploration for nonferrous metals continued in the State during 1970. At least three major companies were engaged in the exploration for lead and zinc in the Valley and Ridge province.

**Legislation and Government Programs.**—The Alabama Surface Mining Act of



1969 became effective in 1970. The Act requires grading to reduce the tops of peaks and ridges, the covering of toxic material, and revegetation.

A new air pollution law enacted in 1971 created a State Pollution Control Commission. Among the new provisions in the new air pollution control law, no officer, employee, agent or stockholder owning 7.5 percent or more of the voting stock of any corporation or organization holding a permit from the Commission for the discharge of air contaminants into the atmosphere, is eligible to serve on the Commission. Furthermore, no representative of any trade association, representing a corporation or organization holding such a permit is eligible to serve on the Commission.

Under the law, municipal governing bodies and local boards of health will be allowed to enact ordinances for control or prevention of air pollution.

Also, the Governor will be able to declare an air pollution emergency when he is advised by the State health officer that a case of air pollution exists that is a threat to the health of the people and that the resources of the control commission are insufficient to abate the threat. The Governor would then have power to prohibit, restrict, or condition various sources of air pollution.

In the new water pollution control law the State Health Officer is chairman. The Conservation Department director is vice-chairman. Neither will have a vote. The remaining five members of the seven-man board, appointed by the Governor with the consent of the Senate, will be as follows: A physician qualified in waterborne

disease, a registered engineer qualified in water resource management and water supply, and an attorney qualified in water supply and riparian rights. Two members whose eligibility to serve is subject to provisions on conflict of interest similar to the new air pollution law, would be selected from the public at large.

The Bureau of Mines published two reports dealing with mineral resources in Alabama.<sup>3</sup>

During the year, the Geological Survey of Alabama was engaged in over 150 projects directed toward geologic mapping, minerals mapping, and evaluation of water, minerals, and petroleum resources. Major areas of the Alabama Piedmont region were mapped, leading to new insights into the geologic history and structure of that region of the State. During 1970 the Geological Survey of Alabama released 20 publications dealing with geology and mineral resources of Alabama.

During 1970 the U.S. Geological Survey released a number of topographic maps of areas in the State and continued with a program of topographic mapping in Alabama. The Geological Survey of Alabama began cooperative work with TVA to prepare geologic and mineral maps of certain quadrangles in areas of TVA jurisdiction.

United States Steel Corp., Fairfield plant, and Riechhold Chemical Co. at Tuscaloosa, working in cooperation with the Geological Survey of Alabama completed deep disposal wells, made plans to install surface equipment, and began seismic monitoring in the area of the Tuscaloosa well in order to determine the normal seismic activity before fluid injection begins at the well.

## REVIEW BY MINERAL COMMODITIES

### MINERAL FUELS

Mineral fuels accounted for 58 percent of the total value of mineral production; bituminous coal value alone was 51 percent of the fuels total.

**Coal (Bituminous).**—Reflecting the growing demand for low-sulfur coal by the electric utilities, plus a broadened demand from foreign countries for high-grade coal, production in 1970 climbed to 20,560,357 tons a 17.7 percent gain over the levels attained in 1969.

While these production gains were being

attained significant changes occurred in the types of mining. For example, strip mining production accounted for more than half (55.1 percent) of the total bituminous coal production in 1970. The year before, 53.2 percent of Alabama's 17,456,000 tons of coal produced came from underground

<sup>3</sup> Ralston, Donald E., and Ronald P. Hollenbeck. The Implications of Urban Growth and the Minerals Industry in the Huntsville, Ala., Area. Bureau Mines Inf. Circ. 8496, 1970, 24 pp.

Sullivan, G. B., and James S. Browning. Recovery of Heavy Minerals from Alabama Sand and Gravel Operations. Tech. Prog. Dept. 22, April 1970, 14 pp.

mining, whereas strip operations produced 46.6 percent. The number of strip operations in 1970 expanded from 64 to 91. Production from strip operations increased from 8.1 million in 1969 to 11.3 million tons, a gain of 39.5 percent.

Thirty-five underground mines operated at yearend, compared with 74 in 1969. Eighteen shutdowns occurred in Marion County, leaving only six underground mines operating at the end of 1970. In Jefferson County, 20 underground mines operated in 1970, compared with 37 at yearend 1969.

Although 39 underground mines had ceased operating by the end of 1970, it was with few exceptions, the smaller operations that shut down. Seventeen of the mines closed produced less than 5,000 tons per year; 10 produced less than 10,000 tons; 11 produced between 10,000 and 20,000 tons; one produced between 25,000 and 50,000 tons. Actually, production from underground mines decreased 2.2 percent from 9,287,000 short tons to 9,078,000 short tons in 1970. Other changes in the methods of operations and production are indicated in table 5.

**Coke.**—Production of oven coke in 1970 reached 6,116,000 tons which was 460,000 tons or 8.1 percent greater than that of 1969. Six plants produced coke in Alabama: four in Jefferson County, and one each in Tuscaloosa and Etowah Counties.

**Natural Gas.**—The marketed production

of natural gas more than tripled in 1970, rising from 180 million cubic feet in 1969 to 627 million cubic feet in 1970. Until 1970, production in the State had been declining. But with the discovery of new gas condensate fields and gasfields and their subsequent development, there is ample reason for a continued uptrend. Also, completion of new natural gas processing plants will pave the way for enhancing the economic importance of natural gas in the mineral production of the State. The new natural gas treating and sulfur recovery plant being constructed in Escambia County, however, will not be operable until 1972.

During 1970, Phillips Petroleum Co. discovered the Chatom field in Washington County. This field, north of the Citronelle field, is a gas and gas condensate field, and the initial production from the discovery well was 900 barrels of condensate and 2 million cubic feet of gas per day. The gas contains about 18 percent hydrogen sulfide.

Another wildcat well produced oil and gas at the Little Escambia Creek field. This field is very close to the Jay field in the Panhandle of Florida.

**Petroleum.**—In 1970, crude petroleum production in the State declined 5 percent in 1970 to 7.3 million barrels, from 7.7 million barrels in 1969, or 438,000 barrels. Production in the State's major field, Citronelle in Mobile County, dropped 367,000 barrels below the 1969 level. In Choctaw County, the State's second largest known

**Table 5.—Alabama: Bituminous coal production<sup>1</sup> by counties**

(Thousand short tons and thousand dollars)

County	Number of mines and method of operation								Production			
	Under-ground		Strip		Auger		Total mines		Quantity		Value	
	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970
Bibb.....	1	1	3	8	--	--	4	9	W	1,046	W	\$6,333
Blount.....	--	--	2	4	--	--	2	4	204	270	W	2,054
Cullman.....	--	--	2	1	--	--	2	1	W	W	W	W
Etowah.....	--	--	1	1	--	--	1	1	W	W	W	W
Jackson.....	2	--	1	3	--	--	3	3	W	W	W	W
Jefferson.....	37	20	16	24	--	1	53	45	8,518	9,892	\$68,453	88,349
Marion.....	24	6	5	7	--	--	29	13	553	650	2,874	4,019
Shelby.....	3	3	--	3	--	--	3	6	W	W	W	W
St. Clair.....	--	--	1	1	--	--	1	1	W	W	W	W
Tuscaloosa.....	1	1	12	12	--	--	13	13	1,868	2,168	10,204	12,097
Walker.....	6	4	20	22	1	2	27	28	4,139	4,236	32,334	38,105
Winton.....	--	--	1	5	--	--	1	5	W	W	W	W
Undistributed.....	--	--	--	--	--	--	--	--	2,174	2,298	16,540	15,351
Total.....	74	35	64	91	1	3	139	129	17,456	20,560	130,405	166,308

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

<sup>1</sup> Excludes mines producing less than 1,000 short tons.

**Table 6.—Alabama: Crude oil production, by fields and counties <sup>1</sup>**  
(42-gallon barrels)

County and field	Production		Producing wells
	1969 <sup>r</sup>	1970	1970
Mobile:			
Citronelle.....	6,406,947	6,040,003	412
Choctaw:			
Choctaw Ridge.....	376,504	302,343	6
Tokey.....	213,051	175,223	7
Okatuppa Creek.....	39,680	10,198	1
Turkey Creek.....	36,727	213,979	3
Gilbertown.....	203,625	160,712	63
South Gilbertown.....	10,062	6,281	4
East Langsdale.....	7,095	6,277	1
Womack Hill.....	--	5,712	1
Escambia:			
Pollard.....	224,363	194,490	27
Flomaton.....	16,350	1,075	9
Little Escambia.....	--	488	1
Baldwin:			
Tensaw Lake.....	25,475	18,810	3
Clarke-Baldwin:			
South Carlton.....	141,882	149,785	22
Washington:			
Chatom.....	--	17,823	1
Monroe:			
Uriah.....	--	6,797	1
Total.....	7,701,761	7,309,996	562

<sup>r</sup> Revised.

<sup>1</sup> As reported by the State Oil and Gas Board, does not agree with figures shown in table 1.  
Source: State Oil and Gas Board.

**Table 7.—Alabama: Oil and gas well drilling**

County	Exploratory wells					Development wells				
	Total	Oil	Gas	Dry	Footage	Total	Oil	Gas	Dry	Footage
Baldwin.....	--	--	--	--	--	3	--	--	3	16,582
Choctaw.....	9	1	--	8	108,999	2	1	--	1	25,775
Clarke.....	3	--	--	3	33,866	1	1	--	--	5,550
Conecuh.....	1	--	--	1	12,870	--	--	--	--	--
Escambia.....	2	--	1	1	31,267	8	1	4	3	119,851
Lauderdale.....	1	--	--	1	925	--	--	--	--	--
Madison.....	1	--	--	1	407	--	--	--	--	--
Marengo.....	4	--	--	4	18,711	--	--	--	--	--
Marion.....	1	--	--	1	1,854	2	--	--	2	3,524
Mobile.....	1	--	--	1	10,525	2	2	--	--	29,241
Monroe.....	1	1	--	--	14,445	--	--	--	--	--
Washington.....	2	--	--	2	13,177	--	--	--	--	--
Wilcox.....	1	--	--	1	5,086	--	--	--	--	--
Total.....	27	2	1	24	252,132	18	5	4	9	200,523

Source: American Petroleum Institute.

oil province, production declines of 189,000 barrels in older fields were almost offset by a gain of 177,000 barrels in the Turkey Creek field in that county. There were four new oil fields discovered in 1970: the Little Escambia Creek field in Escambia County, the Uriah field in Monroe County, the first oil field in that county; the Womack Hill field in Choctaw County; and the East Detroit field in Lamar County.

Sixteen fields in seven counties were in production in 1970. Of the 562 producing wells at yearend, the Citronelle field in Mobile County accounted for 412 of the producers. Choctaw County, with eight fields, had 86 producing wells. Escambia County, with three fields, produced oil from 37 wells. Baldwin had three producers in the Tensaw Lake field. Clarke County and adjoining Baldwin County had

22 producing wells, in the South Carlton field, and Washington and Monroe Counties each had one producing well.

Forty-seven new permits to drill wells were issued by the State Oil and Gas Board in 1970, and the Board reports 20 wells in progress at yearend.

**NONMETALS**

Nonmetals accounted for 40 percent of the State's total value of mineral production in 1970, compared with 44 percent in 1969.

**Cement.**—A decrease in building activity and a shutdown of a cement plant in the fall of 1970 were instrumental in causing the production of portland cement to decline from 13,686,000 barrels to 12,795,000 barrels, or 6.5 percent in 1970. Shipments declined 474,000 barrels, or 2.9 percent to 16,053,000 barrels in 1970. Stocks at yearend were 946,000 barrels, or 8.4 percent below 1969. During 1970, six companies produced only portland cement, and another company devoted its operations to masonry cement. Eight companies operated 10 plants in six counties: Jefferson, Blount, Mobile, Shelby, Saint Clair, and Marengo. Two of these plants produced slag cement. In October 1970, the Lehigh Portland Cement Co. ceased production at its Jefferson County plant, and shipments from that plant halted early in December.

About 88 percent of the cement shipped went to building material dealers, concrete product manufacturers, and ready-mix concrete manufacturers. Highway contractors and Federal, State, and other government agencies accounted for 11 percent of the remainder. About two-thirds of cement

shipments were moved by truck and nearly one-third by rail.

**Clays.**—Common clay and shale were mined by 21 companies at 26 surface mines in 15 counties; total production declined 16 percent. The leading counties, in terms of production of common clays, are Jefferson, Russell, and Shelby. Common clay is used extensively for building brick and for cement. Two companies quarry and process shale into lightweight aggregates.

Fire clay was mined by five companies at six open pits in four counties. Although total production was 14.5 percent below 1969, the value of production in 1970 was 32 percent above the 1969 levels.

Alabama ranked third among the States in the production of kaolin. Three companies mined kaolin from eight open pit mines. Refractory uses absorb most of the kaolin but some of this mineral was used for paper coating and filling and as fillers in fertilizers, insecticides and fungicides, paint, and plastics. Also, some kaolin was used in building brick.

**Lime.**—Five companies produced quicklime and hydrated lime at five plants in Shelby County. Total output was .2 percent or a shade higher than in 1969. Forty-four percent of shipments were intrastate; other shipments to neighboring States were as follows, in percent: Florida, 17; Georgia, 13; Tennessee, 11; Louisiana, 3; Mississippi, 4; Texas 3; other States and exports, 5.

**Mica.**—Scrap mica was produced by one company operating two mines in Randolph County; production increased 5 percent. Among the States, Alabama ranked second in the production of scrap mica.

**Phosphate.**—Phosphate rock was produced from one mine located in Limestone County. This mine started operating during 1969; 1970 represented the first full year of production.

**Table 8.—Alabama: Portland cement salient statistics**

(Thousand 376-pound barrels and thousand dollars)

	1969	1970
Number of active plants during year.....	8	18
Daily rated capacity, Dec. 31....	NA	NA
Production.....	13,686	12,795
Shipments from mills:		
Quantity.....	16,527	16,053
Value.....	\$51,251	\$51,114
Stocks at mills, Dec. 31.....	1,033	946

<sup>r</sup> Revised. NA Not available.

<sup>1</sup> Includes Lehigh Cement Co. Production ceased Oct. 31, 1970. Shipments ceased Dec. 4, 1970.

**Table 9.—Alabama: Fire clay sold or used by producers, by uses**

(Short tons)

Use	1969	1970
Floor and wall tile.....	700	--
Firebrick and block.....	46,353	22,880
Building brick.....	171,269	142,241
Vitrified sewer pipe.....	25,448	37,074
Other uses <sup>1</sup> .....	219,050	193,414
<b>Total.....</b>	<b>462,820</b>	<b>395,609</b>

<sup>1</sup> Includes mortar, foundries, and saggars.

**Table 10.—Alabama: Lime sold or used by producers, by uses**  
(Short tons)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Paper and pulp.....	W		242,394	\$3,232,443
Basic oxygen furnaces.....	161,354		122,372	1,600,320
Water purification.....	68,459		82,515	1,181,709
Electric furnaces.....	W		33,370	506,300
Miscellaneous chemicals.....	W		29,554	419,060
Food.....	W		1,815	24,630
Coke ovens.....	W		1,294	3,779
Other <sup>1</sup> .....	517,134		236,830	3,316,411
Total.....	746,947		749,144	10,285,652

W Withheld to avoid disclosing individual company confidential data; included with "Other."  
<sup>1</sup> Includes agriculture, alkalies, aluminum, brick, calcium carbide, construction, insecticides, magnesium, oil-well drilling, other metallurgy, other steel furnaces, paint, petrochemicals, petroleum refining, refractory dolomite, sewage, sugar refining, tanning, whitening, wire drawing, and uses indicated by W.

**Salt.**—One company produced salt from brine for chemical manufacture; production increased 2 percent in 1970.

**Sand and Gravel.**—Commercial operators reported production of sand and gravel from 56 mines. The impact of less building activity, however, was evident both in sand and in gravel. Production decreased 19 percent, and the value dropped 13.6 percent. Leading producing counties were Montgomery, Mobile, Macon, and Clarke. During 1970, there were 30 stationary plants, five portable plants, and 21 dredges in operation. Nearly all of the production was washed. Of the total production, 55 percent was shipped by truck, 34 percent by rail, and the remaining 11 percent by water. Water transportation has increased at the expense of rail shipments. In 1969, rail shipments accounted for 40 percent, compared with only 34 percent in 1970.

The major uses of the sand and gravel were for building, paving, and fill.

**Stone.**—Limestone and dolomite were quarried and crushed at 41 quarries in 19 counties. Production of crushed limestone was 14.7 million tons from 39 quarries; crushed dolomite, 2.9 million tons from seven quarries. Leading producing counties were Shelby, Jefferson, and Morgan.

Dimension limestone was quarried by one company at an underground operation in Franklin County. Production declined about 1 percent in 1970.

Marble was produced from 4 quarries in Talladega County. Over all demand was about 4 percent higher as shipments of crushed and broken stone for extenders and fillers more than offset declines in demand for broken stone for terrazzo. Lower demand for dimension stone such as dressed building stone and monumental

**Table 11.—Alabama: Sand and gravel sold or used by producers, by counties**  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Autauga.....	1	256	\$171	1	256	\$171
Cherokee.....	1	( <sup>1</sup> )	( <sup>1</sup> )	1	50	40
Coffee.....	1	176	163	1	W	W
Elmore.....	1	469	W	1	W	W
Escambia.....	4	465	570	2	W	W
Macon.....	3	W	1,126	3	W	W
Monroe.....	1	W	52	1	51	65
Montgomery.....	5	2,210	W	5	1,626	1,487
Undistributed <sup>2</sup> .....	34	4,750	7,346	42	4,742	6,381
Total <sup>3</sup> .....	51	8,323	9,427	56	6,725	8,144

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

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

<sup>2</sup> Includes Baldwin, Barbour, Bibb, Chilton, Clarke, Covington (1969), Crenshaw, Dale, Dallas, Etowah (1969), Fayette, Franklin, Geneva, Hale, Houston, Lowndes, Marengo (1969), Marshall, Mobile, Morgan, Russell, Sumter, Tuscaloosa, and some sand and gravel that cannot be assigned to specific counties.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

**Table 12.—Alabama: Sand and gravel sold or used by producers, by classes of operations and uses**  
(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>	•			
<b>Sand:</b>				
Building.....	2,330	\$2,471	1,675	\$1,998
Fill.....	79	31	104	47
Paving.....	1,208	1,228	875	896
Other uses <sup>1</sup> .....	501	645	810	672
<b>Total<sup>2</sup>.....</b>	<b>4,118</b>	<b>4,375</b>	<b>3,465</b>	<b>3,613</b>
<b>Gravel:</b>				
Building.....	2,240	3,049	1,854	2,852
Paving.....	1,034	1,274	1,154	1,375
Other <sup>3</sup> .....	930	729	233	235
<b>Total<sup>2</sup>.....</b>	<b>4,204</b>	<b>5,052</b>	<b>3,241</b>	<b>4,462</b>
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Paving.....	--	--	9	31
<b>Total.....</b>	<b>--</b>	<b>--</b>	<b>9</b>	<b>31</b>
<b>Gravel:</b>				
Paving.....	--	--	11	37
<b>Total.....</b>	<b>--</b>	<b>--</b>	<b>11</b>	<b>37</b>
<b>Total sand and gravel<sup>2</sup>.....</b>	<b>8,323</b>	<b>9,427</b>	<b>6,725</b>	<b>8,144</b>

<sup>1</sup> Includes railroad ballast (1970), fire-furnace, engine, filtration (1970), molding, and other sands.

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

<sup>3</sup> Includes fill and other gravel and miscellaneous gravel.

stone, reflected the slackening in building activity. Dimension marble is obtained from one of the quarries in Talladega County.

Oystershell was dredged from Mobile Bay by one company at two operations. Production increased 12 percent.

Sandstone was quarried and crushed by 3 companies; production in 1970 increased 3.4 percent.

**Talc.**—American Talc Co. mined and ground talc in Talladega County for toilet preparations and other uses. Production, however, was lower in 1970 than in 1969.

**Table 13.—Alabama: Crushed limestone and dolomite sold or used by producers, by counties**  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Colbert.....	3	W	W	3	1,040	\$1,430
Covington.....	1	W	\$20	1	W	20
Jefferson.....	8	4,256	5,237	8	4,244	5,562
Limestone.....	1	18	26	1	W	W
Marshall.....	1	300	W	1	300	W
Shelby.....	9	4,952	7,024	9	4,420	6,757
Undistributed <sup>1</sup> .....	23	8,226	10,012	18	7,611	9,256
<b>Total<sup>2</sup>.....</b>	<b>46</b>	<b>17,752</b>	<b>22,371</b>	<b>41</b>	<b>17,616</b>	<b>23,026</b>

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

<sup>1</sup> Includes Bibb, Calhoun, De Kalb, Etowah, Franklin, Jackson, Lee, Madison, Marengo, Morgan, St. Clair, Talladega, and Washington Counties.

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

**Table 14.—Alabama: Crushed limestone and dolomite sold or used by producers, by uses**  
(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Bituminous aggregate.....	1,133	\$1,388	1,319	\$1,854
Concrete aggregate.....	2,264	2,709	1,669	2,093
Dense graded road base stone.....	3,823	4,673	2,675	3,269
Macadam aggregate.....	---	---	200	300
Surface treatment aggregate.....	711	876	83	114
Unspecified aggregate and roadstone.....	W	W	1,732	2,212
Agricultural limestone.....	949	1,544	2,251	2,753
Cement.....	3,865	3,018	3,755	3,473
Flux.....	W	W	931	1,602
Lime.....	1,404	2,473	1,472	2,758
Other uses <sup>1</sup> .....	3,598	5,691	1,529	2,594
Total <sup>2</sup> .....	17,752	22,371	17,616	23,026

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

<sup>1</sup> Includes refractory stone, chemical stone, asphalt, other fillers, mine dusting, mineral food, metallurgical purposes (1970), riprap, railroad ballast, poultry grit (1970), paper (1969), and other uses in small quantities.

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

### METALS

**Aluminum.**—Primary aluminum production increased nearly 7.6 percent, and the value was 14.6 percent larger than in 1969.

**Bauxite.**—Alabama ranks second among the States in bauxite production. Four companies mined crude bauxite in Barbour and Henry Counties. Production nearly doubled in 1970, which resulted in substantial inventory stockpiles.

**Iron and Steel.**—Shipments of pig iron totaled 4.7 million tons valued at \$300.5 million, compared with 4.9 million tons valued at \$282.4 million in 1969. Eleven of the 19 blast furnaces were operated in 1970. Steel ingot production during the year declined 2.9 percent.

**Iron Ore.**—Usable iron ore shipments were lower than in 1969, reflecting the

expanded use of foreign ores at the expense of domestic ores. Iron ore used at agglomerating plants and blast and steel furnaces in the State consisted of 29 percent domestic ore and 71 percent foreign ore. In 1969, the relationship was 35 percent domestic and 65 percent foreign. Foreign ores were virtually unheard of 15 years ago. The Woodward Company ceased operations at its underground Pyne Mine in Jefferson County in December 1970. This was the last of the red ore mines in operation in Alabama. Three companies mined brown iron ore at four surface mines in two counties. Principal producing counties for both red and brown ores in 1970 were Jefferson, Franklin, and Pike. Imports of iron ore, primarily from Venezuela, were 11.5 higher in 1970.

**Table 15.—Alabama: Mine production and shipments of crude iron ore**

	1969		1970	
	Number of mines	Long tons (thousands)	Number of mines	Long tons (thousands)
Mine production:				
By varieties:				
Hematite.....	1	1,036	1	1,125
Limonite.....	4	1,115	3	W
By mining methods:				
Open pit.....	4	1,115	3	W
Underground.....	1	1,036	1	1,125
Shipments from mines:				
Direct to consumers.....	1	109	1	W
To beneficiation plants.....	5	1,893	4	2,063

W Withheld to avoid disclosing individual company confidential data.

Table 16.—Alabama: Usable iron ore production and shipments

	1969		1970	
	Long tons (thousands)	Iron content (percent)	Long tons (thousands)	Iron content (percent)
<b>Production:</b>				
Hematite.....	W	33	W	35
Limonite.....	389	47	W	48
<b>Shipments:</b>				
Direct-shipping ore.....	109	33	W	32
Concentrates and sinter.....	1,016	39	W	41
<b>Total shipments.....</b>	<b>1,125</b>	<b>38</b>	<b>W</b>	<b>40</b>

W Withheld to avoid disclosing individual company confidential data.

Table 17.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Alumina:</b>			
Aluminum Company of America.....	1501 Alcoa Bldg. Pittsburgh, Pa. 15219	Plant.....	Mobile.
<b>Aluminum smelters:</b>			
Revere Copper and Brass, Inc.....	Box 191 Rome, N. Y. 13440	....do.....	Jackson.
Reynolds Metals Co.....	Reynolds Metals Bldg. Richmond, Va. 23218	....do.....	Colbert.
<b>Bauxite:</b>			
Eufaula Bauxite Mining Co.....	Box 556 Eufaula, Ala. 36027	Open pit mine and plant.....	Barbour.
General Refractories Co.....	Abbeville, Ala. 36310	Open pit mine.....	Henry.
A. P. Green Refractories Co.....	Mexico, Mo. 65265	6 open pit mines and plant.....	Barbour and Henry.
Harbison-Walker Refractories Co.....	2 Gateway Center Pittsburgh, Pa. 15222	Open pit mine and plant.....	Henry.
Wilson-Snead Mining Co.....	Box 563 Eufaula, Ala. 36027	....do.....	Barbour.
<b>Cement:</b>			
Alpha Portland Cement Co. <sup>1</sup> .....	15 S. Third St. Easton, Pa. 18043	Plant.....	Jefferson.
Ideal Cement Co.....	Ideal Cement Bldg. Denver, Colo. 80202	....do.....	Mobile.
Lone Star Cement Corp.....	Box 6237 West End Branch Richmond, Va. 23230	2 plants.....	Jefferson and Marengo.
Martin Marietta Corp. <sup>2</sup> .....	18th Floor Daniel Bldg. Birmingham, Ala. 35233	....do.....	Jefferson and Shelby.
Mead Corp.....	Box 3358 Birmingham, Ala. 35205	Plant.....	St. Clair.
United States Steel Corp.....	600 Grant Street Pittsburgh, Pa. 15230	....do.....	Jefferson.
<b>Clays:</b>			
<b>Bentonite:</b>			
American Colloid Co.....	5100 Suffield Court Skokie, Ill. 60076	Open pit mine.....	Lowndes.
<b>Fire:</b>			
Dixie Clay Co.....	Box 361 Anniston, Ala. 36202	Open pit mine and plant.....	Calhoun.
Donoho Clay Co.....	Box 843 Anniston, Ala. 36202	....do.....	Do.
Harbison-Walker Refrac- tories Co.....	2 Gateway Center Pittsburgh, Pa. 15222	2 open pit mines.....	Blount and Walker.
Marigold Coal, Inc.....	Box 420 Jasper, Ala. 35501	Open pit mine.....	Walker.
<b>Common clay and shale:</b>			
Bickerstaff Clay Products Co., Inc.....	Box 1178 Columbus, Ga. 31902	4 open pit mines and plants.....	Jefferson and Russell.
Glen-Gery Corp.....	Box 1656 East Canton, Ohio 44730	Open pit mine and plant.....	Jefferson.
Ideal Cement Co.....	Ideal Cement Bldg. Denver, Colo. 80202	Open pit mines.....	Mobile.
Jenkins Brick Co.....	Box 91 Montgomery, Ala. 36101	2 open pit mines and plants.....	Elmore and Montgomery.
Marigold Coal, Inc.....	Box 420 Jasper, Ala. 35501	Open pit mine.....	Walker.
Martin Marietta Corp.....	18th Floor Daniel Bldg. Birmingham, Ala. 35233	....do.....	Shelby.
Mead Corp.....	Box 3358 Birmingham, Ala. 35205	Open pit mine and plant.....	St. Clair.

See footnotes at end of table.



Table 17.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Clays—Continued</b>			
Common clay and shale—Continued			
Ragland Brick Co.....	3507 Rainbow Dr. Gadsden, Ala. 35901	Open pit mine and plant.	St. Clair.
Tombigbee Lightweight Aggregate Co.	Box 1247 Nashville, Tenn. 37202	---do.---	Sumter.
United States Steel Corp.....	600 Grant Street Pittsburgh, Pa. 15230	---do.---	Jefferson.
Vulcan Materials Co.....	Box 7324-A Birmingham, Ala. 35220	---do.---	Do.
<b>Kaolin:</b>			
Harbison-Walker Refrac- tories Co.	2 Gateway Center Pittsburgh, Pa. 15222	---do.---	Henry.
Thomas Alabama Kaolin Co.	15 Charles Plaza Baltimore, Md. 21201	Open pit mine.....	Marion.
A. P. Green Refractories Co.	Mexico, Mo. 65265.....	3 open pit mines and plants.	Barbour and Henry.
<b>Coal:</b>			
Alabama By-Products Corp.....	Box 354 Birmingham, Ala. 35210	3 underground and 1 strip mine and 2 plants.	Jefferson.
Arch Minerals Corp.....	400 Mansion House Center St. Louis, Mo. 63100	Strip mine.....	Jackson.
Peabody Coal Co.....	301 N. Memorial Dr. St. Louis, Mo. 63102	2 strip mines and plants.	Jefferson, Tuscaloosa, and Walker.
Southern Electric Generating Co.	600 North 18th St. Birmingham, Ala. 35203	2 underground mines and plants.	Shelby and Walker.
United States Steel Corp.....	Box 599 Fairfield, Ala. 35064	Underground mine and plant.	Jefferson.
Woodward Co.....	Woodward Ala. 35189.....	2 underground mines plants.	Do.
<b>Coke:</b>			
Alabama By-Products Corp.....	Box 354 Birmingham, Ala. 35210	Plant.....	Do.
Empire Coke Co.....	2201 First Ave., N. Birmingham, Ala. 35203	---do.---	Tuscaloosa.
Republic Steel Corp.....	Box 6776 Cleveland, Ohio 44101	2 plants.....	Etowah and Jefferson.
U. S. Pipe & Foundry Co.....	Box 2651 Birmingham, Ala. 35212	Plant.....	Jefferson.
United States Steel Corp.....	Box 599 Fairfield, Ala. 35064	---do.---	Do.
Woodward Co.....	Woodward, Ala. 35189.....	---do.---	Do.
<b>Ferroalloys:</b>			
Calumet & Hecla Corp.....	Calumet Ave. Calumet, Mich. 49913	---do.---	Selma.
Tennessee Alloys Corp.....	Bridgeport, Ala. 35740.....	---do.---	Jackson.
Tennessee Valley Authority.....	Muscle Shoals, Ala. 35660.....	---do.---	Colbert.
Union Carbide Corp.....	270 Park Ave. New York, N. Y. 10017	2 plants.....	Jefferson, and Jefferson.
Woodward Co.....	Woodward, Ala. 35189.....	Plant.....	Jefferson.
<b>Iron ore:</b>			
<b>Limonite:</b>			
Davis Bros. Mining Co.....	Box 6 Brantley, Ala. 36009	Open pit mine.....	Pike.
Shook & Fletcher Supply Co.	Box 2686 Birmingham, Ala. 35202	---do.---	Franklin.
U. S. Pipe & Foundry Co.....	3300 First Ave., N. Birmingham, Ala. 35202	---do.---	Do.
<b>Lime:</b>			
Alabaster Lime Co.....	Siluria, Ala. 35144.....	Limekiln.....	Shelby.
Cheney Lime & Cement Co.....	Algood, Ala. 35013.....	---do.---	Do.
Longview Lime Co.....	Woodward, Ala. 35189.....	---do.---	Do.
Southern Cement Co.....	18th Floor Daniel Bldg. Birmingham, Ala. 35233	---do.---	Do.
United States Gypsum Co.....	101 S. Wacker Dr. Chicago, Ill. 60606	Limekiln and plant...	Do.
<b>Mica, flake:</b>			
United States Gypsum Co.....	101 S. Wacker Dr. Chicago, Ill. 60606	Open pit mine and plant.	Randolph.
<b>Natural gas:</b>			
Black Warrior Petroleum Co., Inc.	Box 1642 Mobile, Ala. 36601	Gasfield.....	Escambia.
<b>Natural gas liquids, including LP- gases and natural gasoline:</b>			
Cities Service Oil Co.....	Bartlesville, Okla. 74003.....	Plant.....	Mobile.
<b>Petroleum:</b>			
<b>Crude:</b>			
Ancora Corp.....	1 Jackson Pl., Suite 620 San Francisco, Calif. 94111	Citronelle field.....	Do.

Table 17.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Petroleum—Continued</b>			
<b>Crude—Continued</b>			
E. L. Erickson	1235 Petroleum Bldg. Jackson, Miss. 39201	Toxey field	Choctaw.
Mobil Oil Corp	Box 900 Dallas, Tex. 75221	Citronelle field	Mobile.
Pruett & Hughes Co.	390 Petroleum Bldg. Jackson, Miss. 39201	Choctaw Ridge field	Choctaw.
Sun Oil Co.	Box 2880 Dallas, Tex. 75221	Citronelle field	Mobile.
<b>Refineries:</b>			
Alabama Refining Co.	Mobile, Ala. 36600	Plant	Do.
Hunt Oil Co.	Tuscaloosa, Ala. 35401	do	Tuscaloosa.
Vulcan Asphalt Refining Co.	Cordova, Ala. 35550	do	Walker.
Warrior Asphalt Co.	Tuscaloosa, Ala. 35401	do	Tuscaloosa.
<b>Phosphate rock:</b>			
Monsanto Co.	800 N. Lindbergh Blvd. St. Louis, Mo. 63144	Open pit mine	Limestone.
<b>Pig iron:</b>			
Republic Steel Corp.	1629 Republic Bldg. Cleveland, Ohio 44115	Blast furnaces and mills.	Etowah and Jefferson.
U. S. Pipe & Foundry Co.	Box 2651 Birmingham, Ala. 35202	do	Jefferson.
United States Steel Corp.	Box 599 Fairfield, Ala. 35064	do	Do.
Woodward Co.	Woodward, Ala. 35189	do	Do.
<b>Salt:</b>			
Olin Mathison Chemical Corp.	Box 28 McIntosh, Ala. 36553	Brine wells	Washington.
<b>Sand and gravel:</b>			
Alabama Gravel Co.	2325 City Federal Bldg. Birmingham, Ala. 35203	Dredge and open pit mine.	Elmore and Montgomery.
Radcliff Materials, Inc.	Mobile, Ala. 36601	Dredge.	Mobile.
W. T. Ratliff Co., Inc.	Box 1111 Knoxville, Tenn. 37901	Open pit mine	Clarke.
C. T. Thackston Sand and Gravel Co.	Box 3211 Montgomery, Ala. 36101	do	Montgomery.
Vulcan Materials Co.	Box 7324-A Birmingham, Ala. 35223	2 open pit mines	Macon and Montgomery.
<b>Stone:</b>			
<b>Dolomite:</b>			
Dolcito Quarry Co.	Box 6566 Birmingham, Ala. 35217	do	Jefferson.
Montevallo Limestone Co., Inc.	Box 6493 Birmingham, Ala. 35217	do	Shelby.
U. S. Pipe & Foundry Co.	3300 First Ave., N. Birmingham, Ala. 35202	do	Jefferson.
United States Steel Corp.	Box 599 Fairfield, Ala. 35064	3 quarries	Do.
<b>Limestone, crushed:</b>			
Lone Star Cement Corp.	Box 623 West End Branch Richmond, Va. 23230	4 quarries	Jefferson, Marengo, and Washington.
Madison Limestone Co., Inc.	Box 46 Huntsville, Ala. 35804	do	Madison.
Martin Marietta Corp.	18th Floor Daniel Bldg. Birmingham, Ala. 35223	2 quarries	Shelby.
Vulcan Materials Co.	Box 7324-A Birmingham, Ala. 35223	6 quarries	Colbert, Etowah, Franklin, Jackson, Shelby, and Talladega.
Wade Sand & Gravel Co., Inc.	Box 39048 Fairview Station Birmingham, Ala. 35208	Quarry	Jefferson.
<b>Limestone, dimension:</b>			
Georgia Marble Co.	Russellville, Ala. 35653	do	Franklin.
<b>Marble, crushed:</b>			
Georgia Marble Co.	Gantts Quarry, Ala. 35069	2 quarries and plant	Talladega.
Moretti-Harrah Marble Co.	Box 330 Sylacauga, Ala. 35150	Quarry and plant	Do.
Thompson-Weinman & Co.	Cartersville, Ga. 30120	Quarry	Do.
<b>Marble, dimension:</b>			
Moretti-Harrah Marble Co.	Box 330 Sylacauga, Ala. 35150	Quarry and plant	Do.
<b>Oystershell:</b>			
Radcliff Materials, Inc.	Box 1288 Mobile, Ala. 36601	2 dredges and plants	Mobile.
<b>Sandstone, crushed:</b>			
Sisson & Bailey Stone Co.	Route 3 Oneonta, Ala. 35121	do	Blount.
United States Steel Corp.	Box 2969 Pittsburgh, Pa. 15230	do	Jefferson.

Table 17.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Sandstone (crushed)—			
Continued			
Enos Vann .....	Box 246 Trussville, Ala. 35173	2 dredges and plants.	Jefferson.
Talc:			
American Talc Co.....	Alpine, Ala. 35014.....	Open pit mine and plant.	Talladega.

<sup>1</sup> Portland and masonry cement.<sup>2</sup> Portland, masonry, and slag cement.

# The Mineral Industry of Alaska

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, the Division of Geological Survey, and the Division of Oil and Gas of the Alaska Department of Natural Resources for collecting information on all minerals.

By Richard B. Smith <sup>1</sup> and Donald P. Blasko <sup>2</sup>

Drilling activity on the North Slope of Alaska, north of the Arctic Circle, decreased appreciably from the boom conditions of 1969 as the petroleum industry awaited approval of the Trans-Alaska Pipeline. Problems of environmental protection combined with native land claims stalled pipeline construction operations; development drilling dropped below anticipated rates; and ancillary industries marked time. Investigators sought alternative routes for transporting crude oil to markets. The converted tanker SS Manhattan completed a second trip through the Northwest Passage to assess this means of transporting oil to the East Coast markets.

Total value of mineral production in 1970 was \$338.3 million, an increase of 31 percent above the 1969 figure. Crude oil and natural gas production, \$251.7 million and \$27.4 million, respectively, made up 83

percent of the total. Value of sand and gravel, the State's second-place mineral commodity, increased from \$18.6 million to \$41.1 million, reflecting an increase in unit value and a 59-percent increase in tonnage produced. Value of coal production was down 7 percent despite an increase in unit value over that of 1969. The value of stone production, which represented less than 2 percent of total mineral value in 1969, increased 157 percent in 1970.

**Wages and Hours.**—Total insured wages in the mineral industries in the calendar year 1970, as reported by the Alaska Department of Labor, were \$52.0 million (\$56.3 million in 1969). Average monthly employment was 2,994 (3,494 in 1969). In the mineral industries covered by the

<sup>1</sup> Petroleum engineer, Division of Fossil Fuels.

<sup>2</sup> Petroleum engineer, Bureau of Mines, Anchorage Field Office, Anchorage, Alaska.

Table 1.—Mineral production in Alaska <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ore and concentrate...short tons, antimony content...	12	\$13	63	\$109
Barite.....thousand short tons.....	W	W	134	835
Coal (bituminous).....do.....	667	4,366	549	4,059
Gold (recoverable content of ores, etc.).....troy ounces.....	21,227	881	34,776	1,265
Lead (recoverable content of ores, etc.).....short tons.....	2	1	--	--
Natural gas.....million cubic feet.....	50,864	12,665	111,576	27,448
Petroleum (crude).....thousand 42-gallon barrels.....	73,953	214,464	83,616	251,684
Sand and gravel.....thousand short tons.....	16,205	18,615	25,825	41,092
Silver (recoverable content of ores, etc.).....thousand troy ounces.....	2	4	2	4
Stone.....thousand short tons.....	1,954	3,902	6,470	10,014
Value of items that cannot be disclosed:				
Barite (1969), gem stones, LP gases (1969), mercury, platinum-group metals, tin, and values indicated by symbol				
W.....	XX	2,865	XX	1,761
Total.....	XX	257,776	XX	338,271
Total 1967 constant dollars.....	XX	243,418	XX	306,135

<sup>p</sup> Preliminary. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

Table 2.—Value of mineral production in Alaska, by region<sup>1</sup>  
(Thousands)

Region	1969	1970	Minerals produced in 1970 in order of value
Aleutian Islands.....	W	W	Stone, sand and gravel.
Bristol Bay.....	W	W	Sand and gravel, mercury.
Cook Inlet-Susitna.....	\$192,658	\$241,534	Petroleum, natural gas, sand and gravel, stone, coal, gold, silver.
Copper River.....	2,000	W	Sand and gravel, stone.
Kenai Peninsula.....	46,902	51,380	Petroleum, natural gas, stone, sand and gravel.
Kodiak.....	W	W	Sand and gravel, stone.
Kuskokwim.....	W	W	Platinum-group metals, mercury, gold, silver, sand and gravel.
Northern Alaska.....	392	1,240	Petroleum, natural gas, sand and gravel.
Northwestern Alaska.....	481	W	Sand and gravel.
Seward Peninsula.....	424	646	Sand and gravel, antimony, tin, stone, gold.
Southeastern Alaska.....	4,333	5,461	Sand and gravel, stone, barite.
Yukon River.....	7,968	30,040	Sand and gravel, stone, coal, gold, silver.
Undistributed <sup>2</sup> .....	2,618	7,970	
Total.....	257,776	338,271	

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

<sup>1</sup> No production reported in the Alaska Peninsula and Bering Sea regions.

<sup>2</sup> Includes gem stones and some sand and gravel and stone that cannot be assigned to specific regions.

Table 3.—Indicators of Alaska business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total labor force.....	107.8	116.1	+8.2
Unemployment.....	9.4	12.0	+28.7
Employment:			
Construction.....	6.6	7.4	+12.1
Mining.....	3.5	2.7	-22.9
Transportation and public utilities.....	8.8	9.2	+4.5
Wholesale and retail trade.....	14.0	14.9	+6.4
Manufacturing.....	7.3	8.1	+11.0
Services.....	10.6	11.4	+7.5
Government.....	33.3	35.4	+6.3
Finance, insurance, and real estate.....	2.7	3.0	+11.1
Personal income:			
Total.....	\$1,258	\$1,426	+13.3
Per capita.....	\$4,249	\$4,676	+10.0
Construction activity:			
Value of authorized nonresidential construction.....	\$16.8	\$21.6	+28.6
Number of authorized new housing units.....	1,534	1,656	+8.0
Highway construction contracts awarded.....	\$38.0	\$74.7	+96.6
Mineral production.....	\$257.8	\$338.3	+31.2
Foreign trade:			
Exports.....	\$94.1	\$134.8	+43.3
Imports.....	\$61.6	\$106.9	+73.5

Sources: Area Trends in Employment and Unemployment; Employment and Earnings; Survey of Current Business; Construction Review; Streets and Roads; Highlights of United States Import and Export Trade; and U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non-fatal	Frequency	Severity
<b>1969:</b>								
Coal.....	62	298	18	158	--	6	38.06	165
Metal.....	200	145	29	256	--	7	27.33	437
Nonmetal.....	15	177	3	20	--	--	--	--
Sand and gravel.....	885	163	145	1,157	--	26	22.47	521
Stone.....	137	163	22	197	--	3	15.24	437
Total.....	1,299	167	217	1,788	--	42	23.49	463
<b>1970: P</b>								
Coal.....	70	303	21	177	--	9	50.90	204
Metal.....	205	142	29	260	--	22	84.60	4,818
Nonmetal.....	15	252	3	26	--	--	--	--
Sand and gravel.....	900	143	129	1,110	--	26	23.43	536
Stone.....	115	123	14	124	1	1	16.11	48,766
Total <sup>1</sup> .....	1,300	151	196	1,697	1	58	34.77	4,678

P Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

**Table 5.—Expenditures by major companies for exploration, prospecting, and development**  
(Thousands)

Type and region	1968	1969 <sup>r</sup>	1970 <sup>p</sup>
Metals exploration:			
Arctic Alaska .....	\$710	NA	\$775
Interior Alaska .....	120	NA	1,325
Western Alaska .....	1,240	NA	1,225
Southwestern Alaska .....	50	NA	150
South-central Alaska .....	850	NA	1,100
Southeastern Alaska .....	1,540	NA	2,275
General .....	( <sup>1</sup> )	NA	( <sup>2</sup> )
<b>Total metals .....</b>	<b>4,510</b>	<b>6,900</b>	<b>6,850</b>

<sup>p</sup> Preliminary. <sup>r</sup> Revised. NA Not available.  
<sup>1</sup> In 1968 and 1970 general expenses were distributed elsewhere.

Source: Division of Geological Survey, Department of Natural Resources, Alaska.

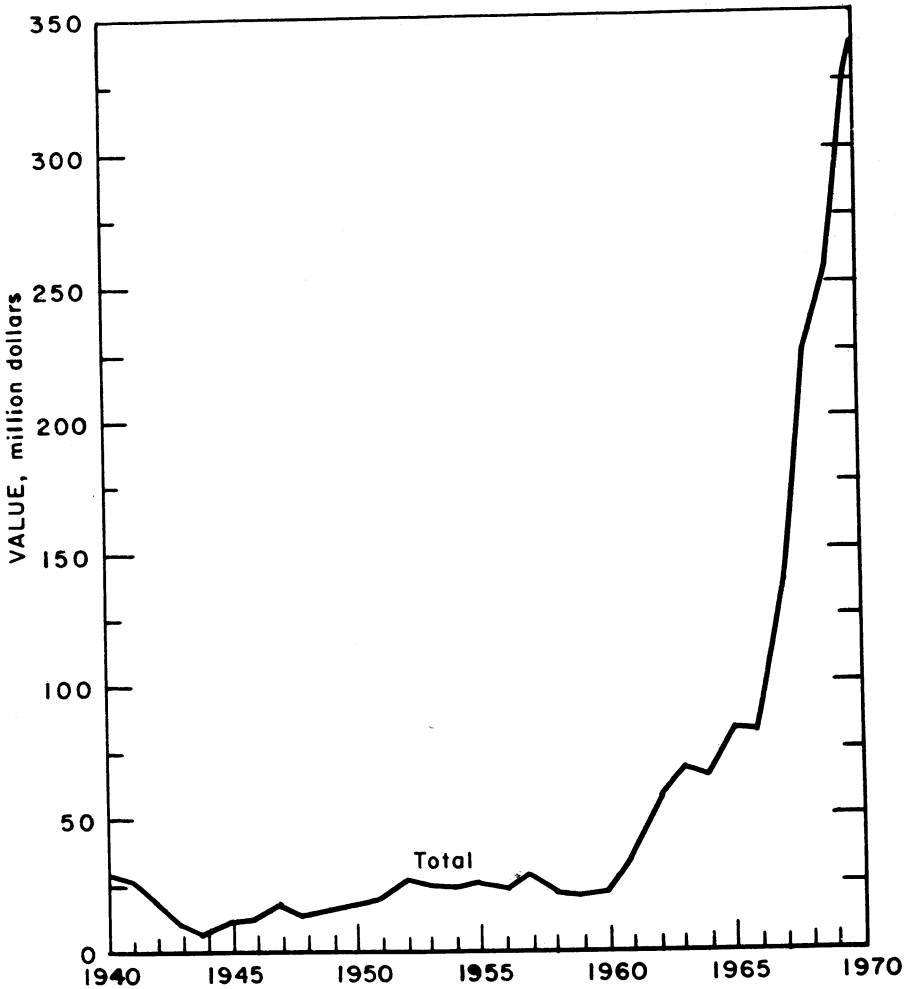


Figure 1.—Total value of mineral production in Alaska.

Employment Securities Act (operators with hired labor), monthly earnings averaged \$1,447, compared with \$1,346 in 1969. Monthly earnings in metal mining were \$997; in oil and gas, \$1,487; and in all other mining, \$1,442.

#### Legislation and Government Programs.

—Construction of the Snettisham hydroelectric plant was resumed during 1970 after the U.S. Army Corps of Engineers revised the design to reduce the cost of construction. The project is scheduled to provide 46,700 kilowatts of power to the Juneau area upon completion in 1972. In 1960 Alaska's electric utilities delivered to the public 349 million kilowatt-hours of electric energy. This increased to 841 million in 1968, 956 million in 1969, and an estimated 1,075 million kilowatt-hours in 1970. The utility load tripled in just 10 years. By comparison, the national average utility load historically doubles in 10 years.

In 1970 Alaska had 714,548 kilowatts of installed generator capacity of which 406,596 kilowatts was for utilities, up from 122,559 kilowatts in 1960. Gas turbines are used to power 33 percent of the total installed capacity, diesel accounts for 30 percent, hydropower 19 percent, and steam, 18 percent. The average cost of a kilowatt-hour of electricity furnished by Alaska utilities for home use continued to decline, from \$0.0432 in 1960 to \$0.0313 in 1969.

The 1970 State Legislature established the Division of Geological Survey within the Department of Natural Resources to replace the former Division of Mines and Geology. The head of the new Division of Geological Survey will be called the State Geologist.

Alaska's new oil severance tax is based on a sliding scale varying between 3 and 8 percent of the value of production depending on the daily average production from the well. In most States, the basis for severance tax is a straight percentage of the value of the oil or a fixed amount of tax per barrel. Production in Alaska will be taxed 3 percent for the first 300 barrels, 5 percent on the next 700 barrels, 6 percent on the next 1,500 barrels, and 8 percent on all production in excess of 2,500 per day on a per-well basis. The new tax results in a slight increase for Cook Inlet wells (about 5.5 percent compared with the former 4 percent). The highly produc-

tive North Slope wells will be taxed at nearer the maximum of 8 percent.

The State rescinded its demand for payment of additional oil royalties on Cook Inlet production pending further study. The demand grew out of a dispute between the State and oil operators over higher prices for Cook Inlet crude oil established during the year by the Department of Natural Resources.

The results of pertinent studies by State and Federal agencies were published.<sup>3</sup>

**Transportation.**—Movement of supplies and equipment to the North Slope continued at a near record pace for the year. Eighteen trucking firms hauled 1,000 loads for a total of more than 20,000 tons of freight to the North Slope over the ice road dedicated in 1970 as the Walter J. Hickel Highway. The road was open from

<sup>3</sup> Asher, R. R. Chemistry and Geology, Boundary Area, Fortymile District, Eagle A-1 Quadrangle, Alaska. Alaska Div. of Geol. Survey Geochemical Rept. No. 23, 1970, 34 pp.

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Warfield, Robert S. Testing for Downward Vein Extensions of Gold-Silver Mineralization in the Wolf Creek-Fairbanks Creek Divide Area, Fairbanks District, Alaska. U.S. BuMines Open-File Rept. 3-70, 1970, 20 pp.

Table 6.—Coastwise receipts and foreign mineral trade  
(Short tons)

Commodity	1968			1969		
	Coastwise receipts	Imports	Exports	Coastwise receipts	Imports	Exports
Bituminous coal and lignite.....	62	---	---	45	---	---
Gasoline.....	343,107	35,428	---	388,509	66,710	---
Kerosine, distillate, residual fuel oil.....	939,514	309,560	---	1,222,850	471,955	---
Asphalt, tar, pitches.....	14,779	---	---	15,979	---	---
Lubricating oils and greases.....	7,521	---	---	6,223	---	---
Petroleum and coal products, n.e.c.....	7,102	120,034	---	1,662	120,833	---
Building cement.....	62,365	1,690	---	57,098	18,222	---
Building stone, unworked; crushed and broken stone.....	---	---	---	64	---	---
Clay, ceramic and refractory materials.....	10,599	---	---	10,691	---	---
Structural clay products including refractories.....	1,615	60	---	2,137	63	---
Sulfur.....	9,608	8,732	---	13,053	7,745	---
Sand and gravel.....	1,020	2,000	---	1,011	9,287	---
Iron ore and concentrate.....	---	---	---	---	---	---
Iron and steel scrap.....	441	---	---	155	---	---
Iron and steel products.....	5,288	1,551	---	32,472	56,389	---
Aluminum and aluminum alloys, unworked.....	51	---	---	204	---	---
Lead and zinc including alloys, unworked.....	84	---	---	---	---	---
Nonferrous metal ores and concentrates, n.e.c.....	36	---	15,197	4	---	16,209
Nonferrous metals primary smelter products, basic shapes, wire, castings and forgings, except copper, lead, zinc, and aluminum.....	416	---	---	995	---	---
Fertilizer materials.....	---	---	---	17	---	---

Source: U.S. Army Corps of Engineers, Waterborne Commerce of the United States, Part 4, Pacific Coast, Alaska and Pacific Islands. Calendar years 1968-69.

January 15 to March 30. The trucking industry performed the maintenance necessary to open the road from Livengood to the Yukon River. The State opened the interval from the Yukon River to Bettles. Pipeline contractors opened the road from Bettles to Sagwon on the North Slope.

The State of Alaska and officials of Trans-Alaska Pipeline System (TAPS) failed to reach agreement on financing and constructing a pipeline haul road from the Yukon River to the North Slope. During 1970, the Alaska Legislature passed a law authorizing the State to advance \$120 million to TAPS for construction of the road. TAPS declined the offer because of the requirement that the State was to be reimbursed by TAPS the full amount of the advanced funds within 5 years, whether or not construction of the pipeline was ever approved. At yearend, TAPS was awaiting a construction permit for the pipeline from the U.S. Department of the Interior.

In 1970, waterborne freight shipments to Alaska's North Slope increased despite delays in approval of the TAPS pipeline. In one of the largest convoys of tugs, barges, and cranes in maritime history, more than 70 oceangoing vessels carrying 185,000 tons of supplies and construction

materials made the trip through the Bering Strait to Prudhoe Bay. The cargo included 169 miles of 48-inch-diameter pipe for the TAPS pipeline, more than 6 million gallons of bulk fuel, and 45,000 tons of general cargo. Two of the 100-foot by 400-foot pipe barges, the largest of their type in the world, were loaded in Tacoma, Wash. Four others, built in the Far East, hauled pipe directly from Japan to Alaska. Following the North Slope delivery, one of the new tugs, the 7,000-horsepower Guardian, was put in service in the floating railroad operated by Hydro-Train as a direct rail-water-rail link between Seattle and Alaska. Anchorage doubled the general cargo-handling facilities of its port by the completion in 1970 of a 320-foot dock extension built at a cost of \$2.3 million. The new construction added a second berth for oceangoing container ships.

The Civil Aeronautics Board (CAB) continued its reevaluation of the Alaska air-service pattern both within the State and between Alaska and the lower 48 States. Major changes have been proposed in the Alaska route structure of Alaska Airlines, Inc., Kodiak Airways, Inc., Pan



American World Airways, Inc., Western Air Lines, Inc., and Wien Consolidated Airlines, Inc. This is the first comprehensive review in 10 years of the major airline routes in the State by the CAB. The primary purpose of the investigation is to

improve the air transportation available at minimal cost to the traveler, shipper, and public.

Humble Oil & Refining Co. announced that its studies on transporting Arctic crude oil through the Northwest Passage

Table 7.—Freight rates, Seattle to selected Alaskan cities in 1970 Hydro-Train service <sup>1</sup>  
(Cents per hundred pounds)

Commodity	Minimum shipment (pounds)	From Seattle to—		
		Anchorage via Whittier	Fairbanks via Whittier	Seward via Whittier
Groceries.....	60,000	238	302	--
Do.....	80,000	189	253	--
Do.....	<sup>2</sup> 100,000	113	178	--
Iron or steel articles.....	50,000	283	382	283
Do.....	80,000	194	272	194
Do.....	100,000	183	261	183
Machinery.....	60,000	269	316	254
Do.....	80,000	231	278	216
Do.....	100,000	220	267	205
Lumber.....	80,000	186	255	187
Do.....	100,000	175	244	177
Do.....	120,000	150		
Ores and concentrates (southbound only) <sup>3</sup> .....	60,000	119	158	--
Do.....	80,000	100	140	--
Do.....	100,000	95	134	--
Petroleum and products.....	60,000	229	336	229
Do.....	80,000	191	298	191
Do.....	100,000	180	287	180

<sup>1</sup> Rates include all-risk insurance.

<sup>2</sup> Excess over 80,000-pound minimum when loaded in or on same car.

<sup>3</sup> Value not to exceed \$60 per ton. Rate increases 25 percent for each additional \$60 (or fraction) per ton valuation.

Source: Alaska Hydro-Train.

to the East Coast by tanker were suspended following an analysis of additional data obtained on the second voyage of the ice-breaking supertanker SS Manhattan in 1970. The physical feasibility of tanker navigation through the Arctic at least as far as Resolute Bay was proved, but the economics appear more favorable for transporting oil by pipeline.

Bell Aerospace Corp., seeking to prove the commercial application of air cushion vehicles (ACV), has put together a feasibility study using the lower Yukon and Kuskokwim River drainage systems as the basis for a model feeder transportation system. Annual operating cost is estimated at \$800,000 for nearly year-round transport of fuel, food, and materials. House trailers designed as mobile clinics, libraries, training schools, and government agencies are envisioned as freight. The backbone of the system would be two 25-ton payload ACV's traveling the river systems at 15 miles per hour fully loaded. Their size would give them a capacity comparable to freight aircraft, such as the Hercules. The first pro-

totype of Bell's "Voyageur" ACV was to be launched near the end of 1971.

Sea-Land Service, Inc., added a third containership to the Alaska-Seattle run and increased their frequency from one to two sailings per week. The result is an 80-percent increase since 1968 in containership capacity in the Alaska trade.

Airfreight to the North Slope decreased from an alltime high reached in 1969. In 1970 the Fairbanks airport, gateway to the North Slope, handled 60,800 tons of air freight, down 49 percent from the 1969 peak of 120,300 tons. Despite this decrease, the 1970 quantity was still more than three times the freight handled during any prior year except 1969. Receipts of airfreight at Fairbanks increased 14 percent over the 1969 level, but outgoing shipments decreased sufficiently to cause a drop in the total freight handled.

Highway construction in 1970 reached a peak of activity exceeded only by that during 1966. The most spectacular and impressive construction was the building of the Anchorage to Fairbanks highway,

which cuts through the Alaska Range parallel to the railroad. If climatic conditions continued to be favorable, the Highway Department was hopeful that the new highway would be open to traffic by the end of the 1971 construction season. The Highway Department continues to seek new ways to protect road surfaces from damage caused by freezing and thawing. In an experiment, a 1,200-foot section of the new Anchorage to Fairbanks highway was treated by the installation of various thicknesses of plastic foam insulation covered with gravel and paving. ARCO Chemical Co.'s experiments on the North Slope with styrene and urethane foam in gravel road construction indicated that polyurethane with a sealant applied was the best insulation material for roads built over permafrost. ARCO reported that use of the insulation can result in savings of \$10,000 to \$150,000 per mile, depending on the length of gravel haul and related factors. The foam was reported to be 30 to 100 times as effective an insulator as gravel, reducing

gravel requirements up to 50 percent, depending on the anticipated traffic.

Other significant transportation projects on which construction was started were the bridge between Sitka and Japonski Island, the Copper River bridge at Chitina, and the first three bridges on the Copper River Delta. The trend of Japanese interest in Alaska bridge construction, which started in 1969, gained considerable momentum during 1970. Of 22 bridges advertised and awarded by the State, the fabrication of 13 is being performed in Japan.

During the fiscal year ending in 1970, the Alaska Department of Highways was successful for the first time in bringing into contract a sufficient number of construction projects to obligate its entire Federal aid apportionment for the year. In addition, \$17.6 million from prior year apportionments was released and obligated, \$8.86 million in emergency assistance funds was obligated, and release was secured of the first \$5 million of Federal assistance authorized by the 1966 Highway Act.

## REVIEW BY MINERAL COMMODITIES

### MINERAL FUELS

**Coal (Bituminous).**—Tonnage of coal produced declined 18 percent from that of 1969. Value decreased 7 percent, and unit value rose from \$6.54 to \$7.39 per ton. Alaska Matanuska Coal Co., operating in the Cook Inlet-Susitna area, and B & R Coal Co., operating in the Yukon River region, were the two principal producers. Usibelli Coal Mine, Inc., and Vitro Minerals Corp. also produced from mines in the Yukon River region until midyear when Usibelli completed purchase of Vitro's Nenana field coal properties. All coal was produced from strip operations.

With the developing national energy availability problem, Alaska coals, particularly those on the North Slope, drew renewed interest. Kaiser Steel Corp. examined coals in the Kukpowruk River area near Cape Beaufort on the northwest flank of the Brooks Range. The Cape Beaufort coals, previously examined by the Bureau of Mines, were found to be capable of producing metallurgical-quality coke by blending with as little as 15 percent strongly coking coals. The deposits are large but as yet sketchily defined. Transportation is a

big problem. An offshore deep-water loading platform with a slurry pipeline from shore is under consideration.

Usibelli Coal Mine, Inc., acquired the equipment and facilities of Vitro Minerals Corp.'s Cripple Creek coal mine in the Nenana fields southwest of Fairbanks. The purchase involved more than \$1 million and leaves Vitro Minerals Corp., a subsidiary of Earth Resources Co., with no operating mines in Alaska. The Usibelli mine and the Cripple Creek mine are adjacent and will be operated as one. The Defense Supply Agency awarded a \$2.4 million contract to Usibelli Coal Mine, Inc., for 350,000 tons of bituminous coal. Northern military bases, including the Clear Missile Tracking Station near Nenana, still use coal-fired equipment. The price per ton for the fiscal year 1971 contract was \$6.86, compared with a price of \$6.47 in fiscal 1970.

American Carbon Co. has filed a request with the U.S. Department of the Interior to modify or amend Public Land Order 4582 so the company can file for coal-prospecting permits and receive subsequent leases on lands in the Bering River coalfields. Supporting the request, the company

listed plans to construct a 7-million-ton-per-year coal mine and beneficiation plant, and auxiliary construction totaling more than \$35 million.

The Bureau of Mines conducted core drilling operations in the Jarvis coal fields located 125 miles southeast of Fairbanks. Twelve holes, less than 120 feet deep, were drilled to confirm the continuity of the seams in the vicinity of present mine workings, and to provide core samples for analysis. The coal is being considered for mine-mouth electric-power generation by the Golden Valley Electric Association.

**Petroleum and Natural Gas.**—Crude oil production in Alaska continued a modest growth rate for the second year; production increased 12 percent in 1969 and 13 percent in 1970. Production of crude oil in 1970 was 83.6 million barrels, up from 74.0 million in 1969. All production was from the five offshore and one onshore field in the Cook Inlet Basin except for 333,000 barrels produced on the North Slope.

Drilling activity in the Cook Inlet Basin, both exploratory and development, continued to decline during 1970. Development well drilling dropped abruptly as fields became fully drilled. There have been no new field discoveries in the Cook Inlet Basin since 1968.

Production of nonassociated gas continued to increase because of demands of the natural gas liquefaction plant and the ammonia-prilled urea petrochemical plant. Production of marketed natural gas during 1970 was 111.6 billion cubic feet, compared with the 1969 total of 50.9 billion.

**Table 8.—Oil and gas lease acreage under Federal supervision**

Year	Acres (thousands)
1966.....	9,275
1967.....	7,135
1968.....	6,841
1969.....	6,936
1970.....	6,168

Source: U.S. Geological Survey.

Reservoir repressurization by gas injection in the Swanson River field, initiated in 1962, has succeeded in reestablishing the original bottom-hole pressure of 5,650 pounds. Oil production increased slightly during the last few months of the year although fewer wells were producing. Natural gas was being supplied from the Kenai gasfield to the Alaska Pipeline Co.,

the Kenai Pipeline Co., the Standard Oil Co. of California, the Collier Carbon and Chemical Corp. petrochemical plant, the Phillips Petroleum Co. liquefied natural gas plant and the city of Kenai. The Sterling gasfield was supplying gas to Consolidated Utilities. Kenai and Sterling were the only producing gasfields on the Kenai Peninsula—the other gasfields on the peninsula—Birch Hill, Beaver Creek, West Fork, Falls Creek, and North Fork—remained shut-in.

The State of Alaska continued to take Cook Inlet oil production royalty payments in kind rather than in money and sold the oil to the Tesoro Petroleum Corp. for refining at its Big Bear refinery north of Kenai. The 15,000-barrel-per-day refinery produced jet and diesel fuels, which were barged to a storage facility in Anchorage for distribution. The low-sulfur residual fuels were shipped by tanker to Japan for industrial use. During 1970, the Collier Carbon and Chemical Corp. ammonia and prilled urea plant processed 17,863 million cubic feet of natural gas supplied by Union Oil Co. of California from the Kenai gasfield. The liquefied natural gas plant owned by Phillips Petroleum Co. and Marathon Oil Co. processed 57,263,376 thousand cubic feet of gas produced by Phillips Petroleum Co. from the offshore North Cook Inlet field and from the Kenai gasfield.

A new 450,000-barrel tanker, the Arctic Tokyo, was put into operation during 1970. It joined its sister ship the Polar Alaska in transporting liquefied methane to Japan from the Phillips-Marathon plant.

A world's record in directional drilling was made by Marathon Oil Co. from their Dolly Varden platform in the McArthur River field, Cook Inlet. The well was drilled to a total measured depth of 17,010 feet and a true vertical depth of 10,517 feet. The bottom of the well is displaced 12,584 feet southeast of its surface location. The long directional displacement of this and other wells in the field is necessary because water depths require the platforms to be located on the west flank of the reservoir structure rather than on the crest.

Operators in the Trading Bay Unit built a \$5 million liquid-extraction plant on the west side of Cook Inlet at West Foreland

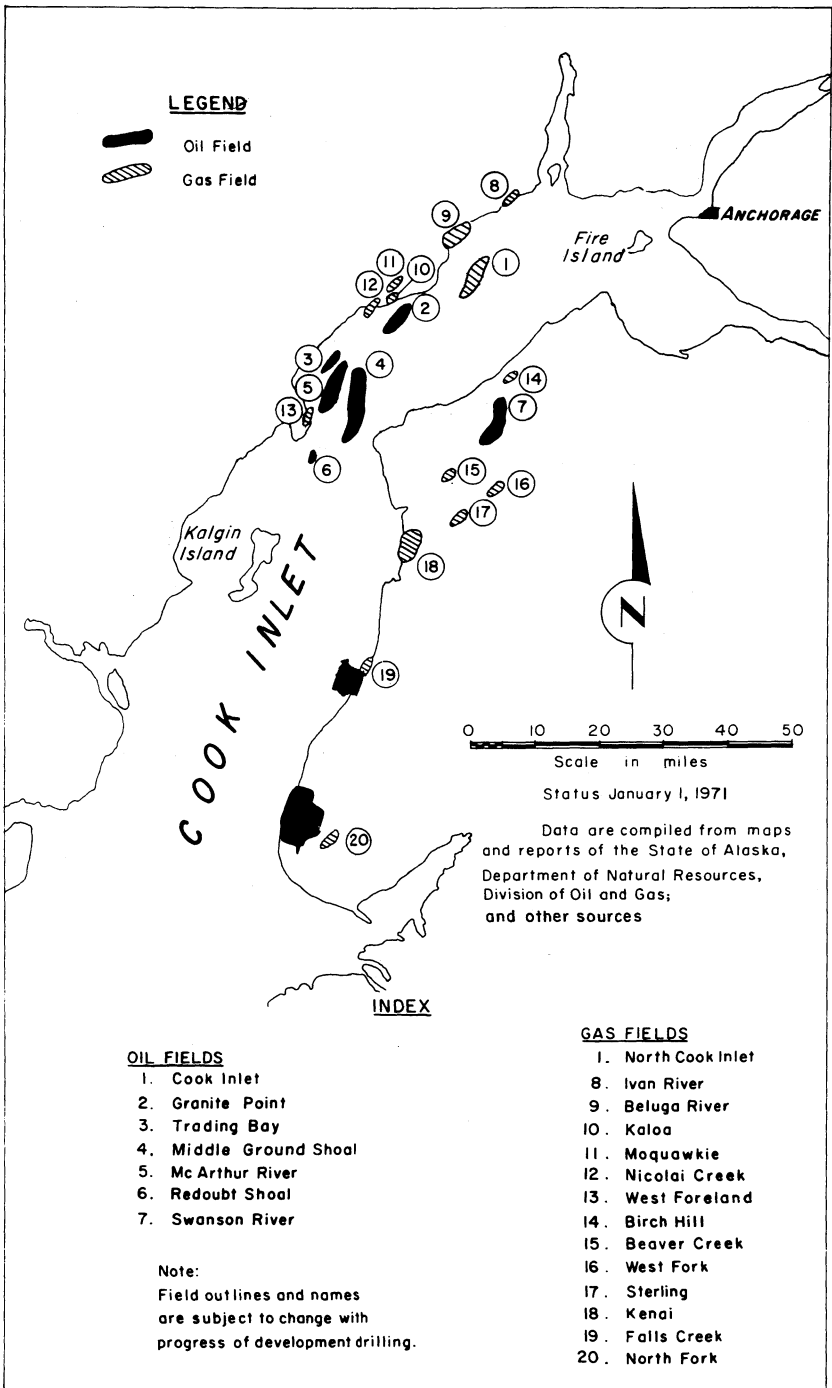


Figure 2.—Cook Inlet oilfields and gasfields.

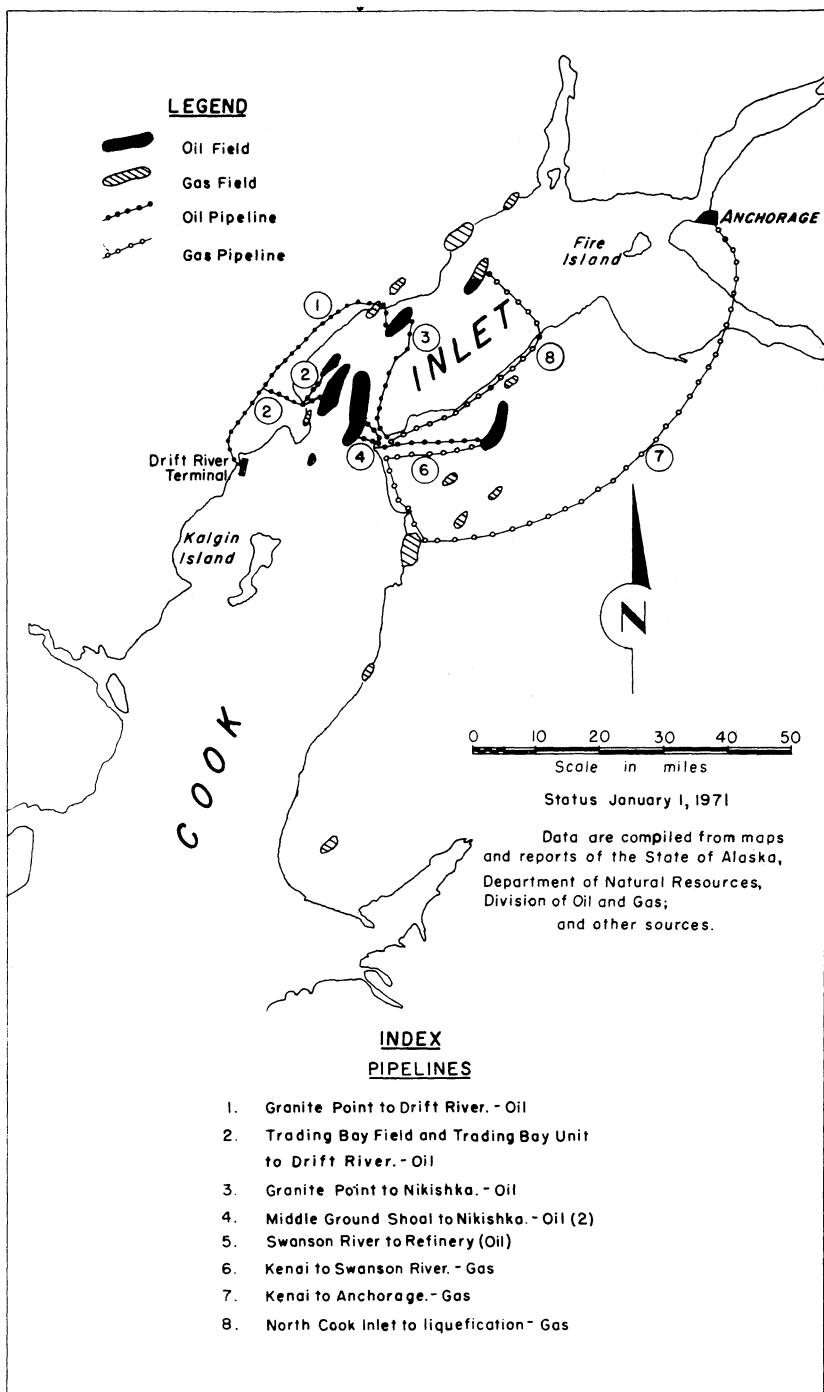


Figure 3.—Cook Inlet oil and gas pipelines.

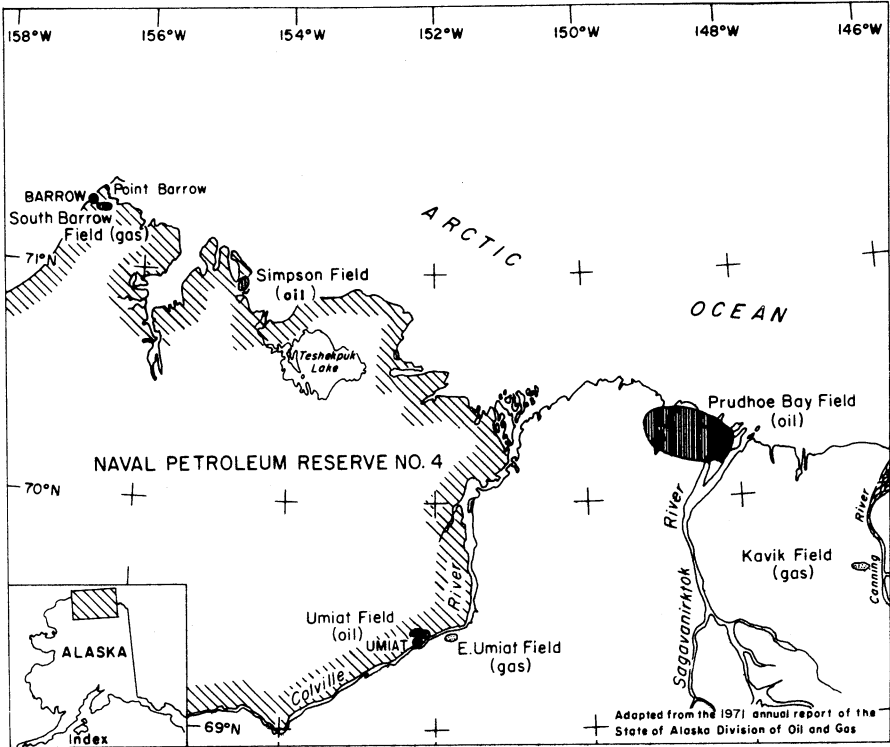


Figure 4.—Oilfields and gasfields of the Arctic North Slope.

and processed 6,985,254 thousand cubic feet of associated gas for the extraction of butanes and heavier fractions. The product is mixed with crude oil, which causes a \$0.05-per-barrel increase in value of the crude, before it enters the Drift River pipeline for transmission to the Drift River tanker terminal. Although there is a market for propane in Anchorage, it is not considered adequate to justify transportation of the product from West Foreland to Anchorage. Other uses of propane in Alaska are being contemplated.

Natural gas was produced from the Beluga River gasfield and sold to the Chugach Electric Association, Inc., mine-mouth power-generation plant at Beluga River. Natural gas was also produced from the Nicolai Creek gasfield for operators' use on offshore platforms and pipeline operations. The Moquawkie gas well, formerly the gas supply for the native village of Tyonek, was shut-in owing apparently to formation damage. The Ivan River, West Foreland,

and Kaloa gasfields have been shut-in since their discovery.

Two companies announced plans in 1969 to build refineries in the Fairbanks area. At the end of 1970 no date had been announced for the start of construction on either refinery. ARCO's plant was to be a 20,000-barrel-per-day refinery fed by North Slope crude oil, which would be transported by the TAPS pipeline. Energy Co. of Alaska, a subsidiary of Earth Resources Co., announced plans to build a 15,000-barrel-per-day refinery and a 40,000-kilowatt powerplant in Fairbanks. A design and engineering contract for the refinery was awarded to Fluor Corp. In June 1970, the Fairbanks North Star Borough passed a resolution allowing Energy Co. of Alaska to locate a refinery within the Borough boundary, thus paving the way for the Alaska Industrial Development Authority to approve Energy Co.'s plans to finance construction of the complex through the sale of bonds. The refinery will produce

Table 9.—Drilling in Alaska

Province and area	Wells				Footage
	Oil	Gas	Dry	Total	
Exploratory drilling:					
North Slope:					
Beechey Point.....	23	--	17	40	426,217
Harrison Bay.....	--	--	1	1	10,101
Mt. Michelson.....	--	1	--	1	9,564
Sagavanirktok.....	--	--	4	4	58,356
Umiat.....	--	--	3	3	12,677
Total.....	23	1	25	49	516,915
Cook Inlet Basin:					
Anchorage.....	--	--	1	1	8,474
Kenai.....	--	--	3	3	37,131
Seldovia.....	--	--	2	2	22,553
Tyonek.....	--	--	2	2	20,759
Total.....	--	--	8	8	88,917
Alaska Peninsula: Port Moller.....	--	--	2	2	20,050
Copper River Basin: Gulkana.....	--	--	1	1	6,721
Total exploratory.....	23	1	36	60	632,603
Development drilling:					
North Slope:					
Barrow.....	--	2	--	2	4,808
Prudhoe Bay.....	29	--	1	30	313,964
Total.....	29	2	1	32	318,772
Cook Inlet Basin:					
Kenai.....	15	1	3	19	193,692
Tyonek.....	--	1	--	1	14,910
Total.....	15	2	3	20	208,602
Total development.....	44	4	4	52	527,374
Grand total.....	67	5	40	112	1,159,977

Source: American Petroleum Institute.

gasoline, aviation gasoline, jet fuel, fuel oil, and asphalt. The adjacent powerplant will sell power to Golden Valley Electric Association, a Rural Electrification Association cooperative.

The Alaska Public Service Corp. announced that a \$1.5 million program is planned to bring liquefied natural gas to Fairbanks for distribution in anticipation of an eventual natural gas supply from the North Slope. The Alaska Public Service will form the Fairbanks Natural Gas Co. and will haul liquefied natural gas from Phillips Petroleum Co.'s plant on the Kenai Peninsula by special tanker and store it in a 50,000-gallon tank in Fairbanks. Cost of the fuel is expected to be less than electricity or propane but probably not as cheap as fuel oil. Fuel oil is being produced at the Tesoro refinery located on the Kenai Peninsula and supplied to the Fairbanks area.

Production of crude oil on the North Slope totaled 332,933 barrels during 1970,

including a small amount produced while testing wells. The major producer was ARCO who used the crude to produce 1,000 barrels per day of diesel fuel for drilling rigs from their small topping plant located at the site of their Sag River State No. 1 well. ARCO's crude oil production was reduced by the Alaska Oil and Gas Conservation Committee from 5,000 to 2,750 barrels per day because of excessive flaring of gas associated with the produced oil.

In early 1970 the Alaska Oil and Gas Conservation Committee defined the rules by which the oil pools in the Prudhoe Bay field will be developed. The three pools that the Committee defined are as follows:

(1) the Prudhoe Bay Kuparuk River oil pool, which occurs at comparatively shallow depths in Cretaceous rocks in the northwest area of the field; (2) the Prudhoe Bay Sadlerochit oil pool, the major reservoir in the field, mainly of Triassic age, 8,500 feet deep and as much as 600

feet thick; and (3) the Prudhoe Bay Lisburne oil pool, a thick carbonate rock reservoir that lies in the eastern portion of the field, mainly Mississippian and Pennsylvanian in age, and is largely undeveloped as yet.

The U.S. Navy, operating the Naval Petroleum Reserve No. 4 in northwest Alaska, produced 615,248 thousand cubic feet of gas from wells in the South Barrow field, a 5.6-percent increase over 1969 production. Slightly more than 80 percent of the gas was used in Government facilities. The remainder was sold to Barrow Utilities, Inc., which distributes gas to the native village of Barrow.

At yearend, TAPS was still awaiting settlement of the ecological and environmental problems, native land claims, and a Department of the Interior land freeze. TAPS is a joint venture of ARCO, BP Alaska, Inc. (whose corporate name was changed during the year from BP Exploration, Inc.), Humble Oil & Refining Co., Mobil Oil Corp., Phillips Petroleum Co., Union Oil Co. of California, Amerada Hess Corp., and Home Gas Co. TAPS was organized to build and operate a pipeline from the Alaska North Slope to the southern coast. TAPS operated as a committee of eight without a chief decisionmaker. In a reorganizational move during 1970, Alyeska Pipeline Service Co. was formed by the TAPS owners to build and operate the pipeline for TAPS. The new organization was intended to provide a more effective and efficient management to develop the pipeline project. Alyeska is a closed corporation with the eight TAPS companies as the only stockholders. Each stockholder will have a share in the new Alyeska organization equal to its share in TAPS.

Proposals to move North Slope oil and gas through Canada to U.S. and world markets were under study. American and Canadian interests continued to investigate the feasibility of oil and gas pipelines from Prudhoe Bay across Canada to markets in California, the Midwestern States, or the East Coast. Additional studies investigated the potentialities of shipping liquefied natural gas by tanker to West Coast and foreign ports. Tests to determine the effects of a hot-oil pipeline on permafrost were conducted at Inuvik on the Mackenzie River north of the Arctic Circle. The experimental facility, operated by Cana-

dian Bechtel, Ltd., for Mackenzie Valley Pipe Line Research, Ltd., consists of a 2,000-foot-long loop of 48-inch pipe carrying hot oil and capable of simulating a variety of field conditions.

## METALS

**Antimony.**—In addition to improvement in the price of antimony in 1970 over the levels of recent years, activity and interest were stimulated by news that smelters were accepting 20 to 30 percent raw ore. Previously 50 percent was the minimum acceptable grade.

Earl Pilgrim's Stampede mine in the Kantishna River district of central Alaska operated in 1970 by flying the ore out in burlap bags by light plane. The operation produced and shipped 116 tons of concentrate having an antimony content of 63 tons at a price of \$17.30 per short ton unit, f.o.b. Seattle, up from \$5.25 per unit received for shipments from the same mine in 1969. The Stampede mine, the only operating mine that responded to the Bureau of Mines canvass, was leased during 1970 to Charles R. Butler of Durango, Colo.

Cantu Mining Co. explored the old antimony mine at Eagle Creek, 12 miles north of Fairbanks. Cantu shipped six cars of stibnite ore from Fairbanks over the Alaska Railroad. Because no mining was done during the year, the shipped ore was taken from developed headings, surface pits, trenches, and from a low-grade stockpile of World War I vintage.

**Copper.**—Recent exploration ventures conducted by major companies in Alaska have been directed largely toward the search for large, low-grade deposits suitable for open pit mining. Copper and nickel deposits are of particular interest. In Arctic Alaska, Bear Creek Mining Co. continued efforts to increase reserves around its copper properties at Bornite in the Kobuk area and did reconnaissance work eastward along the south flanks of the Brooks Range.

Most of the exploratory activity in interior Alaska was in the Eagle and Tanacross quadrangles near the Canadian border. This was the result of favorable geology in the district resembling that around the Casino prospect in the Dawson Range across the border in Canada. Casino is thought to have possibilities of being a commercial copper porphyry. A number of



major companies were active in the Fortymile district including American Exploration & Mining Co. (AMEX), American Smelting and Refining Co. (Asarco), International Minerals & Chemical Corp., Occidental Minerals Corp., Straus Exploration Co., and others. AMEX drilled into a large, low-grade copper deposit at Orange Hill. Other companies including AlVenCo of Anchorage were active in the same area, which is generally referred to as the Shushana or Nabesna district.

In south central Alaska, Hanna Mining Co. continued its detailed study of the old Kennecott Mother Lode property near McCarthy.

Serem of Alaska, Inc., a consortium of three companies wholly owned by the French Government, reportedly investigated a copper-molybdenum prospect near Chignik on the Alaska Peninsula. Paramount Mining Co. and United Copper Corp. jointly evaluated a large, low-grade copper deposit near Ketchikan in Southeast Alaska.

Humble Oil & Refining Co. operated a 16-man camp in the Groundhog Basin area about 12 miles southeast of Wrangell.

Prospecting included drilling of test holes and sampling for copper, lead, and zinc. Alcan Explorations of Canada contracted the work, using helicopters as the prime means of support. The Bureau of Mines examined zinc deposits in this area as a part of the World War II minerals program.

Cities Service Minerals Corp. made good progress with its development program at the Denali copper prospect. The deposit is relatively high grade and is situated close enough to the Alaska Railroad to solve transportation problems. It possibly is the copper mining development closest to actual production in Alaska.

**Gold.**—Production of gold was 64 percent above the 1969 level of 21,227 ounces. The value, which increased only 44 percent, reflects a drop in the average free market value of Alaska gold production from \$41.51 in 1969 to \$36.38 in 1970. Unlike 1968 and 1969, 1970 was a year of calm for the gold industry. During most of the year, prices remained near the \$35-per-ounce level until an October surge to over \$39.

Table 10.—Placer production of gold

Year	Mines producing <sup>1</sup>	Material treated (thousand cubic yards)	Gold recovered		
			Troy ounces	Value (thousands)	Average value per cubic yard
1966-----	55	1,828	26,532	\$929	\$0.508
1967-----	50	1,888	22,948	803	.425
1968-----	37	1,208	21,124	829	.687
1969-----	30	1,081	21,146	878	.812
1970-----	23	999	34,776	1,265	1.266

<sup>1</sup> Excludes itinerant prospectors, "snipers," "highgraders," and others who gave no evidence of legal right to property.

Placers produced all the gold reported in the State; the Yukon River region accounted for almost 98 percent of this total. United States Smelting, Refining and Mining Co.'s Hogatza River dredge again was the leading producer in the region and in the State. The Kuskokwim River region and the Cook Inlet-Susitna region were second and third in production respectively, displacing the Seward Peninsula from the 1969 ranking. The total quantity washed by placer miners was 999,285 yards, from which they recovered an average of \$1.27 per yard, a \$0.46-per-yard increase over the average recovery in 1969. The Bureau of Mines received no confirmation during its canvass, but reports were re-

ceived that the first ore from the Mikado mine of Little Squaw Gold Mining Co. was processed through a new 100-ton-per-day mill. The 3,000 tons of ore reportedly assayed 0.5 ounce of gold per ton. An additional 4,000 tons of ore was stockpiled for milling in 1971. Mining and milling costs averaged \$8.50 per ton. The partners in Little Squaw are Chandalar Gold Mining and Milling Co., Metaline Mining and Leasing Co., Admiral Consolidated, and Grandview Mines, Inc.

**Iron Ore.**—The two principal iron deposits of possible commercial significance are in southeastern Alaska and the area west of Cook Inlet. The southeastern area includes the Klukwan and Snettisham de-

posits in the vicinity of Juneau and others in the Kasaan Peninsula near Ketchikan. The Iliamna area west of Cook Inlet includes a group of deposits discovered in 1963-64 by Pan American Petroleum Corp. The deposits consist of titaniferous magnetite. Most are low grade, ranging from 10 to 20 percent iron and several percent titanium. Bureau of Mines tests of samples from the southeastern deposits indicated that concentrates containing about 60 percent iron and 2 to 4 percent titanium oxide were not difficult to produce by conventional means.

In southeast Alaska, United States Steel Corp. acquired a lease on 589 acres of the Klukwan deposits in 1970. The lease is on the alluvial fan of iron ore along the Chilkat River near Haines. A 10-year mineral rights lease was obtained on a \$50,000 bid by U.S. Steel. Rental fees will be paid on a graduated basis over the 10-year period. If production begins, a royalty payment of \$0.35 per long dry ton of concentrates of 60-percent iron will be paid in lieu of rental. U.S. Steel has been exploring the deposits for several years.

In 1970, Marcona Corp., a San Francisco-based mining and transportation concern, announced plans to develop a \$130 million iron mining complex near Port Snettisham. No starting dates were announced.

**Mercury.**—In 1970, Alaska moved from fifth place in the production of mercury to third place among States by increasing its output by 357 percent over that of 1969. The Red Devil mine in the Aniak district near Sleetmute was one of the principal producers after being closed since the early part of the decade. The mine was dewatered to the 300-foot level, and a 100-ton-per-day concentration plant was installed in 1969. The cinnabar-stibnite concentrate was shipped to Japan.

The second largest Alaska mercury producer is the Haday Mining Co. at Cinnabar Creek in the Aniak district. During the early part of the year a small concentrator was erected near the open pit mine. With a maximum crew of eight men, the operator shipped over 183,000 pounds of cinnabar concentrate from Aniak via Wien Consolidated Airlines, Inc., to Anchorage for retorting.

Production continued in 1970 at the Red Top mine at Marsh Mountain in the Tikchik district, Bristol Bay region. Lyman

Mining Co. continued operations at the White Mountain mine 70 miles southeast of McGrath between the Big and Tatlawiksuk Rivers. Concentrates were shipped to the lower 48 states for retorting.

**Platinum-Group Metals.**—Goodnews Bay Mining Co. continued in 1970 to be the only primary producer of platinum in the State and in the Nation. The company operates a bucket-line dredge in the Salmon River at Goodnews Bay in the Kuskokwim region, southwest Alaska. The company did not authorize the Bureau of Mines to release production information.

**Tin.**—The only tin production in Alaska during 1970 came from the Lost River placer operated by L. Grothe and C. Pearson on Cassiterite Creek in the Cape Nome mining district, Seward Peninsula. The placer mine employed one man for 60 days. The concentrate was shipped to Rotterdam, Netherlands, for reduction.

**Uranium.**—Standard Metals Corp. and Kendrick Bay Mining Co. announced at yearend that Newmont Exploration, Ltd., has begun development work at Kendrick's Alaskan uranium property through Newmont's subsidiary, Dawn Mining Co. The work follows an expenditure exceeding \$500,000 for exploratory work by Newmont, which estimates 50,000 tons averaging 1 percent uranium oxide and an equal amount of thorium oxide to be proved and minable. Under the lease agreement, Kendrick Bay Mining Co. is to receive \$1 per pound of uranium oxide contained in ore shipped from the mine. Actual shipping of ore was expected to commence in May 1971; deliveries were to be made to the Dawn Minerals Co. plant in Washington. Newmont expected that the known ore would be completely extracted during 1971.

## NONMETALS

**Asbestos.**—A mineral prospecting crew has reportedly taken a survey of a little-known asbestos deposit in the Yukon River area due north of Fairbanks. The deposit is on the Little Salt Creek a few miles from the confluence of the Ray and Yukon Rivers, close to the terminus of the TAPS highway on the river. The interest has been generated in part as a result of the proximity to the highway and to a possible future extension of the Alaska railroad.

**Barite.**—Offshore mining was carried on by Alaska Barite Co., 50-percent owned by Inlet Oil Corp., in Duncan Canal adjacent to Castle Island southwest of Petersburg. The ore is in about 20 feet of water and is mined to a depth of 80 feet. Production of barite from the State's only producer was 134,000 short tons, a 39.6-percent increase over 1969 output. Severe winter weather conditions limit operations to 8 months out of the year. In 1970, Alaska Barite Co. purchased a self-propelled working barge equipped with a full machine shop and core holing rig, a new tugboat, and two cranes. Production schedules call for a 15- to 18-man camp. They can mine about 350 tons per hour. Alaska Barite Co. still ships ore to ports in the lower 48 states; in addition, they have a mill located at the old city dock in Kenai. The processing plant, a laboratory, offices, and living quarters have been built into the hull of a grounded former submarine chaser.

**Fluorite.**—P.C.E. Explorations, Ltd., of Toronto bought an option on the old Lost

River tin mine grounds between Teller and Tin City on the tip of Seward Peninsula. Two mobile drilling rigs reportedly found enough fluorite-tin-tungsten ore to justify starting production in 1971, with fluorite the most important of the multi-mineral deposit. The 1970 drilling program consisted of more than 23,000 feet of drilling in 55 holes in zones No. 1 and No. 2. The mine's deposit of lode tin is one of the few such reserves in the world. The mine has an erratic record of production from as early as 1918, but the most important work was done by the United States Tin Corp. from 1949 to 1955.

**Sand and Gravel.**—Sand and gravel output increased 59 percent in quantity and 121 percent in value over 1969 levels. Ninety-one percent of the total was used in Government-and-contractor operations and the remainder in commercial operations. The largest increases in quantity used were for paving by Government-and-contractor operations. This category increased 4.6 times over the 1969 level.

Table 11.—Sand and gravel sold or used by producers, by classes of operation and uses  
(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Construction:</b>				
<b>Building:</b>				
Sand .....	34	\$89	134	\$309
Gravel .....	129	295	322	170
<b>Paving:</b>				
Sand .....	1,142	2,097	6,828	12,241
Gravel .....	3,931	6,212	16,062	25,142
<b>Fill:</b>				
Sand .....	147	173	28	34
Gravel .....	10,822	9,749	1,768	1,390
<b>Other:</b>				
Sand .....	--	--	320	846
Gravel .....	--	--	363	960
<b>Total .....</b>	<b>16,205</b>	<b>18,615</b>	<b>25,825</b>	<b>41,092</b>
<b>Commercial:</b>				
Sand .....	47	128	494	1,195
Gravel .....	897	996	1,947	2,560
<b>Government-and-contractor:<sup>1</sup></b>				
Sand .....	1,276	2,231	6,832	12,289
Gravel .....	13,985	15,260	16,532	25,049

<sup>1</sup> Approximate figures for operations by the State, counties, municipalities, and other Government agencies under lease.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	Region
<b>Barite:</b>			
Inlet Oil Corp.....	Dallas, Tex.....	Open pit.....	Southeastern Alaska.
<b>Coal:</b>			
Alaska Matanuska Coal Co.	Palmer, Alaska.....	Strip mine.....	Cook Inlet-Susitna.
B & R Coal Co.....	Healy, Alaska.....	do.....	Yukon River.
Usibelli Coal Mine, Inc.....	Usibelli, Alaska.....	do.....	Do.
Vitro Minerals Corp.....	Fairbanks, Alaska.....	do.....	Do.
<b>Gold:</b>			
United States Smelting, Refining and Mining Co.	New York, N.Y.....	Dredge.....	Do.
<b>Natural gas:</b>			
Amoco Production Co.....	Anchorage, Alaska.....	Gas production.....	Offshore Cook Inlet.
Mobil Oil Corp.....	do.....	do.....	Westside Cook Inlet.
Phillips Petroleum Co.....	do.....	do.....	Kenai Peninsula, Offshore Cook Inlet.
Standard Oil Co. of California.	do.....	do.....	Kenai Peninsula, Westside Cook Inlet.
Texaco Inc.....	do.....	do.....	Offshore Cook Inlet, Westside Cook Inlet.
Union Oil Co. of California.	do.....	do.....	Offshore Cook Inlet, Kenai Peninsula.
Holmes & Narver, Inc.....	Point Barrow, Alaska.....	do.....	North Slope.
<b>Petroleum—crude:</b>			
Amoco Production Co.....	do.....	Oil production.....	Offshore Cook Inlet.
Atlantic Richfield Co.....	do.....	do.....	Kenai Peninsula, Offshore Cook Inlet, North Slope.
BP Alaska, Inc.....	do.....	do.....	North Slope.
Mobil Oil Corp.....	do.....	do.....	Offshore Cook Inlet.
Shell Oil Co.....	do.....	do.....	Kenai Peninsula, Offshore Cook Inlet.
Texaco Inc.....	do.....	do.....	Offshore Cook Inlet.
Standard Oil Co. of California.	do.....	do.....	Kenai Peninsula.
Union Oil Co. of California.	do.....	do.....	Offshore Cook Inlet.
<b>Petroleum refining:</b>			
Atlantic Richfield Co.....	Prudhoe Bay, Alaska.....	Refinery.....	North Slope.
Standard Oil Co. of California.	Nikiski, Alaska.....	do.....	Kenai Peninsula.
Tesoro-Alaskan Petroleum Corp.	do.....	do.....	Do.
<b>Platinum-group metals:</b>			
Goodnews Bay Mining Co..	Fairbanks, Alaska.....	Dredge.....	Kuskokwim River.
<b>Sand and gravel:</b>			
Alaska Department of Highways.	Juneau, Alaska.....	Open pit.....	Various.
State Division of Aviation..	Anchorage, Alaska.....	do.....	Do.
U.S. Army Corps of Engineers.	do.....	do.....	Do.
<b>Stone:</b>			
Alaska Department of Highways.	Juneau, Alaska.....	Open quarry.....	Do.
S. S. Mullen, Inc.....	Seattle, Wash.....	do.....	Southeastern Alaska.
U.S. Army Corps of Engineers.	Anchorage, Alaska.....	do.....	Various.



# The Mineral Industry of Arizona

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

By John W. Cole <sup>1</sup>

The value of mineral production in Arizona established another high, reaching \$1,167 million, 36 percent above the \$859 million of 1969. Income from the mineral industry ranked second to manufacturing among major sources of income.

Copper accounted for \$1,059 million, 91 percent of the total value of minerals produced. Quantity of copper produced in-

creased almost 15 percent from that of 1969. The State continued to lead the Nation in copper output, 917,918 tons; second in silver, 7.3 million troy ounces; second in molybdenum, 15.7 million pounds; and fourth in gold, 109,853 troy ounces.

Compared with 1969, the values of 17

<sup>1</sup> Physical scientist, Division of Nonferrous Metals.

Table 1.—Mineral production in Arizona <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays..... thousand short tons..	120	\$394	199	\$454
Coal, bituminous..... do.....	-	-	132	W
Copper (recoverable content of ores, etc.)..... short tons..	801,363	761,840	917,918	1,059,277
Diatomite..... do.....	725	W	NA	W
Gem stones.....	NA	153	NA	155
Gold (recoverable content of ores, etc.)..... troy ounces..	110,878	4,603	109,853	3,998
Gypsum..... thousand short tons..	83	424	98	358
Helium, grade A..... million cubic feet..	56	1,126	62	1,186
Iron ore (usable)..... thousand long tons, gross weight..	18	136	W	W
Lead (recoverable content of ores, etc.)..... short tons..	217	65	285	89
Lime..... thousand short tons..	283	5,074	309	4,523
Mercury..... 76-pound flasks..	W	W	-	-
Molybdenum (content of concentrate)..... thousand pounds..	12,699	20,947	15,672	26,700
Natural gas (marketed)..... million cubic feet..	1,136	199	1,101	188
Petroleum (crude)..... thousand 42-gallon barrels..	2,433	7,056	1,784	5,281
Pumice..... thousand short tons..	910	814	824	627
Sand and gravel..... do.....	16,744	18,224	17,822	19,804
Silver (recoverable content of ores, etc.)..... thousand troy ounces..	6,141	10,997	7,330	12,981
Stone..... thousand short tons..	2,827	5,812	3,511	7,094
Tungsten concentrate (60-percent WO <sub>3</sub> basis)..... short tons..	1	2	W	W
Uranium (recoverable content U <sub>3</sub> O <sub>8</sub> )..... thousand pounds..	W	W	-	-
Zinc (recoverable content of ores, etc.)..... short tons..	9,039	2,639	9,618	2,947
Value of items that cannot be disclosed: Asbestos, cement, feldspar, mica (scrap), perlite, pyrites, vanadium, (1969), vermiculite (1969), and values indicated by symbol W.....	XX	18,957	XX	21,105
Total.....	XX	859,462	XX	1,166,767
Total 1967 constant dollars.....	XX	811,590	XX	1,055,924

<sup>1</sup> Preliminary. † Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

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

		(Thousands)	
County	1969	1970	Minerals produced in 1970 in order of value
Apache-----	\$9,002	\$7,231	Petroleum, helium, clays, natural gas, pumice, sand and gravel, stone.
Cochise-----	65,157	78,297	Copper, lime, stone, silver, gold, sand and gravel, lead, zinc.
Coconino-----	3,452	2,290	Sand and gravel, pumice, stone, copper, silver, gold.
Gila-----	99,637	124,653	Copper, molybdenum, asbestos, stone, lime, silver, sand and gravel, gold, clays.
Graham-----	W	W	Sand and gravel, zinc, lead, copper, pumice, silver, gold.
Greenlee-----	134,492	151,043	Copper, silver, lime, stone, gold, sand and gravel.
Maricopa-----	8,403	7,258	Sand and gravel, lime, stone, clays, copper, silver, mica, gold.
Mohave-----	35,326	40,762	Copper, molybdenum silver, zinc, sand and gravel, stone, lead, feldspar, gold, tungsten.
Navajo-----	W	W	Sand and gravel, coal, iron ore, pumice, stone.
Pima-----	251,563	422,298	Copper, molybdenum, cement, silver, sand and gravel, stone, gold, clay, zinc, mica, lead.
Pinal-----	212,541	285,166	Copper, molybdenum, silver, sand and gravel, gold, stone, perlite, lime, gypsum, diatomite, pyrites, pumice.
Santa Cruz-----	W	W	Sand and gravel, stone, tungsten, copper, lead, silver, zinc gold.
Yavapai-----	35,503	41,698	Copper, cement, zinc, stone, sand and gravel, molybdenum, lime, silver, gypsum, clays, gold, lead, iron ore, pumice.
Yuma-----	W	W	Sand and gravel, copper, stone, lead, silver, gold, zinc.
Undistributed <sup>1</sup> ---	4,388	6,071	
Total <sup>2</sup> -----	859,462	1,166,767	

<sup>1</sup> Revised.<sup>2</sup> Includes gem stones that cannot be assigned to specific counties, and values indicated by symbol W.<sup>3</sup> Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Arizona business activity

	1969	1970	Change, percent	
Employment and labor force, annual average:				
Total nonagricultural employment-----	thousands--	517.2	544.8	+5.3
Services and miscellaneous-----	do-----	85.1	90.8	+6.7
Trade-----	do-----	116.9	127.3	+8.9
Mining-----	do-----	18.5	20.6	+11.4
Construction-----	do-----	33.5	37.0	+10.4
Manufacturing-----	do-----	94.2	90.3	-4.1
Government-----	do-----	113.4	118.8	+4.8
All other-----	do-----	55.6	60.0	+7.9
Personal income:				
Total-----	millions--	\$5,709	\$6,334	+10.9
Per capita-----	do-----	\$3,287	\$3,542	+7.8
Construction activity:				
Total value of construction contracts-----	millions--	\$727.7	\$1,055.7	+45.1
Residential-----	do-----	\$327.4	\$405.2	+23.8
Nonresidential-----	do-----	\$243.0	\$225.9	-7.0
Nonbuilding-----	do-----	\$157.3	\$424.6	+169.9
Highway construction contracts awarded-----	do-----	\$80.0	\$85.0	+6.3
Cement shipments to and within the State-----	thousand 376-pound barrels--	5,417	5,638	+4.1
Farm marketing receipts-----	millions--	\$662.0	\$663.0	+0.2
Mineral production-----	do-----	\$859.5	\$1,166.8	+35.8

Sources: U.S. Department of Commerce, Survey of Current Business; Division of Economic and Business Research, University of Arizona; U.S. Department of Labor, Area Trends in Employment and Unemployment; U.S. Department of Commerce, Construction Review; U.S. Department of Labor, Employment and Earnings; U.S. Department of Agriculture, Farm Income Situation; and U.S. Bureau of Mines.

Table 4.—Major sources of income in Arizona<sup>1</sup>

		(Thousands)	
Source of income	1969	1970	Change, percent
Manufacturing-----	\$2,220,000	\$2,300,000	+4
Mining <sup>2</sup> -----	859,462	1,166,767	+36
Tourism-----	530,000	565,000	+7
Crops <sup>1</sup> -----	292,606	284,745	-3
Livestock-----	369,398	378,292	+2

<sup>1</sup> Valley National Bank Research Department, Phoenix, Ariz., August 1971.<sup>2</sup> U.S. Bureau of Mines.<sup>3</sup> Does not include U.S. Government farm subsidy payments.Table 5.—Valuation on centrally assessed groups of property in Arizona<sup>1</sup>

		(Thousands)	
Group	1969	1970	Change, percent
Utilities-----	\$1,213,551	\$1,271,670	+5
Mines-----	602,912	649,473	+8
Pipelines-----	321,537	337,380	+5
Railroads-----	172,162	165,301	-4
Airlines-----	19,844	20,321	+2
Oil and gas-----	8,947	5,896	-34

<sup>1</sup> Pay Dirt, No. 360, June 23, 1969, p. 3; No. 384, June 28, 1971, p. 3.

mineral commodities increased, and 12 declined. The value of metals increased \$304 million to a total of \$1,106 million, non-metals increased \$4.4 million to a total of \$53.7 million, and the value of fuels decreased \$1.4 million to a total of \$7.0 million.

**Employment and Injuries.**—Final statistics for 1969 on employment and injuries in the mineral industries, excluding the petroleum and natural gas industries, and preliminary data for 1970 compiled by the Bureau of Mines, are given in table 6.

**Legislation and Government Programs.**—The Arizona State Department of Property Valuation reported that the cash value of Arizona's producing mines was \$650 million, a 7.8-percent increase over the 1969 valuation. The one new mine added was The Anaconda Company's Twin Buttes mine valued at \$27.3 million. The Morenci Branch of Phelps Dodge Corp. was the State's most valuable property; cash value was set at \$168.8 million in 1970. The State tax rate was reduced from \$2.20 per \$100 in 1969, to \$1.65 in 1970. Mining properties

are taxed at 60 percent of the cash value as set by the State Department of Property Valuation.

The Arizona State Department of Health established sulfur emission regulations in May under authority granted by 36-1707, Arizona Revised Statutes. The regulations limit sulfur emissions from smelters to 10 percent of the sulfur in the feed and to a maximum of 6,500 pounds per hour. The ambient air regulations limit the ground level concentrations of sulfur dioxide outside the boundaries of the operation to the following, in micrograms per cubic meter:

Annual average	-----	50
24-hour average	-----	250
1-hour average	-----	850
Any three-consecutive-day average		120

Operations not in compliance with the regulations may apply for a provisional permit to continue operating. This permit may be granted if evidence is presented that the operator is diligently pursuing a course of investigation, design, and construction that will obtain compliance with the regulations. Full compliance must be met by 1973.

Table 6.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Coal.....	3	140	(1)	3	--	--	--	--
Metal.....	12,309	309	3,805	30,408	12	549	18.45	3,412
Nonmetal...	251	219	55	465	--	5	10.76	99
Sand and gravel.....	1,349	241	325	2,633	1	52	20.13	2,943
Stone.....	409	276	113	907	--	9	9.92	498
Total <sup>2</sup> ....	14,321	300	4,299	34,417	13	615	18.25	3,254
<b>1970:<sup>p</sup></b>								
Coal.....	5	158	(1)	4	--	--	--	--
Metal.....	12,260	332	4,076	32,664	8	768	23.76	2,433
Nonmetal...	240	220	52	442	--	4	9.06	52
Sand and gravel.....	1,390	236	328	2,629	6	59	24.73	14,725
Stone.....	430	284	122	973	--	6	6.17	78
Total <sup>2</sup> ....	14,320	320	4,578	36,711	14	837	23.18	3,222

<sup>p</sup> Preliminary.

<sup>1</sup> Less than 500.

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

**REVIEW BY MINERAL COMMODITIES**

**METALS**

Ninety mines yielded 151 million tons of ore, from which 3.37 million tons of concentrates were produced. Fifty-three mines produced copper ore; 22 mines produced

gold, gold-silver, or silver ore; three produced copper-zinc ore; one produced zinc ore, five mines produced lead ore, and two mines produced lead-zinc ore. One mine produced iron ore and three mines pro-



duced tungsten ore. No marketable production of mercury, uranium, or vanadium was reported in 1970.

**Copper.**—Mines producing copper yielded 917,918 tons, slightly more than 53 percent of domestic copper production. Fifty-three copper mines yielded 135.0 million tons of ore from which 791,033 tons of copper were recovered, an average of 11.7 pounds of copper per ton of ore. The remainder of the copper was recovered from leaching and from copper-lead, copper-zinc, lead, lead-zinc, and other miscellaneous ores.

Pima County continued to lead in tons of copper output (335,586), Pinal County was second (235,114), followed by Greenlee (127,884), Gila (104,904), Cochise (62,109), and Mohave Counties (29,173).

Fifteen major open pits yielded 724,300 tons of copper, 79 percent of the total output. Four underground mines yielded 145,500 tons of copper (15 percent); and 6 percent came from a number of small copper mines and as a byproduct of other mining operations.

A total of 122,300 tons of copper, or 13.3 percent of the State's production, was from leaching operations. Dump and in-place leaching yielded 87,800 tons of precipitates containing 66,200 tons of copper. Heap and vat leaching yielded 21,000 tons of copper in precipitates, and 35,100 tons of copper were won from each solutions by electrolysis.

Approximately 846,000 tons of copper (92 percent of the State total) was produced from 18 mines owned by eight companies as follows: Phelps Dodge Corp., 28 percent; Kennecott Copper Corp., 13 percent; Magma Mining Co., 12 percent; The Anaconda Company, 9 percent; Duval Corp., 9 percent; American Smelting & Refining Co., (Asarco), 8 percent; Inspiration Consolidation Copper Co., 7 percent; and Pima Mining Co., 6 percent.

The Phelps Dodge Corp. open pit mine at Morenci was the State's leading source of copper yielding 53.7 million tons of material, including 19.2 million tons of ore. The plant produced 129,438 tons of copper.<sup>2</sup> The New Cornelia plant at Ajo yielded 26.4 million tons of material, including 10.6 million tons of ore from which 63,097 tons of copper was recovered. The Lavender pit at Bisbee yielded 18.1 million tons of material, including 4.9 million tons of ore from which 29,716 tons of copper was recovered. The Copper Queen underground mines yielded 31,584 tons of copper from 829,000 tons of ore.

The total material mined from Phelps Dodge Corp. properties in Arizona was 98.2 million tons—62.8 million tons of waste and leach material and 35.4 million tons of ore. A total of 253,835 tons of copper, 27.7 percent of the State output, was produced from company mines. An additional 667 tons was recovered from miscellaneous sources for a total of 254,502 tons of copper, down 5 percent from the 1969 record year.

Phelps Dodge Corp. announced in December that development of the Metcalf mine would be continued at a slower rate, and that the target production date would be late in 1974, about 2 years later than had been planned. Exploration and development of its underground mine near Safford was continued.

Magma Copper Co. (wholly owned by Newmont Mining Corp.) continued its expansion programs at both the San Manuel and Superior Divisions. Programs at San Manuel were on schedule, and completion was expected by late 1971. The Superior program is about 1 year behind schedule owing principally to difficulties and delays encountered in shaft sinking.

<sup>2</sup> Phelps Dodge Corp. Annual Report, 1970, p. 10.

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

Year	Arizona		United States		Arizona		
	Total value mineral production (thousands)	Copper production		Copper production		Percent of U.S. copper production	Percent of world copper production
		Short tons	Value (thousands)	Short tons	Value (thousands)		
1966	\$622,079	739,569	\$535,004	1,429,152	\$1,033,850	51.7	12.7
1967	465,255	501,741	383,591	954,064	729,401	52.6	9.1
1968	† 617,541	627,961	525,566	1,204,621	1,008,195	52.1	10.7
1969	† 859,462	801,363	761,840	1,544,579	1,468,400	51.9	12.1
1970	1,166,767	917,918	1,059,277	1,719,657	1,984,484	53.4	14.1

† Revised.

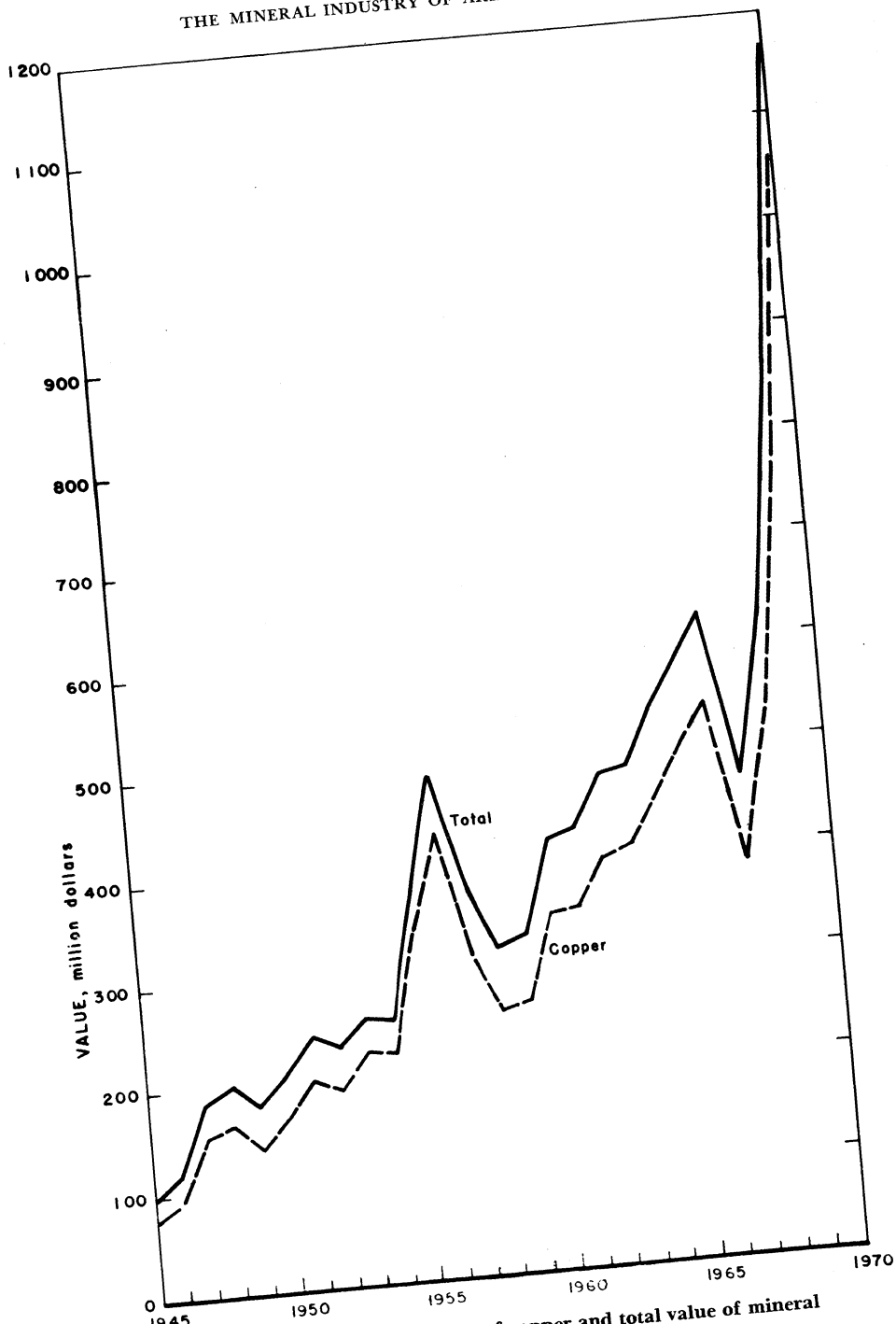


Figure 1.—Value of mine production of copper and total value of mineral production in Arizona.

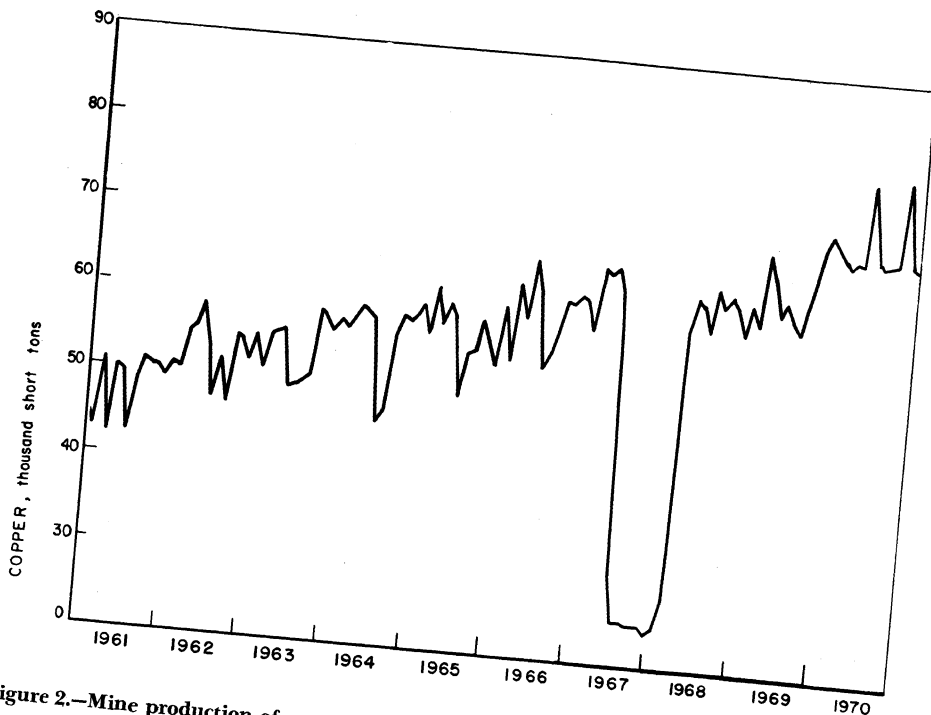


Figure 2.—Mine production of copper in Arizona, by month, in terms of recoverable metal.

The program at San Manuel includes sinking two new shafts and expanding the mill capacity from 40,000 to 60,000 tons per day. The San Manuel smelter is being expanded to handle the increased concentrate production from both San Manuel and Superior. The new electrolytic copper refinery at San Manuel was completed in late 1971. The refinery has an annual capacity of 200,000 tons of cathode plate and continuous cast rod in about equal quantities.

At Superior, a 4,800-foot shaft is being sunk and a 9,000-foot circular tunnel is being driven on the 500-foot level of the mine to connect with the shaft. The openings are being driven to provide more efficient access and rapid haulage from newly developed replacement ore bodies in the far eastern area of the mine. The reserves of this area are estimated at 10.2 million tons of ore,

and the average copper content is 5.8 percent. The capacity of the Superior mill is being doubled to about 3,300 tons per day. The Superior smelter was shut down permanently late in 1971; Superior concentrates are being smelted at San Manuel.

The Ray Mines Division of Kennecott Copper Corp. produced 98,461 tons of copper from 12.4 million tons of ore. Output of copper was 34 percent more than in 1969, principally because of an increase in average grade (from 0.837 to 1.007 percent copper) of ore treated.<sup>3</sup> Work continued on the program to improve operating conditions and expand capacity of the mine. A contract was awarded in October to Fluor Utah Engineers and Constructors, Inc., to build a 3.6-mile-long 16-foot-diameter, con-

<sup>3</sup> Kennecott Copper Corp. Annual Report, 1970, p. 14.

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

Rank in 1970	Rank in 1969	Mine	District	County	Operator	Source of copper in 1970
1	1	Morenci.....	Copper Mountain....	Greenlee..	Phelps Dodge Corp.	Copper ore, copper precipitates, gold-silver ore.
2	3	Ray.....	Mineral Creek.....	Pinal.....	Kennecott Copper Corp.	Copper ore, copper precipitates.
3	2	San Manuel....	Old Hat.....	do.....	Magma Copper Co.	Copper ore.
4	15	Twin Buttes....	Pima.....	Pima.....	The Anaconda Company.	Do.
5	5	Pima.....	do.....	do.....	Pima Mining Co.	Do.
6	4	New Cornelia..	Ajo.....	do.....	Phelps Dodge Corp.	Do.
7	6	Copper Queen, Lavender Pit	Warren.....	Cochise....	do.....	Copper ore, copper precipitates.
8	7	Inspiration....	Globe-Miami.....	Gila.....	Inspiration Consolidated Copper Co.	Do.
9	8	Mission.....	Pima.....	Pima.....	American Smelting and Refining Co.	Copper ore.
10	--	Sierrita.....	do.....	do.....	Duval Sierrita Corp.	Do.
11	9	Mineral Park..	Wallapai.....	Mohave....	Duval Corp.....	Copper ore, copper precipitates.
12	11	Copper Cities..	Globe-Miami.....	Gila.....	Cities Service Co.	Do.
13	12	Esperanza.....	Pima.....	Pima.....	Duval Corp.....	Do.
14	10	Silver Bell.....	Silver Bell.....	do.....	American Smelting and Refining Co.	Do.
15	13	Magma.....	Pioneer.....	Pinal.....	Magma Copper Co.	Copper ore.

Table 9.—Arizona: Ore mined, waste material removed, leach material placed in dumps, and total copper production at principal copper open pit and underground mines

Mine	Ore mined (thousand short tons)		Waste material removed (thousand short tons)		Leach material placed in dumps (thousand short tons)		Total copper produced from all sources (short tons)	
	1969	1970	1969	1970	1969	1970	1969	1970 <sup>1</sup>
OPEN PIT								
Morenci.....	19,271	19,173	19,330	18,657	15,544	15,860	136,773	133,197
Ray.....	12,209	12,432	--	--	27,724	26,421	<sup>2</sup> 96,190	122,679
Twin Buttes....	3,015	8,763	60,718	--	--	--	<sup>2</sup> 11,140	87,876
Pima.....	14,235	14,598	<sup>3</sup> 17,525	<sup>3</sup> 17,327	--	--	<sup>1</sup> 67,000	66,247
New Cornelia..	10,736	10,562	16,856	15,875	--	--	67,792	63,849
Inspiration....	8,855	9,377	11,419	9,541	4,204	4,457	51,757	<sup>4</sup> 50,611
Mission.....	7,940	8,039	20,473	18,549	--	--	50,034	47,678
Sierrita.....	900	14,384	63,627	47,945	--	--	--	32,882
Lavender Pit..	5,550	4,850	7,439	1,108	14,994	12,117	35,528	32,017
Mineral Park..	6,034	5,952	4,791	--	5,870	8,432	<sup>1</sup> 23,721	27,164
Copper Cities..	4,645	5,143	405	4,924	7,900	10,992	<sup>1</sup> 22,446	26,764
Esperanza.....	5,488	5,514	463	--	8,631	8,513	<sup>1</sup> 22,288	22,787
Silver Bell.....	3,870	3,788	7,809	9,099	752	993	<sup>1</sup> 20,599	22,531
UNDERGROUND								
San Manuel....	15,203	15,446	--	--	--	--	100,100	98,180
Copper Queen..	783	829	--	--	--	--	29,555	33,984
Magma.....	422	443	--	--	--	--	18,217	18,735

<sup>1</sup> Gross metal content.<sup>2</sup> Gross metal content in concentrates and precipitates, and electrowon copper.<sup>3</sup> 1,000 cubic yards.<sup>4</sup> Recoverable content.

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

County	Mines producing <sup>1</sup>		Material sold or treated <sup>2</sup> (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
<b>Total:</b>							
1968.....	87	1	101,565,300	95,999	\$3,768,922	4,958,162	\$10,633,275
1969.....	90	1	128,349,904	110,878	4,602,545	6,141,022	10,996,544
<b>1970:</b>							
Cochise.....	4	--	5,696,127	32,126	1,169,065	859,633	1,522,255
Cocconino.....	1	--	30	2	73	74	131
Gila.....	11	--	21,477,122	3,786	137,772	232,741	412,142
Graham.....	3	--	2,434	1	36	573	1,015
Greenlee.....	5	--	19,195,843	13,509	491,592	703,590	1,245,932
Maricopa.....	6	--	657	13	473	2,345	4,152
Mohave.....	7	--	6,162,693	423	15,392	451,146	798,901
Pima.....	11	--	65,837,065	29,083	1,058,330	3,750,642	6,641,712
Pinal.....	14	--	28,769,638	30,607	1,113,789	1,223,615	2,166,801
Santa Cruz.....	2	--	112	1	36	525	929
Yavapai.....	11	--	3,406,210	287	10,443	104,409	184,890
Yuma.....	6	--	458	15	546	859	1,521
Undistributed.....	1	--	16	--	--	265	469
<b>Total<sup>3</sup>.....</b>	<b>82</b>	<b>--</b>	<b>150,548,405</b>	<b>109,853</b>	<b>3,997,547</b>	<b>7,330,417</b>	<b>12,980,850</b>
	<b>Copper</b>		<b>Lead</b>		<b>Zinc</b>		<b>Total value</b>
	<b>Short tons</b>	<b>Value</b>	<b>Short tons</b>	<b>Value</b>	<b>Short tons</b>	<b>Value</b>	
<b>Total:</b>							
1968.....	627,961	\$525,565,679	1,704	\$450,264	5,441	\$1,469,070	\$541,887,210
1969.....	801,363	761,839,777	217	64,644	9,039	2,639,388	780,142,898
<b>1970:</b>							
Cochise.....	62,109	71,673,671	17	5,201	3	812	74,371,004
Cocconino.....	2	1,904	--	--	--	--	2,108
Gila.....	104,904	121,059,561	--	--	--	--	121,609,475
Graham.....	9	10,323	35	10,808	159	48,653	70,840
Greenlee.....	127,884	147,577,964	--	--	--	--	149,315,488
Maricopa.....	17	19,387	--	--	--	--	24,012
Mohave.....	29,173	33,665,874	200	62,616	1,399	428,579	34,971,362
Pima.....	335,586	387,266,648	1	250	44	13,450	394,980,390
Pinal.....	235,114	271,321,737	--	--	--	--	274,602,327
Santa Cruz.....	1	1,615	4	1,375	(4)	123	4,078
Yavapai.....	22,765	26,270,350	14	4,295	8,009	2,453,721	28,923,699
Yuma.....	353	407,593	13	4,139	5	1,424	415,223
Undistributed.....	(4)	173	1	266	--	--	908
<b>Total<sup>3</sup>.....</b>	<b>917,918</b>	<b>1,059,276,805</b>	<b>285</b>	<b>88,950</b>	<b>9,618</b>	<b>2,946,762</b>	<b>1,079,290,914</b>

<sup>1</sup> Operations at old mill or miscellaneous cleanups not counted as mines.

<sup>2</sup> Does not include tonnage of precipitates shipped, uranium ore milled in 1969, or gravel washed from placers.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

<sup>4</sup> Less than 1/2 unit.

crete-lined, diversion tunnel to route the water in Mineral Creek around the active mining area. Construction of the diversion dam at the tunnel inlet also was contracted to the same firm.

Pima Mining Co.'s output of copper in concentrates was 63,500 tons, about the same as in 1969.<sup>4</sup> Plans were announced in December for a \$16.5 million plant expansion to increase output of copper concentrates by about 25 percent.

The Mission and Silver Bell mines of Asarco were operated at capacity. The Mission mine yielded 47,678 tons of copper in concentrates from slightly more than 8 million tons of ore. The Silver Bell mine yielded 19,698 tons of copper in concentrates from 3.8 million tons of ore. Also

produced was 3,490 tons of copper precipitates containing 2,833 tons of copper. The San Xavier mine produced 63,831 tons of siliceous flux ore containing 465 tons of copper. Construction of a plant to treat San Xavier copper oxide ore by leaching was delayed owing to the instigation of litigation by the lessors, the Papago Indian tribe. As a result of further drilling of the Sacaton project near Casa Grande, ore reserves increased to 48 million tons that averaged 0.95 percent copper. Preliminary plans for an open pit mine, mill, and surface facilities were completed.

Duval Corp., a subsidiary of Pennzoil United, Inc., operated three open pit cop-

<sup>4</sup> Cyprus Mines Corp. Annual Report, 1970, p. 6.

**Table 11.—Arizona: Mine production of gold, silver, copper, lead, and zinc in 1970, by classes of ore or other source materials, in terms of recoverable metals**

Source	Number of mines <sup>1</sup>	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Dry gold.....	1	144	65	85	( <sup>2</sup> )	--	--
Dry gold-silver.....	6	60,682	451	12,753	479	1	--
Dry silver.....	8	28,917	55	82,109	1	1	--
Total.....	15	89,743	571	94,947	480	2	--
Copper.....	51	150,240,842	107,292	7,130,261	847,147	2	50
Copper-zinc.....	3	130,953	249	58,408	3,760	210	9,402
Lead.....	5	360	1	2,277	( <sup>2</sup> )	31	2
Lead-zinc and zinc <sup>3</sup> .....	3	2,460	2	1,025	9	37	163
Total <sup>4</sup> .....	64	150,374,615	107,544	7,191,971	850,916	280	9,618
Other lode material:							
Gold-silver and silver tailings.....	2	62,646	839	31,503	104	--	--
Copper cleanup.....	( <sup>5</sup> )	701	--	1,964	164	--	--
Copper precipitates.....	14	87,856	--	--	66,220	--	--
Copper tailings and lead tailings.....	2	20,700	899	10,032	32	3	( <sup>5</sup> )
Total <sup>4</sup> .....	18	171,903	1,738	43,499	66,521	3	( <sup>5</sup> )
Grand total <sup>4</sup> .....	82	150,636,261	109,853	7,330,417	917,918	285	9,618

<sup>1</sup> Detail will not necessarily add to totals because some mines produce more than one class of material.

<sup>2</sup> Less than ½ unit.

<sup>3</sup> Combined to avoid disclosing individual company confidential data.

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

<sup>5</sup> From properties not classed as mines.

**Table 12.—Arizona: Mine production of gold, silver, copper, lead, and zinc in 1970, by types of material processed and methods of recovery, in terms of recoverable metals**  
(All production was lode material)

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Acid leaching (vat, tank, and heap): <sup>1</sup> Ore.....	--	--	56,114	--	--
Smelting of concentrates from—Ore and tailings <sup>2</sup> .....	103,664	7,013,794	786,033	259	9,611
Direct smelting of—					
Ore.....	4,451	273,409	9,249	26	7
Cleanup.....	--	1,964	164	--	--
Precipitates.....	--	--	66,220	--	--
Tailings.....	1,738	41,250	137	--	--
Total <sup>3</sup> .....	6,189	316,623	75,770	26	7
Grand total <sup>3</sup> .....	109,853	7,330,417	917,918	285	9,618

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

<sup>2</sup> Combined to avoid disclosing individual company confidential data.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

per mines in Arizona during 1970—Mineral Park, Esperanza, and the new Sierrita mine. The Mineral Park property near Kingman has operated since 1964. The Esperanza mine, 35 miles southwest of Tucson, has been operated by Duval since 1959. The Sierrita property started production in 1970 and was operating at a rated capacity of 65,000 tons per year of copper in October. Designed to treat 72,000 tons of ore per day, plans are underway to increase capacity to

80,000 tons of ore per day. In addition to copper, the mine is expected to produce 13 million pounds of molybdenum and over 500,000 ounces of silver per year. The company reported on development of a pollution-free hydrometallurgical system for processing copper concentrates. Copper concentrates would be leached in the process with a metal chloride solution followed by precipitation of metallic copper and regeneration of the leach solution. The con-

tinuous process would also recover elemental sulfur, iron oxide, and other metals of value.

The Inspiration Consolidated Copper Co. operated the Thornton, Live Oak, Red Hill, and Black Copper mines in the Inspiration area. Fourteen million tons of waste and 9.4 million tons of ore were mined. The ore processed in the plant yielded 44,459 tons of copper and an additional 10,091 tons was recovered from leaching dumps and mined out areas, and heap leaching at the Black Copper mine. At the Ox Hide mine, 797,000 tons of waste was removed, 3.8 million tons of oxide ore was mined, and 6,720 tons of copper was recovered by leaching. At the Christmas open pit mine, 9.4 million tons of waste and 1.8 million tons of ore were mined; 8,640 tons of copper was recovered. Total production of copper was 69,910 tons, 7.0 percent more than in 1969.<sup>5</sup> Exploration work was suspended at the Sauchez project near Safford, pending formulation of plans for mining and treating the ore. The basic ore reserve indicated by drilling is 39 million tons containing 0.413 percent copper.

The Anaconda Company Twin Buttes copper mine completed its first full year of operation and produced 81,281 tons of copper; the ore treated was higher grade than the estimated average grade of the ore body.<sup>6</sup> The extractive metallurgical research division, at Tucson, completed construction of a pilot plant to develop a chemical process to replace conventional smelting. The plant began operation in July and successfully produced quality products over intermittent periods. Experimental work is continuing.

Hecla Mining Co. continued development of the Lakeshore mine near Casa Grande, which it owns jointly with El Paso Natural Gas Co. Two parallel declines started late in 1969 were advanced a slope distance of 4,700 feet to a vertical depth of 1,200 feet. Core drilling from the surface totaled over 234,000 feet. The segregation plant, formerly operated on copper oxide ore by the El Paso Natural Gas Company was shut down and is being converted into a pilot concentrating plant by Hecla. Hecla has contracted to furnish all funds required to bring the property into production to be recouped by Hecla from future revenues prior to dividing the profit equally between Hecla and El Paso.

During the fiscal year ending June 30, 1970, the Bluebird mine of Rancher's Exploration and Development Co. produced 10.5 million pounds of cathode copper, an increase of 20 percent over the previous year from its solvent extraction-electrowinning plant. Ore reserves are estimated by the company at about 13.5 million tons of 0.50-percent copper.

The Bagdad Copper Corp. produced 11,056 tons of copper in concentrates in 1970 and 6,220 tons of copper from leaching circuits. A solvent extraction-electrowinning plant was installed in August. After 5 weeks of operation, it had reached capacity production of 40,000 pounds per day of copper cathodes. The copper powder refinery produced 7.1 million pounds of copper compared with 6.3 million pounds in 1969.

Standard Metals Corp. completed construction and placed in operation a 250-ton-per-day flotation plant near Kingman. The new facility produces copper, lead, and zinc concentrates from ores derived from the company-owned Antler mine. Output of copper concentrates totals about 7,500 tons per year.

Feasibility studies continued on several properties not yet committed to production. Miami Copper Co. awarded a contract to Boyles Brothers Drilling Co. to extend the No. 5 shaft to a depth of 3,520 feet to permit evaluation of a down-faulted segment of the Miami-Inspiration ore body. Miami Copper also employed Parsons-Jurden Corp. to evaluate the feasibility of a 40,000-ton-per-day operation for a 350-million-ton ore body in the Pinto Valley area adjacent to the Castle Dome mine. Phelps Dodge Corp. completed an 1,800-foot shaft and began drifting to obtain information for a feasibility study of the company's deposit near Safford. Newmont sunk a two-compartment shaft 441 feet and completed 1,700 feet of drift to obtain information for a feasibility study of a 75-million-ton ore body at Vekol Hills on the Papago Indian Reservation.

Many exploration units searched actively for new copper deposits in Arizona, and discovery of several new ore bodies was announced. The Anaconda Company reported the discovery of a new deposit in the Helvetia (Rosemont) District of the Santa Rita mountains in Pima County of about

<sup>5</sup> Inspiration Consolidated Copper Co. Annual Report, 1970, p. 1.

<sup>6</sup> The Anaconda Company. Annual Report, 1970, p. 5.

the same size and grade as the Twin Buttes deposit. Kerr-McGee Corp. announced discovery in Santa Cruz County of a deposit 455 feet thick at a depth of 3,410 to 5,190 feet, averaging 0.71 percent copper. Continental Oil Co. reported the discovery of a porphyry copper deposit near Florence in Pinal County, ranging in depth from 400 to 1,500 feet. Seven widely spaced drill holes indicated a copper oxide sample ranging from 0.52 to 0.59 percent copper and sulfide samples from 0.29 to 0.56 percent copper.

**Gold.**—Output of gold was 109,853 Troy ounces; 106,847 ounces was produced as a byproduct of the large copper mines. The remainder resulted from treatment of gold, gold-silver, silver, copper-lead, copper-zinc, and lead-zinc ores. Only one mine in the State was a gold mine.

**Iron Ore.**—CF&I Steel Corp. continued to explore and develop the Apache pit in Navajo County. Several thousand tons of iron ore was shipped to the firm's steel plant at Pueblo, Colo.

**Lead.**—Most of the lead output was from 14 mines that also produced gold and silver. Production was 285 tons, 31 percent more than in 1969.

**Mercury.**—No mercury was marketed by Arizona mines in 1970. One mine in Gila County produced a small quantity.

**Molybdenum.**—All production of molybdenum was a byproduct from large copper mines. Pima County led in output, followed by Pinal, Mohave, Gila, and Yavapai Counties. A total of 15.7 million pounds valued at \$26.7 million was reported by 12 mines. The State ranked second in the Nation in output.

**Silver.**—Most silver production in Arizona was a byproduct from large copper mines. The State ranked second in the Nation, yielding 7.3 million ounces, an increase of 20 percent from that of 1969.

**Tungsten.**—Small quantities of tungsten concentrate (60-percent  $WO_3$ ) were recovered from processing tungsten ores at three mines. The average grade of the 89 tons of ore mined was 1.6 percent  $WO_3$ . The value of the product sold increased over that of 1969.

**Zinc.**—Thirteen mines in seven counties yielded 9,618 short tons of zinc valued at \$2.9 million, an increase of 6 percent in quantity and 11 percent in value over that of 1969. In order of rank Yavapai County with one producer was first; Mohave Coun-

ty was second with three producers; and Graham County was third with two producers.

#### NONMETALS

The value of nonmetal mineral production increased 9 percent, to \$54 million. The commodities and their percentage increases in value were clays (15), diatomite (35), feldspar (29), gem stones (1), pyrite (80), sand and gravel (9), and stone (22). Decreases in value were registered for asbestos (5), gypsum (16), lime (11), mica (80), perlite (13), and pumice (23).

**Asbestos.**—Chrysotile asbestos was produced from one underground mine. Two other companies shipped asbestos from stocks. Jaquays Mining Corp. announced plans to increase production capacity at its Globe asbestos mill by 50 percent. Crude ore for the mill is obtained from the company mine located 33 miles north of Globe. The primary addition being built is a pre-cleaning plant to provide for the treatment of lower grade ores.

**Cement.**—Production of cement decreased but the value increased 13 percent. Output was by Arizona Portland Cement Division of California Portland Cement Co., at its Rillito plant in Pima County; and by the Phoenix Division, American Cement Corp., at its Clarkdale plant in Yavapai County. All output was used within the State.

The largest use was for ready-mix concrete. Other markets were concrete-product manufacturing plants, building material supply firms, highway and other contractors, and miscellaneous uses.

Arizona Portland Cement began work on a \$12 million expansion and modernization program at its Rillito plant, about 20 miles northwest of Tucson, to increase production from 3 million to 4.2 million barrels per year. The project will require about 18 months to complete. Approximately \$1 million of the total will be used for additional air pollution equipment to eliminate all visible dust.

**Clays.**—Including miscellaneous clay and shale, bentonite, and fire clay, nine companies mined 199,000 tons, an increase of 66 percent. The value increased 15 percent, to \$454,000. Common clay for brick manufacture was produced by Phoenix Brick Yard and by Wallapai Brick and Clay Products, Inc., both in Maricopa County; and



Grabe Brick Co., Inc., Tucson Pressed Brick Corp., and Phoenix Brick Yard, in Pima County. American Cement Corp. produced common clay for manufacturing cement in Yavapai County. The Filtrrol Corp. and McCarrell & Gurley mined bentonite in Apache County; Arizona Gypsum Corp. mined bentonite in Yavapai County. Fire clay was mined by McKusick Mosaic Co. in Gila County.

**Diatomite.**—Arizona Gypsum Corp. mined crude diatomite from the White Cliffs mine near Mammoth in Pinal County. The value of the material sold increased 35 percent over that of 1969. Slightly over 50 percent of the material sold was used as a filler; the remainder was used in lightweight mortar.

**Feldspar.**—International Minerals and Chemical Corp., Industrial Minerals Division, sold ground feldspar from the Taylor mine in Mohave County for use in pottery and enamel. The quantity produced declined 11 percent, but the value was 29 percent higher than in 1969.

**Gem Stones.**—Gem collectors estimated a sales value of collected gem stones to be slightly more than the 1969 estimate of \$153,000. Included in the collected gem stones were agate, petrified wood, turquoise, chrysocolla, and obsidian.

**Gypsum.**—Four open pit mines, three in Pinal County and one in Yavapai County, yielded 98,000 tons of crude gypsum valued at \$358,000. Crude gypsum was sold for agricultural use and portland cement retarder. Calcined gypsum was used for manufacturing building materials. Arizona Gypsum Co., Pinal Mammoth Gypsum Co., and National Gypsum Co. produced gypsum from mines in lower San Pedro Valley deposits near Winkelman. Arizona Gypsum Co. also produced from a deposit near Camp Verde.

**Lime.**—Output of lime increased 26,000 tons (9 percent) to 309,000 tons valued at \$4.5 million, a decrease of 11 percent from the 1969 value. Lime was produced by seven plants, two in Gila County and one each in Cochise, Greenlee, Maricopa, Pinal, and Yavapai Counties. Most of the lime was used as a reagent by the copper companies; the remainder was used in sugar refining, open hearth furnaces, soil stabilization, manufacturing pulp and paper, and mason's lime. Most of the lime was used in Arizona;

however, small quantities were shipped to nearby States and Mexico.

**Mica.**—Two companies produced scrap and flake mica from two mines, one each in Maricopa and Pima Counties.

**Perlite.**—Crude perlite was produced from three open pit mines in Pinal County by three companies. Production decreased slightly (3 percent) and the value decreased 13 percent. Supreme Perlite, Inc., operated a plant to expand crude ore. It is marketed for production of lightweight concrete and plaster aggregate, masonry and cavity-fill insulation, and horticultural aggregates.

**Pumice and Pumicite.**—Eight companies or local government agencies operated 22 mines and eight plants to produce 824,000 tons of pumice, pumicite, and volcanic cinders valued at \$627,000. Production decreased 86,000 tons (9 percent), and the value decreased \$187,000, (23 percent), from that of 1969. Arizona dropped from first to second among the States in production; Oregon was first. Mines were operated in Apache, Coconino, Graham, Navajo, Pinal, and Yavapai Counties. The material was used in about equal quantities for railroad ballast, road construction, and concrete aggregate.

**Pyrite.**—A small quantity of pyrite produced as a byproduct at the Magma Copper Co. mill at Superior was sold to the Ray Mines Division as a supplemental feed for the sulfuric acid plant.

**Sand and Gravel.**—Production of sand and gravel sold or used increased 6 percent in quantity and 9 percent in value to 17.8 million tons valued at \$19.8 million. Output was reported from 124 operations. Of the total quantity, 6.4 million tons was classed as sand valued at \$6.9 million; 11.4 million tons was gravel valued at \$12.9 million.

Of the products sold, 5.1 million tons valued at \$5.7 million was classed as sand; and 6.1 million tons, valued at \$8.4 million was classed as gravel.

Government-and-contractor output consisted of 6.5 million tons of material valued at \$5.7 million—1.3 million tons valued at \$1.1 million was classed as sand and 5.3 million tons valued at \$4.5 million was classed as gravel.

A small quantity of industrial sand was used for sandblast, oil-formation fracturing, engine sand, and filtration.

Sand and gravel was produced in all 14 counties, ranging in quantities from a few thousand tons in Apache County to 6.4 million tons in Maricopa County. Output in

excess of 1 million tons was reported in Coconino, Maricopa, Pima, Pinal, and Yuma Counties.

**Stone.**—The quantity of stone produced

**Table 13.—Arizona: Sand and gravel sold or used by producers, by counties**  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Cochise.....	3	W	W	4	168	\$218
Coconino.....	13	1,904	\$1,785	6	1,853	1,582
Gila.....	6	112	257	5	141	258
Graham.....	3	76	90	2	W	W
Greenlee.....	3	117	142	3	W	W
Maricopa.....	26	6,785	7,858	28	6,363	6,866
Mohave.....	6	180	235	6	477	391
Navajo.....	13	503	602	9	358	357
Pima.....	25	2,570	3,014	21	2,923	3,074
Pinal.....	10	1,487	1,421	9	1,736	1,850
Santa Cruz.....	5	251	282	4	287	355
Yavapai.....	12	715	701	11	756	759
Yuma.....	14	1,913	1,615	13	2,546	3,783
Undistributed <sup>1</sup> .....	3	130	272	3	214	312
<b>Total<sup>2</sup>.....</b>	<b>142</b>	<b>16,744</b>	<b>18,224</b>	<b>124</b>	<b>17,822</b>	<b>19,804</b>

<sup>r</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

<sup>1</sup> Includes Apache County.

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

**Table 14.—Arizona: Sand and gravel sold or used by producers, by classes of operations and uses**  
(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	2,129	\$3,010	3,873	\$4,840
Engine.....	10	12	--	208
Fill.....	629	199	570	434
Paving.....	917	1,069	598	434
Other uses <sup>1</sup> .....	46	178	86	254
<b>Total<sup>2</sup>.....</b>	<b>3,731</b>	<b>4,468</b>	<b>5,126</b>	<b>5,736</b>
<b>Gravel:</b>				
Building.....	3,488	4,478	2,913	4,112
Fill.....	1,140	1,379	749	541
Paving.....	2,240	2,554	2,414	3,617
Other uses <sup>3</sup> .....	15	30	69	134
<b>Total<sup>2</sup>.....</b>	<b>6,882</b>	<b>8,442</b>	<b>6,146</b>	<b>8,403</b>
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Fill.....	35	36	31	31
Paving.....	1,139	990	1,218	1,098
<b>Total<sup>2</sup>.....</b>	<b>1,174</b>	<b>1,026</b>	<b>1,250</b>	<b>1,129</b>
<b>Gravel:</b>				
Building.....	( <sup>4</sup> )	( <sup>4</sup> )	48	40
Fill.....	216	250	101	97
Paving.....	4,739	4,038	4,997	4,222
Other uses.....	--	--	153	176
<b>Total<sup>2</sup>.....</b>	<b>4,956</b>	<b>4,289</b>	<b>5,299</b>	<b>4,535</b>
<b>Total sand and gravel<sup>2</sup>.....</b>	<b>16,744</b>	<b>18,224</b>	<b>17,822</b>	<b>19,804</b>

<sup>r</sup> Revised.

<sup>1</sup> Includes blast, railroad ballast (1970), filtration, oil (hydrafrac), and other sand.

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

<sup>3</sup> Includes miscellaneous, railroad ballast (1970), and other gravel.

<sup>4</sup> Less than 1/2 unit.

in 1970 increased 684,000 tons (24 percent), to 3.5 million short tons. The value increased 22 percent to \$7.1 million. Limestone, quartz and quartzite, traprock, marble, quartz, sandstone, and miscellaneous stone were mined and sold as crushed and broken stone. Sandstone, marble, quartz, and miscellaneous stone also were sold as dimension stone. Uses of crushed and broken stone included cement, flux, lime, roadbase, surface treatment, poultry grit, riprap, terrazzo, acid neutralizer, whiting, and concrete and roofing aggregate. Some dimension stone was used as building stone veneer, flagging, and rough block.

#### MINERAL FUELS

**Coal (Bituminous).**—The Black Mesa No. 1 mine of Peabody Coal Co., division of Kennecott Copper Corp., situated on the Hopi and Navajo Indian reservations in northeast Arizona, began producing coal in mid-1970. Initial deliveries were made in August to Southern California Edison Co.'s Mohave Generating Station in Nevada, via a 275-mile slurry pipeline. Full-scale shipments began in November, and full production at the rate of 5 million tons per year was scheduled for 1971.

In November construction began on a 78-mile railroad from Page, Ariz. to the Black Mesa mine. A single-unit train of 73 cars will make three trips per day to deliver 27,000 tons of coal per day to the Navajo Generating Station to start in June 1974.

The power plant and the railroad will be owned by five companies and agencies headed by the Salt River Project.

By 1974, the Black Mesa mine is expected to be producing about 15 million tons of coal per year to supply the Mohave and Navajo powerplants with fuel.

**Helium.**—The Kerr-McGee Corp. plant operated throughout the year. The Western Helium Corp. plant operated for a short time in December. Quantity and value of output increased 11 percent and 5 percent, respectively, from that of 1969.

**Petroleum and Natural Gas.**—Production of crude oil declined 27 percent in quantity, to 1.8 million barrels; and 25 percent in value to \$5.3 million. Marketed production of natural gas also declined 3 percent in quantity, to 1.101 million cubic feet, and 6 percent in value, to \$188,000. All production was from wells in Apache County.

Transwestern Gas Supply Co. and Pacific Lighting Gas Development Corp. plan a 3-year gas exploration program in areas of Arizona, New Mexico, Oklahoma, and Texas, contiguous to the Transwestern Pipeline Co. system; objective of the program is to find additional gas supplies for the southern California market.

Drilling activity declined from the record activity of 1969. Nine exploratory wells completed with a total drilled footage of 33,000 resulted in nine dry holes. Of three development wells drilled, one was completed as an oil producer.

Table 15.—Arizona: Stone sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Apache.....	3	6	\$23	3	6	\$23
Cochise.....	2	504	1,364	3	602	1,661
Coconino.....	13	192	453	15	139	261
Gila.....	5	200	564	3	155	607
Greenlee.....	4	365	865	5	387	700
Navajo.....	4	1	10	1	1	10
Pinal.....	4	77	153	4	140	316
Santa Cruz.....	1	( <sup>1</sup> )	( <sup>1</sup> )	2	91	193
Undistributed <sup>2</sup> .....	58	1,483	2,380	54	1,990	3,322
Total <sup>3</sup> .....	94	2,827	5,812	90	3,511	7,094

<sup>1</sup> Less than ½ unit.

<sup>2</sup> Includes Maricopa, Mohave, Pima, Yavapai, and Yuma Counties.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

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

Kind of stone	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Sandstone.....	11	\$175	W	W
Undistributed <sup>1</sup> .....	2	27	15	\$280
Total <sup>2</sup> .....	12	201	15	280
<b>Crushed and broken:</b>				
Granite.....	1	1	W	W
Limestone.....	2,340	3,893	2,303	3,941
Quartz.....	349	1,163	W	W
Quartzite.....	78	225	W	W
Traprock.....	W	W	413	W
Other stone.....	W	W	218	321
Undistributed <sup>3</sup> .....	46	329	552	2,551
Total.....	2,814	5,611	3,496	6,813
Grand total <sup>2</sup> .....	2,827	5,812	3,511	7,094

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

<sup>1</sup> Includes marble, quartz, and other stone in smaller quantities.

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

<sup>3</sup> Includes marble, sandstone, and other stone in smaller quantities.

**Table 17.—Arizona: Stone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars, unless otherwise specified)

Use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Irregular-shaped stone.....	3	\$50	1	W
Rubble.....	1	5	2	\$14
Other rough.....	4	79	7	198
Dressed architectural..... thousand cubic feet.....	r 60	r 64	61	65
Other dressed..... do.....	r 3	r 4	3	4
Total (approximate in short tons).....	12	201	15	280
<b>Crushed and broken:</b>				
Bituminous aggregate <sup>1</sup> .....	--	--	323	503
Concrete aggregate.....	W	W	221	502
Dense graded roadbase stone.....	W	W	215	342
Surface treatment aggregates.....	W	W	8	25
Lime.....	530	1,245	559	1,419
Metallurgical.....	629	1,709	596	1,567
Riprap and jetty stone.....	W	W	9	18
Other <sup>2</sup> .....	1,655	2,657	1,566	2,438
Total <sup>3</sup> .....	2,814	5,611	3,496	6,813
Grand total <sup>3</sup> .....	2,827	5,812	3,511	7,094

<sup>r</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included in "Other rough" for dimension stone, and in "Other" for crushed and broken stone.

<sup>1</sup> Data includes macadam and unspecified aggregates.

<sup>2</sup> Includes stone used in acid neutralizers, cement, poultry grit, roofing aggregates and terrazzo; also, whitening (1969) and railroad ballast, stone sand, mine dusting, and other uses not listed (1970).

<sup>3</sup> Data may not add to totals shown because of independent rounding.

Table 18.—Arizona: Oil and gas well drilling, by counties

County	Oil	Gas	Dry	Total	Foot- age	County	Oil	Gas	Dry	Total	Foot- age
1969:						1970:					
Exploratory completions:						Exploratory completions:					
Apache.....	--	--	21	21	76,601	Apache.....	--	--	8	8	26,936
Coconino....	--	--	4	4	8,770	Mohave.....	--	--	1	1	5,984
Yavapai.....	--	--	7	7	7,764	Total.....	--	--	9	9	32,920
Total.....	--	--	32	32	93,135	Development completions:					
Development completions:						Apache.....	1	--	2	3	11,360
Apache.....	9	2	6	17	66,777	Total all drilling.....	1	--	11	12	44,280
Total all drilling.....	9	2	38	49	159,912						

Sources: Petroleum Information Corp., 1969 and 1970 Résumés, Oil and Gas Operations in the Rocky Mountain Region. American Petroleum Institute, 1970.

Table 19.—Principal producers

Commodity and company	Address	Type of activity	County
Asbestos: Jaquays Mining Corp.	1219 South 19th Ave. Phoenix, Ariz. 85009	Underground mine and crushing, screening, and air-separation plant.	Gila.
Cement:			
American Cement Corp., Phoenix Division	2404 Wilshire Blvd. Los Angeles, Calif. 90057	Dry process, 3-rotary-kiln plant.	Yavapai.
Arizona Portland Cement Co., a division of California Portland Cement Co.	612 South Flower St. Los Angeles, Calif. 90017	do.	Pima.
Clays:			
American Cement Corp., Phoenix Division	2404 Wilshire Blvd. Los Angeles, Calif. 90057	Open pit mine	Yavapai.
Filtrol Corp.	3280 East Washington Blvd. Los Angeles, Calif. 90023	do.	Apache.
McCarrell & Gurley	Box 1377 Gallup, N. Mex. 87301	do.	Do.
Phoenix Brick Yard	1314 South 7th Ave. Phoenix, Ariz. 85007	do.	Maricopa.
Tucson Pressed Brick Corp.	Box 2592 Tucson, Ariz. 85702	do.	Pima.
Copper:			
American Smelting and Refining Co.	120 Broadway New York, N. Y. 10005	3 open pit mines, 2 mills, leach dumps, and precipitation plant.	Do.
The Anaconda Company	Box 1271 Sahuarita, Ariz. 85629	Open pit mine and mill	Do.
Bagdad Copper Corp.	Box 245 Bagdad, Ariz. 86321	Open pit mine, mill, leach dumps, precipitation plant, and copper powder refinery.	Yavapai.
Cyprus Mines Corp., Bruce Mine Division	Box 487 Bagdad, Ariz. 86321	Underground mine and mill	Do.
Duval Corp.	Box 1271 Kingman, Ariz. 86401	Open pit mine, mill, leach dumps, and precipitation plant.	Mohave.
Inspiration Consolidated Copper Co.	Box 38 Sahuarita, Ariz. 85629	do.	Pima.
	Inspiration, Ariz. 85537	4 open pit mines, 2 mills, leach dumps and in place leaching, heap leaching, precipitation plant, rough plant rolling mill, custom smelter, electrolytic refinery	Gila.
Kennecott Copper Corp., Ray Mines Division	Hayden, Ariz. 85235	Open pit mine, leach dumps and in place leaching, electro-winning plant, and precipitation plant.	Pinal.
Magma Copper Co.:			
San Manuel Division	Box M San Manuel, Ariz. 85631	Underground mine, mill, and smelter.	Pinal.
Superior Division	Box 37 Superior, Ariz. 85273	Underground mine, mill, and custom smelter.	Do.
Phelps Dodge Corp.:			
Copper Queen Branch	Drawer K Bisbee, Ariz. 85603	Open pit mine, underground mine, mill, leach dumps and in place leaching, and precipitation plant.	Cochise.
Morenci Branch	Douglas, Ariz. 85607	Custom smelter	Do.
	Morenci, Ariz. 85540	Open pit mine, mill, leach dumps, precipitation plant, and smelter.	Greenlee.
New Cornelia Branch	Drawer 9 Ajo, Ariz. 85321	Open pit mine, mill, and smelter.	Pima.

Table 19.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Copper—Continued			
Phelps Dodge Corp., (Big Hole Mining Co., lessee)	Box 125 Jerome, Ariz. 86331	Open pit mine, leach dumps, and precipitation plant.	Yavapai
Pima Mining Co.	Box 7187 Tucson, Ariz. 85713	Open pit mine and mill.	Pima
Ranchers Exploration and Development Corp.	Box 6217 Albuquerque, N. Mex. 87107	Open pit mine, heap leaching, and electro-winning plant.	Gila
Cities Service Co., Miami Copper Co. Division	Box 100 Miami, Ariz. 85539	Open pit mine, mill, leach dumps and in place leaching, and 3 precipitation plants.	Do.
Diatomite: Arizona Gypsum Corp.	Box 6495 Phoenix, Ariz. 85005	Open pit mine and plant.	Final.
Feldspar: International Minerals & Chemical Corp., Industrial Minerals Division.	Administrative Center Old Orchard Road Sooke, Ill. 60079	Open pit mine and plant.	Mohave.
Gold:			
Inspiration Consolidated Copper Co.	Inspiration, Ariz. 85537	See Copper.	Gila.
Kennecott Copper Corp., Ray Mines Division	Hayden, Ariz. 85235	do.	Final.
Magma Copper Co.	Box M	do.	Do.
San Manuel Division	Box 37 San Manuel, Ariz. 85631	do.	Do.
Superior Division	Superior, Ariz. 85273	do.	Do.
Phelps Dodge Corp.	Drawer K	do.	Cochise.
Copper Queen Branch	Bisbee, Ariz. 85603	do.	Cochise.
Morenci Branch	Morenci, Ariz. 85540	do.	Greenlee.
New Cornelia Branch	Drawer 9	do.	Pima.
Cities Service Co., Miami Copper Co. Division	Ajo, Ariz. 85821	do.	Gila.
Box 100	Box 100	do.	Gila.
Miami, Ariz. 85593	Miami, Ariz. 85593	do.	Gila.
Gypsum:			
Arizona Gypsum Corp.	Box 6675 Phoenix, Ariz. 85005	Open pit mine and plant.	Yavapai
Verde Division	do.	do.	Final.
Winkelman Division	325 Delaware Ave. Buffalo, N.Y. 14202	do.	Do.
National Gypsum Co.	do.	do.	Do.
Helium:			
Kerr-McGee Corp., Gas Processing Department	Kerr-McGee Bldg. Oklahoma City, Okla. 73102	6 wells and plant; Pinta Dome field.	Apache.
Iron ore: CF&I Steel Corp.	Box 316 Pueblo, Colo. 81002	Open pit mine.	Navajo.
Lime:			
Paul Lime Plant, Inc.	Drawer T Douglas, Ariz. 85607	5 rotary-kiln plant.	Cochise.
Phelps Dodge Corp., Morenci Branch	Morenci, Ariz. 85540	1 rotary-kiln, 1 fluidized-bed-kiln plant.	Greenlee.
Mercury:			
Gordon K. Grimes	Box 499 Payson, Ariz. 85541	Open pit mine, crusher, and furnace.	Gila.

Mica:					
San Antonio Mica Co.	Box 397	-----	Open pit mine.	-----	Pima.
Ajo, Ariz. 85821	Ajo, Ariz. 85821	-----	do.	-----	Maricopa.
V. B. West.	913 Austin St.	-----		-----	
	Amarillo, Tex. 79102	-----		-----	
Molybdenum:					
American Smelting and Refining Co.	120 Broadway	-----	See Copper.	-----	Pima.
	New York, N. Y. 10005	-----	do.	-----	Yavapai.
Bagdad Copper Corp.	Box 245	-----		-----	
	Bagdad, Ariz. 86821	-----		-----	
Duval Corp.	Box 1271	-----		-----	
	Kingman, Ariz. 86401	-----		-----	
Inspiration Consolidated Copper Co.	Inspiration, Ariz. 85537	-----		-----	
Kennecott Copper Corp., Ray Mines Division	Hayden, Ariz. 85295	-----		-----	
Magma Copper Co., San Manuel Division	Box M	-----		-----	
	San Manuel, Ariz. 85681	-----		-----	
Pima Mining Co.	Box 7187	-----		-----	
	Tucson, Ariz. 85713	-----		-----	
Cities Service Co., Miami Copper Co. Division.	Box 100	-----		-----	
	Miami, Ariz. 85589	-----		-----	
Natural gas and petroleum:					
Humble Oil & Refining Co.	2000 Classen Center-North	-----	Crude oil and natural gas wells; East	-----	Apache.
	Oklahoma City, Okla. 73106	-----	Boundary Butte field.	-----	
Kerr-McGee Corp.	Kerr-McGee Bldg.	-----	Crude oil and natural gas wells; Dineh bi	-----	Do.
	Oklahoma City, Okla. 73102	-----	Keyah field.	-----	
Perlite:					
Supreme Perlite, Inc.	321 So. 27th Ave.	-----	Open pit mine.	-----	Maricopa.
	Phoenix, Ariz. 85009	-----		-----	
Pumice:					
Apache County Highway Department.	Box 428	-----	do.	-----	Apache.
Atchison Topoka & Santa Fe Railway Co.	St. Johns, Ariz. 85936	-----	Open pit mine and plant.	-----	Coconino.
Supperlite Bldrs. Supply, Inc.	Winslow, Ariz. 86047	-----	Open pit mine.	-----	Do.
	5201 North 7th St.	-----		-----	
	Phoenix, Ariz. 85014	-----		-----	
Pyrites: Magma Copper Co., Superior Division.	Box 87	-----	See Copper.	-----	Pinal.
	Superior, Ariz. 85273	-----		-----	
Sand and Gravel (commercial):					
Arizona Sand & Rock Co.	Box 20067	-----	2 pits and plants.	-----	Maricopa.
	Phoenix, Ariz. 85036	-----	Pit and plant.	-----	Pima.
	2430 West Curtis St.	-----	3 pits and plants.	-----	Maricopa.
	Tucson, Ariz. 85705	-----	5 pits and plants.	-----	Do.
	2800 South Central Ave.	-----	2 pits and plants.	-----	Pinal.
	Phoenix, Ariz. 85040	-----	Pit and plant.	-----	Yuma.
	Box 13809	-----		-----	
	Phoenix, Ariz. 85002	-----		-----	
Silver:					
American Smelting and Refining Co.	120 Broadway	-----	See Copper.	-----	Pima.
	New York, N. Y. 10005	-----	do.	-----	Do.
The Anaconda Company.	Box 127	-----	do.	-----	Yavapai.
Bagdad Copper Corp.	Sanurta, Ariz. 85629	-----		-----	
	Box 245	-----		-----	
	Bagdad, Ariz. 86821	-----		-----	
Cyprus Mines Corp., Bruce Mine Division.	Box 487	-----		-----	
	Bagdad, Ariz. 86821	-----		-----	



Table 19.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Silver—Continued			
Duval Corp.	Box 1271 Kingman, Ariz. 86401	See Copper	Mohave.
	Box 38 Sahuarita, Ariz. 85629	do.	Pima.
E. E. Lewis, Inc.	Box 1481 Grand Junction, Colo. 81501	Underground mine	Greenlee.
Inspiration Consolidated Copper Co.	Inspiration, Ariz. 85537	See Copper	Gila.
Kennecott Copper Corp., Ray Mines Division	Hayden, Ariz. 85235	do.	Pinal.
Magma Copper Co.:			
San Manuel Division	Box M San Manuel, Ariz. 85631	do.	Do.
Superior Division	Box 37 Superior, Ariz. 85273	do.	Do.
Magma Copper Co., (McFarland & Hullinger, lessee).	Box 238 Tooele, Utah 84074	Dump	Do.
Phelps Dodge Corp.:			
Copper Queen Branch	Drawer K Bisbee, Ariz. 85603	See Copper	Cochise.
Morenci Branch	Morenci, Ariz. 85540	do.	Greenlee.
New Cornelia Branch	Drawer 9 Ajo, Ariz. 85921	do.	Pima.
Pima Mining Co.	Box 7187 Tucson, Ariz. 85713	do.	Do.
Cities Service Co., Miami Copper Co. Division	Box 100 Miami, Ariz. 85539	do.	Gila.
Stone:			
American Cement Corp., Phoenix Division	2404 Wilshire Blvd. Los Angeles, Calif. 90057	Quarry and plant	Yavapai.
Arizona Portland Cement Co., a division of California Portland Cement Co.	612 South Flower St. Los Angeles, Calif. 90017	do.	Pima.
Paul Lime Plant, Inc.	Drawer T Douglas, Ariz. 85607	do.	Cochise.
Zeolite: Union Carbide Corp., Mining & Metals Division	270 Park Ave. New York, N. Y. 10017	Open pit mine	Graham.
Zinc: Cyprus Mines Corp., Bruce Mine Division	Box 457 Bagdad, Ariz. 86321	See Copper	Yavapai.

# The Mineral Industry of Arkansas

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and by Norman F. Williams, Director and State Geologist, Arkansas Geological Commission, Little Rock, Ark. under a cooperative agreement for collecting information on all minerals except fuels.

By Grace N. Broderick <sup>1</sup>

Value of Arkansas mineral production in 1970 was \$225.6 million, an increase of 8.4 percent from the previous record high of \$208.1 million set in 1969. The gain in value over that of 1969 was highlighted by a record output of bromine and natural gas. Arkansas ranked first among the States in recovery of bauxite and bromine, second in vanadium output, and third in barite production. Combined value of mineral fuels represented 39 percent of the State's total mineral production value. Petroleum continued as the leading commodity in mineral value accounting for \$51.8 million. Natural gas production established a high of nearly \$30 million. Coal output increased, and, in November, the first ship-

ments of Arkansas coal utilizing the newly completed Arkansas River navigational system were made.

Nonmetals in 1970 accounted for a large part of the State's total mineral production value. A downturn in markets in the State was reflected by the decline in production of barite, common clay, cement, gypsum, and stone for building and construction, particularly nonresidential.

Bauxite output and value increased more than 6 percent over those of 1969; output and value of vanadium also increased. Mercury production was reported for the first time since 1967.

<sup>1</sup> Physical scientist, Division of Ferrous Metals.

Table 1.—Mineral production in Arkansas <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite..... thousand short tons..	210	\$4,616	168	\$3,721
Bauxite..... thousand long tons, dried equivalent..	1,755	24,706	1,869	26,293
Bromine..... thousand pounds..	145,100	23,287	W	W
Clays..... thousand short tons..	992	2,426	1,014	2,902
Coal (bituminous)..... do.....	223	1,802	268	2,225
Gem stones.....	NA	24	NA	25
Lime..... thousand short tons..	184	2,748	136	2,630
Natural gas..... million cubic feet..	169,257	26,743	181,351	29,560
Natural gas liquids:				
Natural gasoline and cycle products				
thousand 42-gallon barrels..	692	2,049	643	1,824
LP gases..... do.....	1,279	2,098	1,205	2,482
Petroleum (crude)..... do.....	18,049	51,079	18,035	51,760
Sand and gravel..... thousand short tons..	12,674	14,949	13,301	16,036
Stone..... do.....	16,463	23,134	15,284	22,786
Value of items that cannot be disclosed:				
Abrasive stone, cement, gypsum, mercury (1970), soapstone, tripoli, vanadium, and values indicated by symbol W.....	XX	23,465	XX	63,331
Total.....	XX	208,126	XX	225,625
Total 1967 constant dollars.....	XX	196,533	XX	p 204,191

p Preliminary. 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.—Value of mineral production in Arkansas, by counties  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Arkansas.....	---	\$3	Sand and gravel.
Ashley.....	\$261	W	Sand and gravel, lime.
Baxter.....	250	W	Sand and gravel, stone.
Benton.....	W	W	Stone, sand and gravel.
Boone.....	559	W	Sand and gravel, stone.
Bradley.....	336	285	Petroleum, sand and gravel.
Calhoun.....	783	989	Sand and gravel, petroleum.
Carroll.....	564	327	Stone, sand and gravel.
Chicot.....	157	W	Sand and gravel.
Clark.....	244	W	Sand and gravel, stone, clays.
Clay.....	136	245	Sand and gravel, stone.
Cleburne.....	31	W	Stone.
Cleveland.....	35	W	Sand and gravel.
Columbia.....	30,229	40,179	Bromine, petroleum, natural gas, LP gases, natural gasoline, sand and gravel.
Conway.....	669	262	Natural gas, stone, sand and gravel.
Craighead.....	585	W	Sand and gravel, clays, stone.
Crawford.....	4,925	W	Natural gas, stone, sand and gravel.
Crittenden.....	73	W	Clays, sand and gravel, stone.
Cross.....	509	716	Sand and gravel.
Dallas.....	170	W	Do.
Desha.....	157	W	Do.
Drew.....	106	W	Do.
Faulkner.....	586	569	Stone, sand and gravel.
Franklin.....	9,232	10,065	Natural gas, stone, coal, sand and gravel.
Fulton.....	150	208	Stone, sand and gravel.
Garland.....	W	W	Vanadium, abrasives, tripoli, gem stones, sand and gravel.
Grant.....	119	102	Sand and gravel.
Greene.....	230	194	Do.
Hempstead.....	281	W	Sand and gravel, clays, petroleum.
Hot Spring.....	5,852	4,509	Barite, clays, stone, sand and gravel.
Howard.....	W	W	Cement, gypsum, stone, clays, sand and gravel.
Independence.....	2,898	W	Stone, lime, sand and gravel.
Izard.....	2,463	2,202	Sand and gravel, stone.
Jackson.....	155	41	Do.
Jefferson.....	306	317	Sand and gravel.
Johnson.....	3,672	4,931	Natural gas, coal, stone, sand and gravel, clays.
Lafayette.....	15,984	16,368	Petroleum, natural gas, LP gases, natural gasoline, sand and gravel.
Lawrence.....	330	359	Stone, sand and gravel.
Lee.....	19	---	---
Lincoln.....	65	159	Sand and gravel.
Little River.....	W	W	Cement, sand and gravel, stone, clays.
Logan.....	1,671	1,721	Natural gas, stone, coal.
Lonoke.....	765	W	Stone, clays, sand and gravel.
Madison.....	77	1	Sand and gravel.
Marion.....	237	115	Do.
Miller.....	6,213	W	Petroleum, sand and gravel, natural gas, clays, stone.
Mississippi.....	17	6	Sand and gravel.
Monroe.....	120	( <sup>1</sup> )	Do.
Montgomery.....	W	W	Stone.
Nevada.....	2,015	W	Petroleum, sand and gravel, stone.
Newton.....	224	W	Sand and gravel, stone.
Ouachita.....	8,743	8,323	Petroleum, sand and gravel, clays, natural gas.
Perry.....	160	147	Stone.
Phillips.....	90	75	Sand and gravel.
Pike.....	896	W	Sand and gravel, gypsum, tripoli, mercury.
Poinsett.....	376	449	Sand and gravel, stone.
Polk.....	191	W	Stone, sand and gravel, clays.
Pope.....	1,422	W	Natural gas, stone, sand and gravel.
Prairie.....	---	27	Sand and gravel.
Pulaski.....	9,672	9,047	Stone, clays, bauxite, sand and gravel.
Randolph.....	126	W	Stone, sand and gravel.
St. Francis.....	W	W	Sand and gravel.
Saline.....	26,866	27,869	Bauxite, lime, sand and gravel, soapstone, stone.
Scott.....	244	83	Natural gas.
Searcy.....	3	3	Sand and gravel.
Sebastian.....	4,231	4,923	Natural gas, coal, stone, sand and gravel, clays.
Sevier.....	73	W	Sand and gravel.
Sharp.....	70	10	Do.
Stone.....	46	1	Do.
Union.....	30,329	29,476	Bromine, petroleum, sand and gravel, natural gas.
Van Buren.....	245	W	Stone.
Washington.....	W	W	Stone, sand and gravel, natural gas.
White.....	W	1,046	Stone, sand and gravel.
Woodruff.....	9	W	Sand and gravel.
Yell.....	150	28	Natural gas.
Undistributed.....	29,273	58,743	
Total <sup>2</sup> .....	208,126	225,625	

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

<sup>1</sup> Less than ½ unit.

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

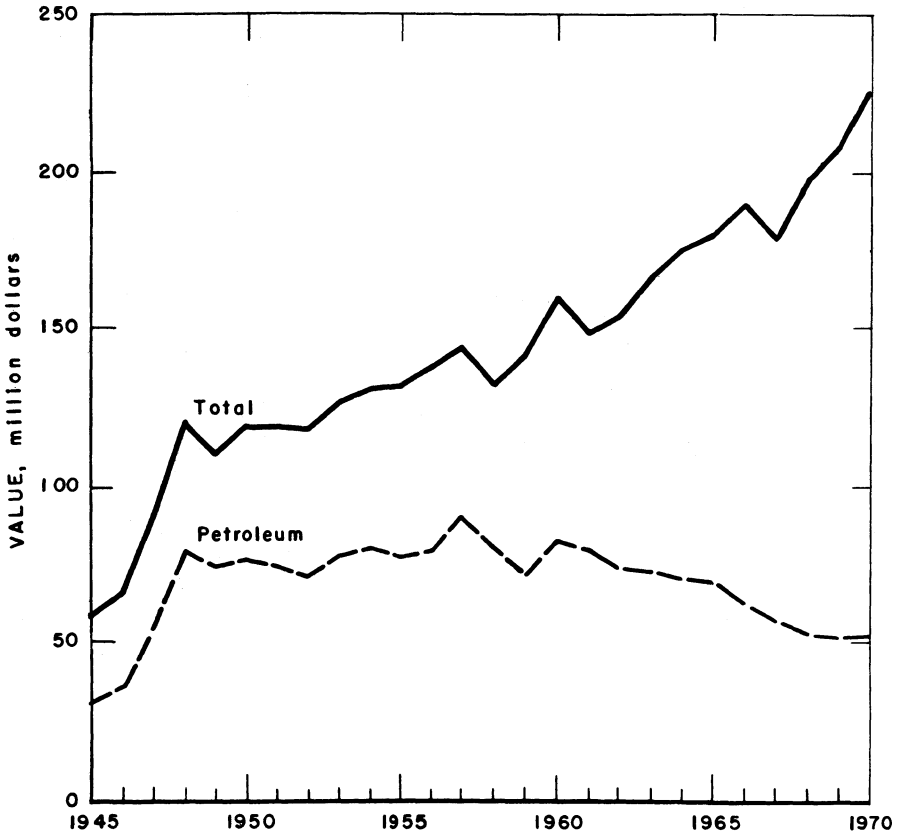


Figure 1.—Value of petroleum and total value of mineral production in Arkansas.

Table 3.—Indicators of Arkansas business activity

	1969	1970	Change, percent
<b>Annual average labor force and employment:</b>			
Total labor force..... thousands.....	726.8	731.4	+1.0
Unemployment..... do.....	30.0	37.8	+26.0
<b>Employment:</b>			
Food and kindred products..... do.....	24.4	25.2	+3.3
Lumber and wood products..... do.....	22.3	20.5	-8.1
Chemicals and allied products..... do.....	5.5	5.2	-5.5
Petroleum refining and related industries..... do.....	1.9	1.8	-5.3
Stone, clay, and glass products..... do.....	4.4	4.4	---
Primary metal industries..... do.....	4.8	4.5	-6.3
Mining..... do.....	4.6	4.5	-2.2
Contract construction..... do.....	29.0	25.8	-11.0
All industries..... do.....	696.8	693.6	-5
Factory payrolls..... millions.....	\$744.9	\$952.4	+27.9
<b>Personal income:</b>			
Total..... do.....	\$4,963.0	\$5,283.0	+6.4
Per capita..... do.....	\$2,594.0	\$2,742.0	+5.7
<b>Construction activity:</b>			
Building permits, total private nonresidential..... millions.....	\$57.0	\$36.4	-36.1
Construction contracts..... do.....	\$354.0	\$329.7	-6.7
Cement shipments to and within Arkansas thousand 376-pound barrels.....	3,844.8	3,270.0	-15.0
Farm marketing receipts..... millions.....	\$1,086.6	\$1,003.7	-7.6
Mineral production..... do.....	\$208.1	\$225.6	+8.4

Sources: Survey of Current Business, U.S. Department of Commerce; Bureau of Business and Economic Research, University of Arkansas; State Employment Security Division, Department of Labor, Arkansas; Farm Income Situation, U.S. Department of Agriculture; Employment and Earnings, U.S. Department of Labor; U.S. Bureau of Mines.

Output of the Bromet Co.'s bromine plant in Columbia County, which went on stream in 1969, helped boost Arkansas into first place among States, surpassing Michigan in bromine production. Five plants in the State extracted bromine from brine produced from the Smackover Limestone of Jurassic age.

Although oil and gas drilling activity decreased in 1970, continued interest was shown in exploration and development of the Smackover limestone trend in south Arkansas. A new Smackover discovery, the Mt. Zion field, was made in Union County, and the Walker Creek oilfield (Columbia and Lafayette Counties), an important Smackover limestone discovery of 1968, was extended 2-½ miles west and 1 mile east during the year. The Walker Creek field currently has a productive area extending about 7 miles east-west and about 1-½ miles wide.

The Arkansas Geological Commission completed field investigations of mercury deposits and is preparing a report of the results. Cooperative work with the U.S. Geological Survey on a revision of the State geological map is continuing. The revised map will be published on a scale of 1:500,000.

Estimates of strippable coal resources in Arkansas made by the U.S. Bureau of

Mines are to be published by the Bureau of Mines.

A comprehensive report on the mineral resources and industries of Arkansas was issued late in 1969.<sup>2</sup> Items discussed include the following: engineering, geological, and economic features; mineral reserves and resources; uses and markets; and the status and future potential of mineral commodities available in the State. A county map showing distribution of mineral commodities and other features accompanies each of the 75 county discussions.

The Arkansas Land Reclamation Commission, formed by H.B. No. 279, 1969 Regular Session, proposed legislation for reclamation of land after opencut mining. The proposed legislation, "The Arkansas Open Cut Land Reclamation Act of 1971," declares it to be the policy of the State to provide for the reclamation and the restoration of lands affected by surface mining operations to productive use.

The Arkansas River Waterway, a 9-foot navigable channel extending 441 river miles from the Mississippi River to the eastern outskirts of Tulsa, Okla., can be expected to stimulate agriculture, transpor-

<sup>2</sup> Stroud, Raymond B., Robert H. Arndt, Frank B. Fulkerson, and W. G. Diamond. Mineral Resources and Industries of Arkansas. BuMines Bull. 645, 1969, 418 pp.

tation, mining, and manufacturing in Arkansas and eastern Oklahoma. Among those industries likely to flourish because of the new waterway are the following: mining, processing, and shipping of coal and coke; production and shipment of stone; and the warehousing and distribution of steel, petroleum products, fertilizers, and industrial chemicals.

Preliminary data on Arkansas River freight movements, by major commodity group, for 1970, released by the Corps of Engineers in Little Rock, showed total tonnage of waterborne commerce on the Arkansas River Navigation Project to be 3.4 million tons. The tonnages, which are preliminary estimates for the completed portion of the project, are reported in the following tabulation:

Commodity group	Tons
Grain.....	106,200
Bauxite.....	833,300
Coal.....	13,100
Chemicals.....	166,775
Iron and Steel.....	126,244
Sand and gravel.....	1,569,160
Rock.....	508,630
Miscellaneous.....	95,120
Total.....	3,418,529

When the official statistics are published, it is likely that most of the 508,630 tons of "rock" will be classified as "waterway improvement material."

Some of the firms that are using, or are about to use, the navigation facilities include the following:<sup>3</sup>

Reynolds Metals Co. has off-loaded bauxite, at Brown's Bend and more recently at the Port of Little Rock, for use at its Bauxite alumina plant. The company has a ten-year contract with Orgulf Transport Co., an affiliate of the Ohio

River Co., for transporting about 1 million tons of South American and Caribbean bauxite per year. The Port of Little Rock is constructing a bauxite unloading facility downstream from its existing wharf and will provide rail extensions that will allow shipment of bauxite to move to the Reynolds plant by rail, rather than by truck as it has up to the present time.

AFCO Metals, Inc. (owned by Arkansas Foundry Co.) has constructed a new 140-foot by 680-foot plant and warehouse in the Little Rock Port industrial park. This facility will serve as a regional distribution center for the firm's metal products.

In the Russellville area, The Dow Chemical Co. has under construction a facility for the manufacture of chlorine cells.

The Arkansas Power and Light Co. nuclear plant west of Russellville may be said to depend on navigation; the pressure vessel that contains the reactor is too large to be shipped in by any mode other than barge or ship. Pressure vessels for this type of plant are not fabricated in the field.

Garland Coal & Mining Co. has applied to the Corps of Engineers for a permit to construct a coal loading facility on the west side of the San Bois navigation channel.

**Employment.**—Preliminary data for 1970 and final data for 1969 compiled by the Federal Bureau of Mines for employment and injuries in the mineral industries, excluding the petroleum industry, are shown in table 4.

<sup>3</sup> Sonstegaard, Miles H. The New Arkansas River Waterway: Part I. Significance and Current Status. Arkansas Business and Econ. Rev. February 1971, p. 12.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Coal.....	108	202	22	174	-----	9	51.84	1,613
Metal.....	2,135	285	608	4,861	1	54	11.31	2,012
Nonmetal.....	962	248	239	1,916	1	67	35.49	4,935
Sand and gravel.....	772	240	185	1,642	-----	36	21.93	522
Stone.....	1,337	285	381	3,300	-----	88	26.67	1,294
Total <sup>1</sup> .....	5,314	270	1,435	11,892	2	254	21.53	2,072
<b>1970:<sup>p</sup></b>								
Coal.....	130	199	26	208	-----	13	62.51	1,938
Metal.....	1,515	252	382	3,056	-----	51	16.69	1,224
Nonmetal.....	900	250	225	1,801	-----	55	30.54	715
Sand and gravel.....	740	249	184	1,702	-----	29	17.04	1,163
Stone.....	1,370	281	384	3,274	-----	83	25.35	1,919
Total <sup>1</sup> .....	4,650	258	1,201	10,040	-----	231	23.01	1,364

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

## MINERAL FUELS

Value of mineral fuels produced was \$87.9 million, or 39 percent of the total mineral production value. Petroleum remained the most important single contributor to the State's total mineral value. Marketed production of natural gas increased to a record high of 181,351 million cubic feet. Output of bituminous coal increased to 268,152 short tons from 228,062 short tons produced in 1969.

**Carbon Black.**—The only carbon black plant in the State, Cities Service Co.'s Columbian Carbon Division El Dorado plant in Union County, continued production for the 19th consecutive year. Quantity and value increased over 8 percent compared with 1969 data. The plant manufactures carbon black by the furnace process using hydrocarbon liquids and natural gas as feedstock.

**Coal (Bituminous).**—Output of coal increased more than 23 percent in value compared with 1969. Eight bituminous coal mines with outputs greater than 1,000 tons per year were operated. Of these, two were underground and six were strip mines; the strip mines accounted for 81 percent of the production. Four counties contributed to the State's total output; these were, in order of tonnage and value, Johnson, Franklin, Sebastian, and Logan. In Johnson County, a new strip operation was started by Garland Coal & Mining Co. Another new strip operation was started in Logan County by the Arkansas Valley Coal Co. The first shipment of metallurgical grade coal using the newly completed Arkansas River navigational system was made

by the Farrell Mining Co. Leasing activity for coal acreage was carried on by several companies.

**Natural Gas.**—Natural gas production continued to increase, reaching a record high of 181,351 million cubic feet. Production and value increased 7.1 and 10.5 percent, respectively, over 1969. Gas production from the north Arkansas dry gas fields, according to the Arkansas Oil and Gas Commission, was 128,940,883 thousand cubic feet. Reserves declined for the third year and were 2,580,674 million cubic feet, 2 percent below the 1969 reserve, according to the American Gas Association, Inc.

**Pipeline Construction.**—Arkansas-Louisiana Gas Co. has approved status on its 22-mile, 30-inch gas line in Arkansas and Oklahoma and a 33-mile, 10-inch lateral in the Little Rock area.

**Natural Gas Liquids.**—Output of natural gas liquids declined 6.2 percent to 1,848 thousand barrels, but value increased 3.8 percent to \$4,306,000. Of the gas-processing plants, Arkla Chemical Corp.'s Hamilton plant produced the most liquids. According to the American Gas Association, Inc., reserves of natural gas liquids including condensate, natural gasoline, and LP gases were 12.3 million barrels at yearend.

**Petroleum.**—Petroleum continued to be the most significant commodity in the overall State mineral value, contributing 23 percent of the total. Production of 18 million barrels was at about the same level as 1969. Reserves of crude oil, according to the American Petroleum Institute, were 129,577,000 barrels on December 31, 1970, an increase of 2,231,000 barrels over the

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

Year	Gross withdrawals <sup>1</sup>			Disposition			Vented and wasted <sup>3</sup>
	From gas wells	From oil wells	Total	Marketed production <sup>2</sup>		Repressuring	
				Quantity	Value (thousands)		
1966.....	63,100	58,479	121,579	105,174	\$16,407	15,196	1,209
1967.....	81,491	46,038	127,529	116,522	17,828	10,010	997
1968.....	110,898	51,257	162,155	156,627	24,456	4,633	895
1969.....	119,230	56,105	175,335	169,257	26,743	4,752	1,326
1970.....	128,241	55,409	183,650	181,351	29,560	2,073	226

<sup>1</sup> Marketed production plus quantities used in repressuring, vented, and wasted.

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

<sup>3</sup> Includes direct waste on producing properties and residue blown to air.

previous year. Smackover field, in Union and Ouachita Counties, for the third successive year, was the State's leading oilfield, producing about 3 million barrels.

**Table 6.—Arkansas: Crude petroleum production, indicated demand, and stocks in 1970, by months**

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	End-of-month stocks originating within Arkansas
January	1,517	1,495	778
February	1,382	1,341	819
March	1,507	1,548	778
April	1,475	1,542	711
May	1,500	1,589	622
June	1,443	1,421	644
July	1,548	1,581	611
August	1,547	1,554	604
September	1,494	1,542	556
October	1,543	1,436	663
November	1,504	1,467	700
December	1,575	1,588	687
Total:			
1970	18,085	18,104	XX
1969	18,049	18,170	XX

XX Not applicable.

**Petroleum and Natural Gas Exploration and Development.**—The total number of well completions in Arkansas declined in 1970. Of the 307 wells drilled, 100 were completed as oil wells, 36 as gas wells, and 171 as dry holes. Overall success ratio was about 44 percent; more than 12 percent of the exploratory wells were completed as oil and gas producers.

According to the 1970 Annual Oil and Gas Report of the Arkansas Oil and Gas Commission, there were five new fields, three rediscoveries, and 14 new pools proven productive during the year. Of these, two new fields, three rediscoveries, and 10 new pools were in south Arkansas; three new fields and four pools were in northwest Arkansas.

The two new oil fields, Marysville and Mt. Zion, were located in Union County. Both fields produce from Jurassic formations—the Marysville field from the Cotton Valley, and the Mt. Zion field from the Smackover. The three rediscoveries were in Lafayette County. New pool discoveries were established in the following fields: Champagnolle and Nick Springs fields, Union County; the Patmos field in Hempstead County; the Dooley Creek, Lewisville West, Lewisville Old Town, and McKamie-Patton fields in Lafayette County; the Willisville Southwest field in Nevada County; and two Smackover field areas, Bollenbacher and Shuler, in Ouachita County.

Two of the three new gas fields, Witcherville and Excelsior, were discovered in Sebastian County, and the third field, Delaware, was located in Logan County. New pools were completed in the Witcherville field of Sebastian County, the Moreland field of Pope County, and the Hollis Lake field of Crawford County.

**Table 7.—Arkansas: Oil and gas well drilling completions in 1970, by counties**

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
Ashley						7	7	40,683
Bradley	1						1	3,507
Calhoun			1			2	3	11,572
Columbia	9	1	5	1		6	22	195,962
Crawford		8	1				9	52,933
Drew						1	1	4,830
Faulkner						1	1	6,556
Franklin		3	3				6	36,256
Hempstead			1	1			2	11,774
Johnson		10	2			1	13	76,011
Lafayette	9		14	4		19	46	321,351
Little River						1	1	4,168
Logan			1		1		2	17,137
Lonoke						1	1	6,667
Madison						1	1	1,524
Miller			1			6	7	52,374
Nevada	6		5			7	18	60,896
Ouachita	11		11			6	28	103,116
Pope					1	2	3	19,735
Sebastian		9	9		2		20	162,863
Union	57	1	43	1		13	115	482,145
Total	93	32	97	7	4	74	307	1,672,060

Source: American Petroleum Institute.



**Table 8.—Arkansas: Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas**

	Proved reserves Dec. 31, 1969	Changes in proved reserves, due to revisions, exten- sions, and new discoveries in 1970	Proved reserves, Dec. 31, 1970 (Production deducted)	Change from 1969 (percent)
Crude oil.....thousand barrels..	127,346	+19,341	129,577	+1.8
Natural gas liquids <sup>1</sup> .....do.---	13,161	+1,564	12,272	-6.8
Natural gas.....million cubic feet..	2,632,773	+77,802	2,580,674	-2.0

<sup>1</sup> Includes condensate, natural gasoline, and LP gases.

Sources: American Gas Association, Inc., and American Petroleum Institute.

### NONMETALS

A major part of the total Arkansas mineral value in 1970 was contributed by a wide variety of nonmetallic minerals. The largest gain in value was registered by bromine. Production of barite, common clay, cement, gypsum, and stone for construction and building, particularly nonresidential construction, declined. Kaolin output increased as two new producers began operations.

**Abrasive Stone.**—Seven operators mined novaculite in Garland County for manufacture into oilstones used to sharpen various types of cutlery. Volume decreased 24 percent, but value was 34 percent higher than in 1969. Arkansas Oilstone Co., Inc. processed crude novaculite at its plant in Hot Springs, Garland County, and Norton Co. shipped novaculite out of Arkansas for finishing into whetstones.

**Barite.**—Barite production and value decreased over 19 percent from 1969. National Lead Co., Baroid Division, and Dresser Minerals mined and processed ore in Hot Spring County. During the latter part of 1970 the Baroid Division was on strike. Barite mined in Missouri was processed by The Milwhite Co., Inc., at Bryant, Saline County. All of the barite was used in making drilling muds. For the third consecutive year, the State ranked third in the United States in barite output.

**Bromine.**—In 1970 bromine continued as the second most important mineral commodity in value to Arkansas. Brine production from the Smackover Limestone averaged about 357,412 barrels per day. At yearend, there were 51 brine supply wells for five plants operating in the State. Nationally, Arkansas replaced Michigan as the leading bromine producer. Ethyl Corp.

plans to produce vinyl bromide at a plant presently under construction at Magnolia.

For the second consecutive year the largest increase in bromine production in the United States occurred in Arkansas where the output of the Bromet Co., which came on stream in 1969, helped to boost the State's production. In 1957, the first bromine recovery plant in Arkansas was established with a rated capacity of 5 million pounds of bromine per year; this year, Arkansas has five plants (two in Columbia County and three in Union County) with a total capacity of 322 million pounds.

**Table 9.—Arkansas: Bromine compounds sold or used by primary producers**  
(Thousand pounds and thousand dollars)

Year	Quantity		Value
	Gross weight	Bromine content	
1968.....	95,499	86,426	\$20,790
1969.....	145,100	129,550	28,287
1970.....	186,113	157,006	32,375

**Cement.**—Compared with 1969 shipments, portland cement decreased 1 percent, and masonry cement decreased 6 percent. The two producing companies were Ideal Cement Co., a division of Ideal Basic Industries, Inc., which has been manufacturing cement at its Okay plant in Howard County since 1929, and the Arkansas Cement Corp., which began manufacturing cement near Foreman, Little River County, in 1958.

Most of the cement shipments were by truck in bulk form. Building material dealers, concrete products manufacturers, and ready-mix manufacturers were the major users.

**Clays.**—Clay production was reported from 14 counties; in addition, the U.S. Forest Service produced clay for road con-

struction in various counties. Total clay output increased 2 percent, and value increased more than 19 percent over the 1969 level. Quantity and value of common clay decreased, but kaolin increased considerably in quantity and value. Common clay was used for manufacturing building brick, drain tile, sewer pipe, and cement by eight companies; one company produced light-weight aggregate at two plants (England and West Memphis).

Hot Spring County ranked first in clay output, followed by Pulaski, Lonoke, Crittenden, and Little River. These five counties accounted for over 73 percent of the State's total output. Pulaski County led in value of clay production.

**Gem Stones.**—Quartz crystals were recovered in Montgomery County. In Pike County, the Murfreesboro diamond pipe, which is owned by General Earth Minerals, a subsidiary of GF Industries, Inc., was open to collectors on a daily fee basis.

**Gypsum.**—The quantity of crude gypsum produced was 9 percent less and the total value 15 percent less than in 1969. The State's two producing companies, Dulin Bauxite Co., and Weyerhaeuser Co., mined

and processed gypsum for use in cement and wallboard manufacture, respectively.

**Lime.**—Output of lime increased 1 percent, and value decreased 2 percent from that of 1969. Quicklime was made from limestone mined in Izard County by Aluminum Co. of America (Alcoa) and by Reynolds Metals Co. at plants in Saline County for use in the reduction of bauxite to alumina; quicklime also was made by the Georgia-Pacific Corp. in Ashley County. Rangaire Corp., Batesville White Lime Division, was the only producer of both quick and hydrated lime manufactured from limestone mined in Independence County. Hydrated lime was used by the construction and paper industries.

**Sand and Gravel.**—Output and value increased in 1970 by 5 and 7 percent, respectively.

**Soapstone.**—Arkansas' only producer of soapstone, The Milwhite Co., Inc., decreased output 10 percent in 1970. This was the 18th consecutive year of production from Saline County, where soapstone is both mined and processed.

**Stone.**—Production of stone decreased 7 percent in volume and 2 percent in value.

Table 10.—Arkansas: Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building .....	1,444	\$1,807	1,398	\$1,766
Paving .....	2,187	2,343	1,785	1,823
Other uses <sup>1</sup> .....	805	1,485	604	1,269
Total <sup>2</sup> .....	4,436	5,637	3,787	4,858
Gravel:				
Building .....	1,675	2,821	1,530	2,734
Paving .....	3,722	4,175	4,618	5,299
Other uses <sup>3</sup> .....	233	235	704	661
Total <sup>2</sup> .....	5,630	7,282	6,852	8,695
<b>Government-and-contractor operations:</b>				
Sand:				
Building .....	4	2	30	21
Paving .....	561	325	1,094	1,051
Total <sup>2</sup> .....	564	327	1,124	1,072
Gravel:				
Building .....	5	5	---	---
Paving .....	2,038	1,697	1,538	1,413
Total <sup>2</sup> .....	2,043	1,703	1,538	1,413
Total sand and gravel <sup>2</sup> .....	12,674	14,949	13,301	16,036

<sup>1</sup> Includes fill, and ground and unground sand.

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

<sup>3</sup> Includes fill, railroad ballast (1969), miscellaneous, and other gravel.

**Sulfur (Recovered Elemental).**—Bromet Co. at its Columbia County bromine extraction plant continued recovery of sulfur released from hydrogen sulfide during the processing of brines as a pollution control measure. Three other plants treated sour gas for sulfur recovery. Total gross shipments from the four plants was 31,395 long tons, valued at \$819,432. Olin Corp. was the leading producer.

**Tripoli.**—Output of tripoli increased, but value declined in 1970. Two producers, Malvern Minerals Co. and Hercules Minerals Corp., operated open pit mines in Garland and Pike Counties, respectively. Its principal use was for abrasives.

### METALS

Arkansas bauxite, alumina, and aluminum operations were expanded and production increased in 1970. Reynolds Metals Co. continued importing bauxite from the Caribbean area and received its first shipments via Arkansas River waterway facilities. Mining and processing vanadium-bearing ores contributed significantly to the Nation's supply of vanadium.

**Aluminum.**—Reynolds Metals Co. continued to be the only producer of aluminum from alumina in Arkansas with operation of its reduction plants in Malvern and Arkadelphia. Aluminum metal was rolled, extruded, and drawn into various semifabricated shapes at several plants. Dow Chemical started up its Russellville mill, which contains an 8,000-ton press, one of 10 this size in the United States. The Rus-

sellville plant will initially specialize in large-scale magnesium and aluminum extrusions. Alcoa is enlarging its reactive alumina capacity by building a new plant at its bauxite-alumina complex in Arkansas.

**Bauxite.**—Output and value of bauxite increased more than 6 percent over those of 1969. The mineral value of \$26.3 million was second only to the value in 1943 (\$29.4 million) since bauxite production began in 1899. There were four crude bauxite producers during 1970; Reynolds Mining Corp., Alcoa, American Cyanamid Co., and A. P. Green Refractories Co. Most of the bauxite was mined in Saline County, but there also was production from Pulaski County. Reynolds Mining Corp., a subsidiary of Reynolds Metals Co., operated both underground and strip mines; the other companies produced from open pit operations. Arkansas continued to rank first among the states in bauxite production with 90 percent of the U.S. total.

**Gallium.**—Gallium metal was produced as a byproduct of alumina production by Alcoa at its Bauxite plant.

**Mercury.**—Pike County reported mercury production.

**Vanadium.**—Union Carbide Corp. was the only producer of vanadium oxide in the State from its Wilson Springs plant near Hot Springs, Garland County. Production of both ore and oxide increased over that of 1969. The vanadium oxide was shipped to Union Carbide's Marietta, Ohio, plant for conversion prior to marketing. Arkansas ranked second to Colorado in domestic vanadium production.

Table 11.—Arkansas: Bauxite mine production and shipments from mines and processing plants to consumers

(Thousand long tons and thousand dollars)

Year	Mine production			Shipments from mines and processing plants to consumers		
	Crude	Dry equivalent	Value <sup>1</sup>	As shipped	Dry equivalent	Value <sup>1</sup>
1966.....	2,060	1,718	\$19,439	1,891	1,636	\$19,788
1967.....	1,943	1,571	18,269	2,022	1,742	21,343
1968.....	1,961	1,582	23,058	1,962	1,680	25,349
1969.....	2,116	1,755	24,706	2,044	1,765	26,304
1970.....	2,251	1,869	26,293	2,194	1,917	29,049

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

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Abrasives:</b>			
Arkansas Oilstone Co., Inc.-----	P.O. Box 1426 Hot Springs, Ark. 71901	Mine and plant	Garland.
Norton Pike Division, Norton Co.-----	Littleton, N.H. 03561	Mine-----	Do.
Hiram A. Smith Whetstone Co.-----	11 Snider St. Hot Springs, Ark. 71901	-----do-----	Do.
<b>Barite:</b>			
Dresser Minerals-----	P.O. Box 6504 Houston, Tex. 77005	Mine and plant	Hot Spring.
National Lead Co.-----	P.O. Box 1675 Houston, Tex. 77001	-----do-----	Do.
<b>Bauxite:</b>			
Aluminum Co. of America-----	1036 Alcoa Bldg. Pittsburgh, Pa. 15219	Mine-----	Saline.
American Cyanamid Co.-----	Berdan Avenue Wayne, N.J. 07472	Mine and plant	Pulaski and Saline.
A. P. Green Refractories Co.-----	Mexico, Mo. 65265	Mine-----	Saline.
Reynolds Mining Corp.-----	P.O. Box 398 Bauxite, Ark. 72011	-----do-----	Do.
<b>Bromine:</b>			
Arkansas Chemicals, Inc.-----	Route 6, Box 98 El Dorado, Ark. 71730	Brine wells and plant.	Union.
Bromet Co.-----	P.O. Box B Magnolia, Ark. 71753	-----do-----	Columbia.
The Dow Chemical Co.-----	Midland, Mich. 48640	-----do-----	Do.
Great Lakes Chemical Corp.-----	P.O. Box 2200, West Lafayette, Ind. 47901	-----do-----	Union.
Michigan Chemical Corp.-----	2 N. Riverside Plaza Chicago, Ill. 60606	-----do-----	Do.
<b>Carbon Black:</b>			
Cities Service Co., Columbian Division.	60 Wall St. New York, N.Y. 10005	Furnace-----	Do.
<b>Cement:</b>			
Arkansas Cement Corp.-----	P.O. Box 398 Foreman, Ark. 71836	Plant and quarry.	Little River.
Ideal Cement Co., Div. of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	-----do-----	Howard.
<b>Clays:</b>			
Acme Brick Co.-----	P.O. Box 425 Fort Worth, Tex. 76101	Mine and plant	Hot Spring and Sebastian.
Arkansas Cement Corp.-----	P.O. Box 398 Foreman, Ark. 71836	-----do-----	Little River.
Arkansas Lightweight Aggregate Corp.	P.O. Box 99 England, Ark. 72046	-----do-----	Crittenden and Lonoke.
W. S. Dickey Clay Manufacturing Co.	P.O. Box 13125 Kansas City, Mo. 64199	-----do-----	Miller and Polk.
Eureka Brick & Tile Co.-----	Clarksville, Ark. 72830	-----do-----	Johnson.
A. P. Green Refractories Co.-----	Mexico, Mo. 65265	-----do-----	Pulaski.
Hope Brick Works.-----	Hope, Ark. 71801	-----do-----	Clark, Hemp- stead, and Ouachita.
<b>Coal:</b>			
Dixie Construction Co.-----	P.O. Box 477 Fort Smith, Ark. 72901	Strip mine----	Johnson.
Excelsior Valley Coal Co.-----	Midland, Ark. 72945	-----do-----	Sebastian.
Garland Coal & Mining Co.-----	P.O. Box 186 Fort Smith, Ark. 72901	-----do-----	Franklin and Johnson.
Johnson Coal Co., Inc.-----	P.O. Box 508 Clarksville, Ark. 72830	Underground mine	Johnson.
Prairie Coal Co., Inc.-----	415 Grandview Clarksville, Ark. 72830	-----do-----	Do.
<b>Gypsum:</b>			
Dulin Bauxite Co., Inc.-----	335 Valley Hot Springs, Ark. 71901	Mine and plant	Pike.
Weyerhaeuser Co.-----	310 Whittington Avenue Hot Springs, Ark. 71901	-----do-----	Howard.
<b>Lime:</b>			
Aluminum Co. of America-----	1124 Alcoa Bldg. Pittsburgh, Pa. 15219	Plant-----	Saline.
Georgia Pacific Corp.-----	Crossett, Ark. 71635	-----do-----	Ashley.
Rangaire Corp., Batesville White Lime Division.	P.O. Box 1311 Batesville, Ark. 72501	-----do-----	Independence.
Reynolds Metals Co.-----	6603 W. Broad Street Richmond, Va. 23226	-----do-----	Saline.
<b>Roofing Granules:</b>			
Bird and Son, Inc.-----	East Walpole, Mass. 02032	-----do-----	Montgomery.
Minnesota Mng & Mfg Co.-----	3 M Center (220-13W) St. Paul, Minn. 55101	-----do-----	Pulaski.
<b>Sand and Gravel:</b>			
Arkansas Rock & Gravel Co.-----	P.O. Box "T" Murfreesboro, Ark. 71958	Stationary----	Pike.
Arkholia Sand & Gravel Co.-----	323 Merchants Bank Bldg. Fort Smith, Ark. 72901	-----do-----	Crawford.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Sand and Gravel—Continued</b>			
Belvedere Sand & Gravel Co.-----	P.O. Box 243 Benton, Ark. 72015	Stationary-----	Saline.
Big Rock Stone & Material Co.-----	P.O. Box 28 Little Rock, Ark. 72203	---do-----	Pulaski.
Braswell Sand and Gravel Co., Inc.-----	P.O. Box 798 Minden, La. 71055	---do-----	Little River.
Gifford-Hill & Co., Inc.-----	P.O. Box 47127 Dallas, Tex. 75247	---do-----	Lafayette and Miller.
Jeffrey Sand Co.-----	P.O. Box 5054, North Little Rock, Ark. 72114	---do-----	Pulaski and Franklin.
Malvern Gravel Co.-----	P.O. Box 337 Malvern, Ark. 72104	---do-----	Hot Spring.
Mobley Construction Co., Inc.-----	P.O. Box 109 Morrilton, Ark. 72110	Portable-----	Jackson, Pope, Monroe, and Yell.
Pine Bluff Sand and Gravel.-----	P.O. Box 7008 Pine Bluff, Ark. 71601	Stationary-----	Ouachita and Jefferson.
St. Francis Material Co.-----	P.O. Box 999 Forrest City, Ark. 72335	---do-----	Ashley, Cal- houn, Craig- head, Poin- sett, and St. Francis.
Silica Products Co., Inc.-----	P.O. Box 248 Guion, Ark. 72540	---do-----	Izard.
<b>Stone:</b>			
Arkansas Cement Corp.-----	P.O. Box 398 Foreman, Ark. 71836	Quarry-----	Little River.
Arkholia Sand & Gravel Co.-----	323 Merchants Bank Bldg. Fort Smith, Ark. 72901	---do-----	Crawford.
Big Rock Stone & Material Co.-----	P.O. Box 28 Little Rock, Ark. 72203	---do-----	Pulaski.
Freshour Corp.-----	P.O. Box 77 Sweet Home, Ark. 72164	---do-----	Carroll, Fulton Cleburne, Conway, Craighead, Faulkner, Franklin, Johnson, In- dependence, Lawrence, Lonoke, Newton, Pope, Pulaski, Randolph, Sebastian, and White.
Ben M. Hogan Co., Inc.-----	P.O. Box 2860 Little Rock, Ark. 72203	---do-----	Fulton, Johnson, Lawrence, Lonoke, Pope, and White.
Ideal Cement Co., Div. of Ideal Basic Industries, Inc.-----	420 Ideal Cement Bldg. Denver, Colo. 80202	---do-----	Howard.
Jeffrey Stone Co., Inc.-----	P.O. Box 185, North Little Rock, Ark. 72114	---do-----	Pulaski.
McClinton Brothers Co.-----	P.O. Box 790 Fayetteville, Ark. 72701	---do-----	Baxter, Benton, and Wash- ington.
McGeorge Contracting Co.-----	P.O. Box 7008 Pine Bluff, Ark. 71601	---do-----	Pulaski.
Missouri City Stone Co.-----	1961 N. Industrial Blvd. Dallas, Tex. 75207	---do-----	Perry and Pulaski.
Rangaire Corp.-----	P.O. Box 1311 Batesville, Ark. 72501	---do-----	Independence and Izard.
<b>Talc and Soapstone:</b>			
The Milwhite Co., Inc.-----	P.O. Box 15038 Houston, Tex. 77020	Mine and plant	Saline.
<b>Tripoli:</b>			
Hercules Minerals Corp.-----	114 National Old Line Bldg. Little Rock, Ark. 72201	Mine-----	Pike.
Malvern Minerals Co.-----	P.O. Box 1246 Hot Springs, Ark. 71901	---do-----	Garland.
<b>Vermiculite:</b>			
W. R. Grace and Co.-----	62 Whittemore Avenue Cambridge, Mass. 02140	Exfoliating----	Pulaski.
<b>Natural Gas Liquids:</b>			
Arkla Chemical Corp.-----	Magnolia, Ark. 71753	Plant-----	Columbia.
Austral Oil Co., Inc.-----	Stamps, Ark. 71860	---do-----	Lafayette.
Phillips Petroleum Co.-----	do-----	---do-----	Do.
Sun Oil Co., DX Division-----	do-----	---do-----	Do.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Petroleum:</b>			
American Oil Co. ....	El Dorado, Ark. 71730 .....	Refinery .....	Union.
Berry Petroleum Co. ....	Magnolia, Ark. 71753 .....	do .....	Columbia.
Cross Oil & Refinery Co. of Arkansas.	Smackover, Ark. 71762 .....	do .....	Union.
Lion Oil, Div. Monsanto Co. ....	El Dorado, Ark. 71730 .....	do .....	Do.
Macmillan Ring-Free Oil Co., Inc.	Norphlet, Ark. 71759 .....	do .....	Do.
<b>Vanadium:</b>			
Union Carbide Corp. ....	Route 2, Box 563 Hot Springs, Ark. 71901	Mine .....	Garland.



# The Mineral Industry of California

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

By Francis C. Mitko<sup>1</sup> and John A. Stock<sup>2</sup>

California's mineral production reached another alltime high of \$1.90 billion in 1970, surpassing the previous record of \$1.84 billion in 1969 by 2.9 percent. Although the combined value of 11 metals produced decreased 4 percent, that of the 25 nonmetals produced increased 6 percent. The combined value of six mineral fuels increased 2 percent despite quantity declines for nearly all fuels, including petroleum and natural gas. The value of petroleum output rose 3 percent despite a slight decrease in quantity produced. Mineral fuels retained dominance of the State's mineral production, accounting for 64 percent of overall production value; nonmetals accounted for 32 percent and metals, 4 percent.

**Consumption, Trade, and Markets.**—California led all States in diversity of minerals produced and in value of raw materials consumed. Despite its abundance of mineral resources, California was not self-sufficient in minerals, particularly mineral fuels. Refinery receipts (all sources) rose slightly and natural gas receipts (pipeline) from out-of-State increased 8 percent compared with those of 1969. California was third highest in petroleum production but consumed more petroleum products than any other State. Although California was sixth in output of natural gas, nearly 1,566 billion cubic feet was received from sources outside the State.

California supplied the entire domestic demand for boron minerals and compounds plus large quantities for export and was the leading producer of short-fiber asbestos, portland cement, diatomite, mercury, rare-earth concentrate, salt cake, sand and gravel, and tungsten concentrate.

Many nonmetal ores produced in other States, principally Arizona and Nevada, were processed in California.

**Trends and Developments.**—The minerals industry in California continued to be influenced by the emphasis on preservation of the environment and concern for ecology. Dozens of bills were introduced in the State Legislature to improve the quality of air and water and prevent unsightly damage to the landscape. To comply with State and local pollution control requirements, millions of dollars were spent by the minerals industry to improve dust-collecting facilities and treat waste-water effluent. Solid waste disposal became increasingly expensive. More expenditures were anticipated because the standards were being raised. Mining profits were narrowed by soaring real estate values and zoning regulations, and a number of quarries and placer deposits were priced out of business. As a result of the population growth in some areas, housing developments and recreational facilities were encroaching on valuable mercury, gold, and other mineral deposits.

Although petroleum (crude oil and condensate) production dropped 1 percent, to slightly below the 1969 level, it exceeded 1 million barrels per day for the third consecutive year. Exploratory and development drilling increased slightly from that of preceding years. Notices to drill new wells increased 1 percent from the 1969 figure, to 2,033 wells. There were 1,450 wells completed to production, 45 more than in 1969. The drilling moratorium in the offshore Santa Barbara Channel contrib-

<sup>1</sup> Economist, Division of Nonferrous Metals.

<sup>2</sup> Mining engineer, Health and Safety.



Table 1.—Mineral production in California<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony.....short tons.....			4	\$10
Asbestos.....do.....	75,828	\$5,956	78,966	6,332
Boron minerals.....do.....	1,020,000	81,261	1,041,039	86,827
Cement, portland.....thousand 376-pound barrels.....	50,610	170,612	49,499	173,126
Clays.....thousand short tons.....	2,993	7,443	2,824	6,506
Copper (recoverable content of ores, etc.).....short tons.....	1,129	1,073	2,308	2,663
Gem stones.....NA.....	NA	200	NA	200
Gold (recoverable content of ores, etc.).....troy ounces.....	7,904	328	4,999	182
Gypsum.....thousand short tons.....	1,210	3,339	1,132	3,271
Lead (recoverable content of ores, etc.).....short tons.....	2,518	750	1,772	553
Lime.....thousand short tons.....	585	9,666	572	9,911
Magnesium compounds from sea-water bitters (partly estimated) short tons MgO equivalent.....	76,220	7,143	73,726	7,489
Mercury.....76-pound flasks.....	18,480	9,333	18,593	7,582
Natural gas.....million cubic feet.....	677,639	207,440	649,117	208,367
Natural gas liquids:				
Natural gasoline and cycle products				
LP gases.....thousand 42-gallon barrels.....	12,954	39,944	11,993	38,478
Peat.....do.....	8,238	17,646	7,051	16,006
Perlite.....thousand short tons.....	11	106	10	W
Perlite.....do.....	11,419	105	W	W
Petroleum (crude).....thousand 42-gallon barrels.....	375,291	920,060	372,191	945,365
Pumice, pumicite, and volcanic cinder.....thousand short tons.....	866	1,229	491	841
Salt (common).....do.....	1,895	W	1,656	14,407
Sand and gravel.....do.....	124,718	155,883	140,259	174,221
Silver (recoverable content of ores, etc.).....thousand troy ounces.....	492	881	451	799
Stone <sup>2</sup> .....thousand short tons.....	38,033	57,757	46,399	66,950
Talc, pyrophyllite, and soapstone.....short tons.....	145,158	2,329	184,660	2,545
Zinc (recoverable content of ores, etc.).....do.....	3,327	971	3,514	1,077
Value of items that cannot be disclosed:				
Barite, bromine, calcium magnesium chloride, carbon dioxide, coal (lignite), diatomite, feldspar, iron ore, lithium minerals, molybdenum, phosphate rock, potassium salts, rare-earth metals, sodium carbonate, sodium sulfate, tungsten concentrates, wollastonite (1969), and values indicated by symbol W.....		XX <sup>3</sup> 142,633	XX	123,428
Total.....		XX <sup>3</sup> 1,844,088	XX	1,897,136
Total 1967 constant dollars.....		XX <sup>3</sup> 1,741,372	XX <sup>3</sup> 1,716,908	

<sup>1</sup> Preliminary. <sup>2</sup> Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

<sup>4</sup> Includes slate.

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

(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Alameda.....	\$25,744	\$23,796	Sand and gravel, salt, stone, petroleum clays.
Alpine.....	W	W	Silver, gold, sand and gravel, lead, copper, zinc.
Amador.....	4,093	3,731	Sand and gravel, clays, stone, coal (lignite), gold, silver.
Butte.....	3,400	2,507	Natural gas, sand and gravel.
Calaveras.....	16,673	16,115	Cement, asbestos, stone, sand and gravel, clays.
Colusa.....	3,775	W	Natural gas, sand and gravel, mercury.
Contra Costa.....	15,200	12,975	Natural gas, stone, petroleum, lime, sand and gravel, clays, peat.
Del Norte.....	251	201	Sand and gravel, stone, gold.
El Dorado.....	2,897	2,628	Stone, lime, sand and gravel, soapstone.
Fresno.....	57,217	55,114	Petroleum, sand and gravel, natural gas, asbestos, natural gas liquids, stone, gold, clays, mercury.
Glenn.....	3,914	5,124	Natural gas, sand and gravel, lime.
Humboldt.....	2,108	2,054	Sand and gravel, natural gas, stone.
Imperial.....	4,301	W	Gypsum, sand and gravel, lime, clays, stone.
Inyo.....	20,657	23,722	Tungsten, copper, talc, zinc, molybdenum, silver, stone, lead, sand and gravel, perlite, boron, mercury, gold, clays.
Kern.....	464,738	472,573	Petroleum, boron, natural gas, cement, natural gas liquids, sand and gravel, stone, clays, gypsum, sodium sulfate, salt, carbon dioxide, iron ore, pumice, silver, gold, copper, zinc, lead.

See footnotes at end of table.

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

County	(Thousands)		Minerals produced in 1970 in order of value
	1969	1970	
Kings.....	\$10,282	W	Natural gas, petroleum, natural gas liquids, sand and gravel, mercury.
Lake.....	1,329	\$1,259	Mercury, sand and gravel, volcanic cinder, stone.
Lassen.....	690	W	Sand and gravel, pumice, stone.
Los Angeles.....	415,842	402,746	Petroleum, sand and gravel, natural gas, natural gas liquids, stone, clays, lime, soapstone, gold.
Madera.....	766	1,468	Natural gas, stone, sand and gravel, clays, volcanic cinder, tungsten.
Marin.....	3,459	2,638	Stone, mercury, clays, sand and gravel.
Mariposa.....	104	W	Sand and gravel, stone, gold, silver.
Mendocino.....	660	316	Sand and gravel, stone.
Merced.....	2,666	W	Sand and gravel, gold.
Modoc.....	330	W	Sand and gravel, stone, volcanic cinder.
Mono.....	450	511	Sand and gravel, clays, pumice, pyrophyllite, stone, gold.
Monterey.....	32,695	44,022	Petroleum, sand and gravel, magnesium compounds, lime, stone, feldspar, natural gas, mercury, salt.
Napa.....	3,018	3,135	Salt, stone, mercury, clays, diatomite, sand and gravel, pumice.
Nevada.....	1,029	W	Sand and gravel, stone, gold.
Orange.....	107,622	109,544	Petroleum, sand and gravel, natural gas, natural gas liquids, clays, lime, peat.
Placer.....	1,028	1,170	Sand and gravel, clays, stone.
Plumas.....	456	105	Sand and gravel, stone, gold.
Riverside.....	74,544	74,549	Iron ore, cement, sand and gravel, stone, clays, petroleum, natural gas.
Sacramento.....	20,162	W	Natural gas, sand and gravel, petroleum, gold, clays.
San Benito.....	11,334	9,824	Cement, stone, mercury, asbestos, petroleum, clays, sand and gravel, natural gas.
San Bernardino.....	136,770	152,989	Cement, stone, boron, sand and gravel, potassium salts, sodium carbonates, sodium sulfate, rare-earth minerals, salt, petroleum, lime, pyrophyllite, calcium-magnesium-chloride, lithium minerals, clays, bromine, tungsten, natural gas, pumice and volcanic cinder, antimony, gypsum, gold, silver, lead, copper, zinc.
San Diego.....	19,608	22,077	Sand and gravel, stone, salt, magnesium compounds, clays, pyrophyllite.
San Francisco.....	W	W	Sand and gravel.
San Joaquin.....	16,499	W	Natural gas, sand and gravel, lime, gold.
San Luis Obispo.....	6,147	7,039	Petroleum, mercury, natural gas, sand and gravel, stone, gypsum, clays.
San Mateo.....	14,588	12,873	Cement, magnesium compounds, salt, stone, sand and gravel, clays, petroleum, natural gas.
Santa Barbara.....	113,979	104,857	Petroleum, diatomite, natural gas, natural gas liquids, sand and gravel, mercury, lime, stone, phosphate rock.
Santa Clara.....	38,969	31,700	Cement, stone, sand and gravel, mercury.
Santa Cruz.....	13,757	W	Cement, sand and gravel, stone, clays.
Shasta.....	5,945	6,217	Cement, sand and gravel, stone, clays, volcanic cinder, copper, barite, gold.
Sierra.....	210	66	Sand and gravel, gold, silver.
Siskiyou.....	2,371	W	Sand and gravel, stone, pumice and volcanic cinder, gold.
Solano.....	18,296	23,700	Natural gas, sand and gravel, stone, petroleum.
Sonoma.....	5,401	5,275	Sand and gravel, mercury, stone, clays, natural gas.
Stanislaus.....	2,163	2,426	Sand and gravel, gold, clays.
Sutter.....	11,584	12,865	Natural gas, sand and gravel, clays.
Tehama.....	1,903	W	Natural gas, sand and gravel, volcanic cinder, stone.
Trinity.....	606	723	Sand and gravel, stone, mercury.
Tulare.....	2,991	3,422	Sand and gravel, natural gas, stone, petroleum, clays, tungsten.
Tuolumne.....	2,022	1,082	Stone, sand and gravel, lime.
Ventura.....	83,142	85,461	Petroleum, natural gas, sand and gravel, natural gas liquids, stone, clays.
Yolo.....	4,050	W	Sand and gravel, natural gas, lime.
Yuba.....	1,376	808	Sand and gravel, stone, clays.
Undistributed <sup>1</sup> .....	28,277	151,728	
Total.....	<sup>1</sup> 1,844,088	<sup>2</sup> 1,897,136	

<sup>1</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

<sup>2</sup> Includes Federal offshore petroleum and natural gas, copper, gem stones, mercury, sand and gravel, and tungsten that cannot be assigned to specific counties and values indicated by symbol W.

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

Table 3.—Indicators of California business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total labor force.....thousands..	8,368	8,610	+2.9
Unemployment.....do.....	372	519	+39.5
<b>Employment:</b>			
Mining.....do.....	33	32	-3.0
Contract construction.....do.....	302	301	-.3
Manufacturing.....do.....	1,661	1,568	-5.6
Government.....do.....	1,392	1,426	+2.4
Wholesale and retail trade.....do.....	1,493	1,548	+3.7
Services.....do.....	1,223	1,283	+4.9
Transportation and public utilities.....do.....	461	461	—
Finance, insurance, and real estate.....do.....	367	384	+4.6
<b>Personal income:</b>			
Total.....millions	\$83,408	\$89,761	+7.6
Per capita.....do.....	\$4,232	\$4,469	+5.6
<b>Construction activity:</b>			
Total private nonresidential construction.....millions..	\$1,972.8	\$1,973.6	(1)
Number of new housing units authorized.....do.....	184,864	195,221	+5.6
Portland cement shipments to and within California million 376-pound barrels.....do.....	51	45	-11.8
Farm marketing receipts.....millions..	\$4,371.3	\$4,489.1	+2.7
Mineral production.....do.....	\$1,844.1	\$1,897.1	+2.9
Exports through California ports.....do.....	\$3,910	\$4,237	+8.4
Imports through California ports.....do.....	\$3,917	\$4,407	+12.5

<sup>1</sup> Less than 1/2 of 1 percent.

Sources: Area Trends in Employment and Unemployment; Construction Review; Survey of Current Business; Employment and Earnings; Highlights of U.S. Export and Import Trade; and U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man- days worked (thou- sands)	Man- hours worked (thou- sands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non- fatal	Fre- quency	Severity
<b>1969:</b>								
Coal.....	6	110	1	5	--	--	--	--
Peat.....	14	124	2	14	--	--	--	--
Metal.....	2,367	247	585	4,689	2	188	40.52	3,757
Nonmetal and native asphalt.....	4,422	278	1,230	9,868	2	225	23.00	2,583
Sand and gravel.....	5,359	238	1,275	10,453	3	238	23.06	2,388
Stone.....	4,230	310	1,313	10,585	2	145	13.89	1,606
Total <sup>1</sup> .....	16,398	269	4,405	35,614	9	796	22.60	2,389
<b>1970: <sup>p</sup></b>								
Coal.....	5	107	1	6	--	--	--	--
Peat.....	12	114	1	11	--	--	--	--
Metal.....	2,180	288	628	5,020	3	146	29.68	5,507
Nonmetal.....	4,010	281	1,126	9,051	1	271	30.05	1,532
Sand and gravel.....	5,675	239	1,358	11,039	6	270	25.00	5,000
Stone <sup>2</sup> .....	4,465	307	1,372	11,039	3	120	11.14	2,160
Total <sup>1</sup> .....	16,350	274	4,486	36,165	13	807	22.67	3,333

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

<sup>2</sup> Beginning in 1970 data on asphaltic stone operations, which formerly were included in "Native asphalt" have been included in "Stone."

Table 5.—California: Principal custom mills, commercial grinding plants, and primary smelters in 1970

Company	County	Nearest city or town	Minerals processed	Remarks
American Smelting & Refining Co. <sup>1</sup>	Contra Costa	Selby	Lead, zinc, silver, gold.	Smelter, refinery and fuming plant.
Wilbur Ellis Co.	Fresno	Fresno	Nonmetals.	Commercial grinding.
Standard Industrial Minerals, Inc.	Inyo	Bishop	do	Do.
Paramount Pacific, Inc.	Kern	Rosamond	do	Do.
American Minerals Co.	Los Angeles	Los Angeles	do	Do.
Industrial Minerals Co.	Sacramento	Florin	do	Do.
Kaiser Steel Corp.	San Bernardino	Fontana	Iron ore	Blast furnaces, steel plants, and fabri- cating plants.
Chas. Pfizer & Co., Inc.	do	Victorville	Nonmetals	Commercial grinding.
Western Talc Co.	do	Dunn	do	Do.

<sup>1</sup> Shut down Dec. 31, 1970.

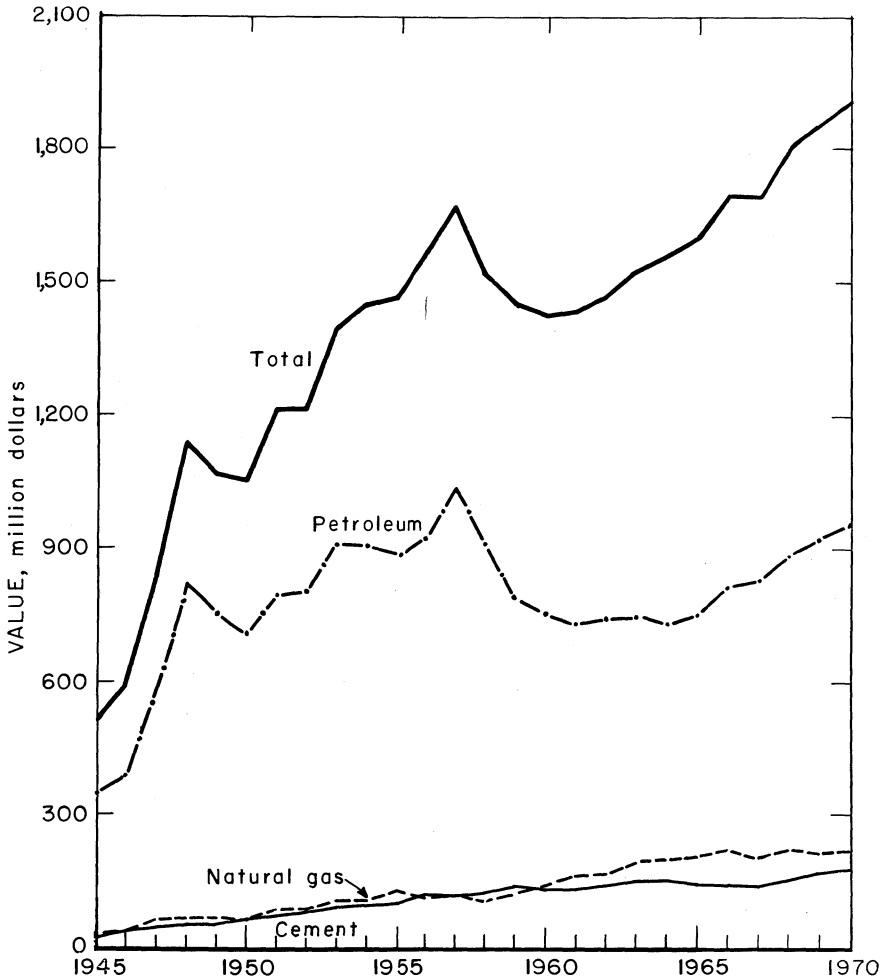


Figure 1.—Value of petroleum, natural gas, cement, and total value of mineral production in California.

uted to a reduction in offshore exploration and development. Oil production from State and Federal offshore fields comprised 30 percent of the California total, up from 27 percent in 1969 and 24 percent in 1968. Production from the Wilmington field, the State's largest, decreased 8 percent to around 82 million barrels. Production off California shores decreased for the first time in 11 years.

Consolidated General Corp. and Monte Cristo Mining Corp. began a 50-50 joint

venture for antimony near Wheaton Springs, San Bernardino County. A mill near Gorman, Kern County, previously used for tin ore, was modified for flotation of antimony ore. Tenneco, Inc., planned to open a large deposit of colemanite near Death Valley Junction, Inyo County. The colemanite was to be calcined in Nevada for use in glass fiber manufacture. Occidental Petroleum Corp. completed technical evaluation of its salines project near the south end of Searles Lake, San Bernar-

dino County, and planned construction beginning in 1971 of a \$20 million plant to recover salt cake, borates, soda ash, potash, and common salt.

Calaveras Cement Division of The Flintkote Corp. completed construction of a 7-inch pipeline to transport limestone slurry the 17.5 miles from its new Cataract quarry to the cement plant at Kentucky House, Calaveras County. This was the Nation's first long distance pipeline to transport limestone slurry. Ideal Cement Co. announced a plan to shut down its Redwood City plant in San Mateo County and operate it only as a distribution terminal for cement shipped in from other plants. Pacific Cement and Aggregates, division of Lone Star Cement Corp., completed the longest (3 miles) permanent belt conveyer system in California at its Davenport mill. The electric railroad system, which had been in use since 1922, was retired.

The Oriental mine, Sierra County, the last operating lode gold mine in the Sierra Nevada, closed near the end of the year. Sampling and testing for gold was reported in Mono and Imperial Counties. The low price for mercury caused many mines to cease production, including the Juniper, El Capitan, and Gambonini mines. Exploration for copper was reported in Plumas (American Exploration Co. and Norandex Corp.), San Bernardino (Humble Oil Co.), Inyo (M. S. & W. Co. and Cordilleran Co.) and Tehama (Cordilleran Engineering Ltd. of Vancouver, British Columbia) Counties. Further work was done by unnamed firms in Calaveras, Mariposa, and Mono Counties.

In December, Standard Slag Co. announced plans to open the Beck iron ore deposit in the Kingston Range, San Bernardino County. The company said it had a contract to supply 2.5 million tons of iron ore to Nippon Steel Corp. of Tokyo over the next 5 years. Kaiser Steel Corp. planned work on an experimental underground mine on the Black Eagle property near the northwest end of its Eagle Mountain deposit.

Exploration continued for silver in the Calico area of San Bernardino County. Some of the companies that own property there are American Smelting and Refining Co. (Asarco), The Superior Oil Co., Bunker Hill Co., and Geodata Systems, Inc. After 85 years of production,

Asarco closed its Selby lead smelter in Contra Costa County, on December 31, 1970.

Exploration for tungsten was reported in the Rand and Kern River Canyon districts of Kern County and the Atolia district of San Bernardino County.

**Legislation and Government Programs.**<sup>3</sup>  
—Five Federal bills relevant to the mineral industry in California were passed by the 91st Congress: Public Law 91-190, the "National Environmental Policy Act of 1969," enacted January 1, established a national policy for the environment and the Council on Environmental Quality; Public Law 91-512, "Resources Recovery Act of 1970," enacted October 26, amended the Solid Waste Disposal Act to provide financial assistance for the construction of solid waste disposal facilities and to improve research programs pursuant to such Act; Public Law 91-581, "Geothermal Steam Act of 1970," enacted December 24, provided for the leasing of public lands for geothermal resource exploration, development, and production; Public Law 91-631, "Mining and Minerals Policy Act of 1970," enacted December 31, established a National mining and minerals policy; and Public Law 91-604, "Clean Air Amendments of 1970," enacted December 31, amended the Clean Air Act to provide for a more effective program to improve the quality of the Nation's air.

More than 300 environmental bills were introduced in both houses of the State Legislature during the year, of which only about one-quarter were passed by the Legislature and signed by the Governor. Twenty-eight bills and seven resolutions that affected or were related to the mineral industry, were passed and became Chapters of the California Statutes of 1970.

The following four bills and three resolutions dealt with oil and gas operations: Senate Bill (SB) 161 (Chapter 799) required the State Oil and Gas Supervisor to include actions to prevent damage to life, health, property, and natural resources in his supervision of drilling, operating, maintenance, and abandonment of oil and gas wells; Assembly Bill (AB) 150 (Chapter 1530) prohibited oil and gas leases of coastal tidelands or submerged lands in State waters within the Santa Barbara Channel, and required the State Lands

<sup>3</sup> Prepared by W. H. Kerns, Bureau of Mines Liaison Officer, Sacramento, Calif.

Commission to determine and establish precise boundaries for such areas; AB 684 (Chapter 1383) dealt with lands that may not be leased for oil and gas purposes except under specific conditions, including State-owned tidelands in San Mateo, San Francisco, Marin, Sonoma, and Del Norte Counties; AB 2464 (Chapter 1438) prohibited any offshore oil and gas development or extraction operation within the boundaries of Los Angeles County; Assembly Joint Resolution (AJR) 2 (Chapter 24) memorialized the President, Congress, and the Secretary of the Interior to allow California to control and apply stricter regulations with regard to all oil and gas drilling conducted in Federal waters more than 3 miles off the California coast and memorialized the Federal Government to halt oil and gas drilling, permanently, on Federal tidelands in Santa Barbara Channel; AJR 11 (Chapter 85) requested the President to permit continued importation of low-sulfur fuel oil unhampered by costly tariffs; AJR 13 (Chapter 78) memorialized the President and Congress to establish oil drilling sanctuaries on submerged Federal lands off the California coast as an extension of oil-drilling sanctuary-area boundaries that have been created by the State of California.

One bill and one resolution were passed that affected the geothermal resource development in California as follows: AB 213 (Chapter 117) was similar to SB 161, as shown previously, in giving extra responsibilities to the State Oil and Gas Supervisor in his supervision of drilling, operation, maintenance, and abandonment of geothermal wells, to take actions to prevent damage to life, health, property, and natural resources; and Senate Resolution (SR) 331 requested the Geothermal Resources Board to make a report to the Legislature, not later than the fifth calendar day of the 1971 Regular Session, on the California geothermal sources and make recommendations for appropriate legislative action to maximize the geothermal resource potential of the State consistent with environmental protection.

Two bills concerned disposal of solid wastes were as follows: SB 21 (Chapter 65) required counties and cities to include in the general plans sites for solid and liquid waste disposal facilities; and AB 16 (Chapter 1579) prohibited after July 1,

1971, the use of open fires for disposal of solid wastes.

Two resolutions controlling pesticides-containing minerals were as follows: Senate Concurrent Resolution (SCR) 41 (Chapter 192) urged the U.S. Department of Public Health to set tolerances for mercury content of all food; and AJR 35 (Chapter 266) asked Federal officials and agencies to provide for safe and efficient disposal of harmful chemicals.

The following two water pollution control bills were passed that could affect the mineral industry: SB 55 (Chapter 1042) provides that no person shall apply fertilizer or soil conditioner containing phosphate or nitrate without first registering with the Secretary of the State Resources Agency; and AB 2516 (Chapter 1224) required any person depositing certain pollutants into water to remove those substances or pay the cost of removal after a hearing rather than after court trial.

The following nine bills to control air pollution that could affect the mineral industry were passed: AB 831 (Chapter 714) required a single air resource agency to be established in each air basin and the submission of a coordinated basin-wide air pollution control plan from each of these agencies to the State Air Resources Board by July 1, 1972; AB 1580 (Chapter 1367) required the State Air Resources Board to establish standards for lead compounds emitted into the air by nonvehicular sources; SB 848 (Chapter 1599) required the State Air Resources Board and the University of California to conduct research relating to air pollution and to make annual reports to the Legislature; AB 78 (Chapter 451) required the State Air Resources Board to prepare a program for obtaining data on air quality in each air basin; AB 1247 (Chapter 1533) directed the State Resources Agency to draft a 20-year plan of new electric powerplants and additions with recommendations on environmental considerations; AB 1942 (Chapter 1299) declared State policy in that electric powerplants shall be located and operated in such a manner as to protect against damage to environment and directed the State Resources Agency to continue research relating to nuclear powerplant siting; AB 387 (Chapter 1230) required the Bay Area Air Pollution Control District to establish standards for emission of odors from commercial opera-

tions, without exceptions or variances; AB 1137 (Chapter 1386) required State agencies in air pollution regulation to comply with local regulations where they are stricter than those of the State, and where there are no local regulations, compliance with standards in effect in the Los Angeles County Air Pollution Control District is required; and AB 86 (Chapter 1347) authorized the State Air Resources Board to repeal and replace any local air pollution control rule on a finding that it is ineffective.

The following ten bills and one resolution of a general nature that could affect the mineral industry were passed: AB 2045 (Chapter 1433), known as the Environmental Quality Act of 1970, was patterned after the National Environmental Policy Act of 1969 (Public Law 91-190) and required that all State agencies, boards, and commissions prepare and submit an environmental impact report on any project they propose to carry out that could have a significant effect on the environment of the State, and required that State agencies, boards, and commissions obtain similar reports from local agencies on projects where State funds are involved; AB 2070 (Chapter 1534) abolished the State Office of Planning and established an Office of Planning and Research within the Governor's Office and directed it to assure compliance throughout State Government with legislative environmental policies and directed the Governor to prepare and regularly update a comprehensive State Environmental Goals and Policy Report; Assembly Concurrent Resolution (ACR) 65 (Chapter 104) requested that the Governor detail in future annual budget requests a summary of expenditures proposed for meeting environmental protection needs and the order of priority assigned to these proposals; SB 1107 (Chapter 1142) extended life of the Environmental Quality Council 1 year to the end of the 1972 Regular Session and made related changes in reporting dates; AB 2433 (Chapter 1437) required the addition of two public members with a knowledge of environment to each of certain State boards and commissions having to do with resources, including among others the State Mining and Geology Board, Colorado River Board, California Water Commission, and State district oil and gas commissioners; AB 2167 (Chapter 1555) directed the State Lands Commission to in-

ventory State lands and identify such lands with unique environmental values and submit a report of the findings to the Legislature by January 1, 1972, proposing methods for the protection of any such lands; AB 1566 (Chapter 717) required, rather than permitted as before, that the general plan of a city or county include a conservation element for the conservation, development, and use of natural resources; AB 271 (Chapter 163) added one Senator and one Assemblyman to the membership of the Environmental Quality Study Council; SB 948 (Chapter 1558) authorized the State Department of Education to make grants to certain educational agencies for the maintenance of conservation education programs; AB 225 (Chapter 90) amended sections of the Public Resources Code relative to the procedures for locating, monumenting, and posting mining claims; and AB 447 (Chapter 896) amended sections of the Business and Professions Code relating to the registration of professional geologists.

Growing concern about California's environment prompted appointment of the Assembly Select Committee on Environmental Quality on January 7 to develop a comprehensive environmental program. A report entitled "Environmental Bill of Rights" was published by the Committee in March 1970. The report made 34 major recommendations proposing Assembly action during the 1970 Legislative Session, one of which resulted in the California Environmental Quality Act of 1970.

The first Progress Report of the California Environmental Quality Study Council, activated in April 1969, was published in February. It reported the findings of hearings, which were held by the Council in six cities, on major environmental issues with Statewide implications. The issues considered and reported were land use, air quality, noise abatement, and water resources. During 1970 the Council held 10 general meetings, eight public hearings, and nine committee study sessions. The second Progress Report, on its 1970 findings and recommendations, was scheduled for publication in February 1971.

On July 1, 1970, responsibility for the California Comprehensive Ocean Area Plan for a long-range conservation and development program of marine and coastal resources to insure their wise multiple use in the total public interest was assigned to

the California Department of Navigation and Ocean Development.

Public land orders restored 495 acres of land in two counties to mineral location and leasing under the U.S. mining laws. Other land orders withdrew 6,421 acres in 16 counties from mine location for use by Federal agencies. California received U.S. Treasury checks amounting to \$3,376,685.63, representing 37½ percent of Federal revenues collected within the State from mineral leasing bonuses, rentals, and royalties on public land.

During 1970, the Bureau of Mines Marine Minerals Technology Center, Tiburon, Marin County, conducted research on improving the fundamental technology that would make it possible for industry to exploit undersea minerals commercially in a manner that would protect the environment and be compatible with other uses of the sea. Under a reorganization plan submitted by the President, the facility was transferred to the newly established National Oceanic and Atmospheric Administration, U.S. Department of Commerce, in October.

The Bureau's San Francisco Petroleum Research Office, San Francisco, conducted long-range studies to insure the availability of additional oil from California fields at

the least possible cost, with emphasis on methods to make available the large resources of heavy viscous crude oil prevalent in California but not being produced.

In conformance with Bureau of Mines reorganization plans, functions of the San Francisco Office of Mineral Resources were assigned to other Bureau establishments, and, by yearend 1970, the office was virtually closed. During the second half of 1970, the Bureau established Liaison Offices in San Francisco and Sacramento to further Federal-State cooperation in solving supply and environmental quality problems associated with minerals, and to achieve a closer and more productive relationship between the State and the Federal Government.

The Office of Minerals Exploration (OME), U.S. Geological Survey, received three applications from individuals interested in exploring for minerals in California under the OME program. One new contract, for gold and silver exploration in Mono County, was executed for an estimated total cost of \$36,815, with Government participation of \$27,610. No contracts from the preceding year were active, and at the end of the year only one contract was in force.

## REVIEW BY MINERAL COMMODITIES

### MINERAL FUELS

**Carbon Black.**—Carbon black production increased by almost 6 percent over the 1969 level, owing entirely to the increased output of Columbian Carbon Co.'s first full year of operation at its new plant in Kern County. This new operation more than offset decreased output at the Continental Ore Co. and Ashland Chemical Co. plants in Kern County. The value of total production increased 2 percent. Thermal-grade carbon black was recovered as a by-product by Shell Chemical Co. at Pittsburgh, Contra Costa County, from a storage pond of an ammonia-manufacturing facility, which had ceased operating in 1967.

**Carbon Dioxide.**—Production of carbon dioxide was nearly triple the 1969 figure. Standard Oil Co. of California extracted carbon dioxide from natural gas at a natural gasoline plant near Taft, Kern County.

The product was sold for use in the manufacture of dry ice.

**Coal (Lignite).**—In 1970, Alpco Division of Interpace Corp., the sole producer, processed lignite mined from an open pit in Amador County to recover industrial waxes. This was the only plant in the United States producing montan wax in 1970. Production of lignite declined sharply from 1969.

**Coke.**—Kaiser Steel Corp. operated California's only coking facility at Fontana, San Bernardino County. The coke was consumed in company blast furnaces, and coke breeze was used in the agglomerating plant. Consumption of coke increased 1 percent and that of coke breeze decreased 9 percent compared with 1969 levels. The bulk of coking coal was obtained from the York Canyon mine in New Mexico and the Sunnyside mine in Utah and shipped by unit trains to Fontana. Smaller amounts were obtained from Colorado and West Virginia.



**Geothermal Power.**—Impetus was given to a more rapid development of geothermal resources by events on a State and Federal level during 1970. In October, the State Geothermal Resources Board held a hearing on the geothermal resources of the Imperial Valley-Salton Sea area. In December, the President signed the Geothermal Steam Act, which directed the U.S. Geological Survey to study and classify all Federal land with a potential for geothermal energy production. Leasing of these lands was expected near the end of 1971. In California, it was expected that areas affected would include The Geysers, Surprise Valley, Glass Mountain, Lassen, Wendel-Amadee, Hot Springs, Mono Lake, Casa Diablo, Coso Hot Springs, and several localities in Imperial Valley.

It was estimated that the West Coast holds about 10 percent of the world's supply of geothermal energy, but currently the only U.S. geothermal power installation is at The Geysers, about 90 miles north of San Francisco in Sonoma County. Electricity was generated by Pacific Gas and Electric Co. (PG&E) from steam purchased from Magma Power Co. and Thermal Power Co. who jointly drilled and owned the steam wells. At yearend 1970, two automatically operated powerplants were in operation, each containing two turbogenerators. These four units together produced 81,500 kilowatts of power. PG&E had two other plants under construction, which were to contain an additional four generators. Two of these were expected to be operating by mid-1971. Each of these two generators would generate 55,000 kilowatts and would bring total power capacity of The Geysers area to 191,500 kilowatts. PG&E planned to add generating capacity at the rate of 110,000 kilowatts per year beginning in 1972.

Drilling of steam wells at The Geysers increased during the year. Of the 14 new wells drilled, 11 were completed to steam production, one was subcommercial and standing idle, and one was drilled to dispose of waste water. Eight were completed by Union Oil Co. (operating for itself, Magma Power Co., and Thermal Power Co.), and three were completed by Signal Oil and Gas Co. The eight wells averaged 100,000 pounds of steam per hour and added the equivalent of 80,000 kilowatts of proven capacity to the field. At the end of 1970, Union Oil had two wells in progress

and Signal Oil had one. Based on a conservative well spacing, the proven capacity of The Geysers field was determined to be about 1 million kilowatts of electric power; less conservative estimates put the capacity at 2 million kilowatts. Generator condensate was disposed of by reinjection into nonproductive steam wells. By the end of 1970, about 700 gallons of water per minute were being put back into the field.

The Casa Diablo field, Mono County, was inactive during the year, but a special use permit was approved by the U.S. Bureau of Land Management to allow drilling of a geothermal test well at Mono Lake. The permit was issued to Geothermal Resources International, Inc. (GRI) of Bakersfield, Kern County, to drill diagonally from a site near the south shore of Mono Lake on Federal land to land under the lake leased from the State. Southern California Edison Co. had also leased State land under the lake and planned to drill from a parcel of free land near the southwest side of the lake. Drilling was planned for mid-1971, and if geothermal steam is found, the resource could be leased at a later date. Under GRI's permit, there must be no pollution of the lake or atmosphere and noise levels must not exceed 60 decibels at 1,000 feet from the source.

Geothermal leases held by GRI, Inc., were sold to Resources Investment Co. of Los Angeles during the year.

Union Oil Co. of California planned to reenter an idle well in the Salton Sea area to test its geothermal energy potential. This would be the first activity in southern California since the enactment of the Geothermal Resources Act in 1965.

Southern Union Production Co. drilled a steam well in Lake County, which was judged subcommercial and abandoned. Union Oil Co. drilled two steam wells in Sonoma County, but both were subcommercial.

**Natural Gas.**—Marketed production of natural gas was down 4 percent in quantity, but up slightly in value from 1969 figures. The greatest decrease was in gas from oil zones, which was 38,465 million cubic feet less than in 1969. Extensive development was reported in the following fields: Malton (Glenn and Tehama Counties), four new wells; Trico (Kern, Kings, and Tulare Counties), four new wells; Grimes (Colusa and Sutter Counties), five

new wells; and Maine Prairie (Solano County), five new wells.

Exploratory drilling in California resulted in discovery of no new gasfields, but new pools at Green's Lake, Yolo County, by Superior Oil Co. and at Vernalis, San Joaquin County, by Great Basin Petroleum Co. Sales of oil well gas, which decreased slightly, constituted about 55 percent of total natural gas sales. Natural gas reserves as of December 31, 1970, totaled 6,300 billion cubic feet, a decrease of 8 percent below the 1969 figure. Natural gas was produced in 27 counties.

**Natural Gas Liquids.**—The quantity and value of natural gasoline and cycle products declined 7 percent and 4 percent, respectively; and the quantity and value of LP gases declined 14 percent and 9 percent, respectively. At yearend there were 87 producing condensate wells, a decrease of 4 from yearend 1969. Estimated reserves of natural gas liquids at yearend were 170.2 million barrels, down 15.7 million barrels from those of 1969.

**Peat.**—The quantity of peat produced was 9 percent below that of 1969, but

value increased 15 percent because a larger quantity of prepared material was marketed. Two deposits in Contra Costa County produced 8 percent of the total as reed-sedge material, and one operator produced humus in Orange County. All peat was used for soil improvement.

**Petroleum.**—Production from an average of 40,811 wells, 245 less than in 1969, decreased less than 1 percent in quantity and increased 3 percent in value compared with 1969 totals. A 9.1-million-barrel decrease in onshore production and a 9.4-million-barrel decrease from State offshore fields was almost offset by an increase of 15.4 million barrels from Federal offshore fields. Nearly 28 percent of total production was from Federal and State offshore fields. Owing to drilling restrictions in the Santa Barbara Channel, offshore drilling decreased from 4.6 percent of the wells drilled in the State in 1969 to 3.6 percent.

Major increases in production were recorded in the Federal offshore Dos Cuadras field and the State-owned Ventura field, Ventura County. The other eight fields with the largest production in 1970 all de-

Table 6.—California: Natural gas (marketed production) and petroleum produced in 1970, by counties

County	Number of producing wells		Petroleum Production (thousand barrels)	Natural gas, marketed production	
	Oil (average)	Dry gas (maximum)		Oil zones (million cubic feet)	Dry gas zones (million cubic feet)
Alameda	6	--	134	--	--
Butte	--	26	--	--	5,473
Colusa	--	92	--	--	12,013
Contra Costa	44	61	1,452	2,726	13,681
Fresno	2,701	2	16,113	12,730	414
Glenn	--	102	--	--	11,723
Humboldt	--	22	--	--	2,534
Kern	21,399	75	116,179	134,288	5,201
Kings	174	16	525	13,772	2,151
Los Angeles	7,180	6	121,743	94,359	366
Madera	--	22	--	--	3,733
Monterey	944	--	10,407	1,481	--
Orange	3,606	1	34,810	15,145	77
Riverside	8	5	76	1	385
Sacramento	--	125	128	--	57,576
San Benito	23	--	63	31	--
San Bernardino	36	--	553	185	--
San Joaquin	--	100	--	--	43,936
San Luis Obispo	180	--	1,906	1,274	--
San Mateo	9	--	20	1	--
Santa Barbara	1,587	15	120,455	36,926	25,717
Solano	--	177	172	--	60,686
Sonoma	--	5	--	--	17
Sutter	--	140	--	--	39,631
Tehama	--	40	--	--	5,127
Tulare	24	20	45	--	1,604
Ventura	2,777	4	23,625	32,976	328
Yolo	--	33	--	--	3,506
Other: Federal offshore	113	--	24,985	7,343	( <sup>o</sup> )
<b>Total</b>	<b>40,811</b>	<b>1,089</b>	<b>372,191</b>	<b>353,238</b>	<b>295,879</b>

<sup>o</sup> Estimated.

<sup>1</sup> Includes field condensate.

<sup>2</sup> Included in estimate of Federal offshore oil zones.

clined, with Wilmington field and Beverly Hills field, both of Los Angeles County, declining by 19,700 and 6,700 barrels per day, respectively. Petroleum was produced in 18 counties.

New wells drilled in all counties and on State and Federal offshore leases totaled 2,161, an increase of 8.1 percent over that of 1969. The Kern River field was the most active field in the State with 442 wells drilled, including 196 steam-flood injectors and 191 producers. Average depth of all new wells was 2,565 feet, about 800 feet less than in 1969.

The California Division of Oil and Gas reported 886 million barrels of water were injected into 1,822 waterflood wells, 99 more wells than in 1969. Eleven new projects were started. About 199 million cubic feet of gas per day was injected into wells to increase oil recovery.

Exploratory drilling in 262 wells seeking new production totaled over 1.6 million feet, a decrease of less than 6 percent from the footage in 1969. Of the 262 wells drilled, 42 were discovery wells for a success ratio of 16 percent, an increase from 10.8 percent in 1969. New oilfields or new reservoirs in older fields were discovered by 34 of these wells and eight wells disclosed new gasfields or pools. The only major new oil field was discovered on the Outer Continental Shelf in Federal waters (tract 325) by Humble Oil and Refining Co. The name, Pescadero, was proposed for the field. New oil pools included the Beverly Hills and Salt Lake in Los Angeles County, San Miguelito and Rincon in Ventura County, and Greeley in Kern County.

Crude oil refining capacity increased 4 percent, to 1,701,900 barrels per calendar day, with about 10,000 barrels per day of

Table 7.—California: Oil and gas well drilling completions, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
Alameda	--	--	--	--	--	2	2	3,568
Butte	--	2	--	--	--	1	3	6,048
Colusa	1	5	2	--	--	2	10	80,401
Contra Costa	--	--	1	--	--	3	4	37,523
Fresno	91	--	11	--	1	13	116	324,829
Glenn	--	5	3	--	--	4	12	58,072
Humboldt	--	2	1	--	--	1	4	20,202
Kern	982	--	47	10	1	55	1,095	1,985,802
Kings	--	7	3	2	--	6	18	62,753
Los Angeles:								
Onshore	104	2	5	4	--	15	130	659,835
Offshore <sup>1</sup>	49	--	--	--	--	1	50	229,809
Madera	--	1	--	--	--	--	1	4,150
Merced	--	--	--	--	--	5	5	36,691
Monterey	71	--	4	--	--	7	82	187,185
Orange:								
Onshore	94	--	5	1	--	5	105	256,662
Offshore <sup>1</sup>	12	--	--	--	--	--	12	34,450
Riverside	2	--	--	--	--	--	1	14,461
Sacramento	--	2	--	--	--	7	9	67,187
San Benito	1	--	1	--	--	2	4	5,128
San Bernardino	5	--	2	2	--	5	14	62,834
San Joaquin	--	2	7	--	1	6	16	111,955
San Luis Obispo	2	--	--	1	--	3	6	25,327
Santa Barbara:								
Onshore	80	--	1	4	--	5	90	350,592
Offshore <sup>1</sup>	69	--	--	1	--	13	83	337,568
Santa Clara	--	--	--	--	--	2	2	2,121
Santa Cruz	--	--	--	--	--	1	1	7,377
Solano	--	11	6	--	--	14	33	232,477
Sonoma	--	--	1	--	--	--	1	1,332
Stanislaus	--	--	--	--	--	2	2	13,777
Sutter	--	2	--	--	--	1	3	22,205
Tehama	--	2	6	--	--	1	9	44,810
Tulare	--	2	--	--	--	2	4	23,497
Ventura	106	--	4	3	--	13	126	853,374
Yolo	--	3	7	--	3	16	29	171,384
Other: Federal offshore	* 62	--	* 3	* 6	--	* 6	77	336,757
Total	1,731	48	120	34	8	220	2,161	6,672,143

\* Estimate.

<sup>1</sup> State leases, Federal offshore shown separately.

Sources: American Petroleum Institute, American Association of Petroleum Geologists, and U.S. Bureau of Mines.

crude oil capacity under construction at yearend. Most of the gain in capacity resulted from completion of Champlin Oil Co.'s 30,000-barrel-per-day refinery at Wilmington, Los Angeles County; Texaco Inc.'s 17,000-barrel-per-day expansion at Wilmington; and Humble Oil and Refining Co.'s 8,000-barrel-per-day increase at Benicia, Contra Costa County.

### NONMETALS

**Asbestos.**—California, with shipments of 78,966 tons, continued as the Nation's largest producer of asbestos, accounting for 63 percent of the total. Output increased 4 percent in quantity and 6 percent in value over the 1969 figures and came from the open pit operations of Pacific Asbestos Corp., Calaveras County, Atlas Asbestos Co. and Coalinga Asbestos Co., Fresno County, and Union Carbide Corp., San Benito County. Pacific Asbestos produced four grades of fiber—4, 5, 6, and 7—for asbestos-cement pipe and sheets and asphalt tile. The other companies produced only the short, group 7, fibers. Principal asbestos products manufactured in California are asbestos-cement construction materials, insulation materials, and composition roofing and flooring.

**Barite.**—Crude barite sold or used declined markedly. The only producer was Yuba Minerals and Milling Co., from its Castella mine in Shasta County. Yuba sold its mills in Sutter and Fresno Counties in September and went out of business in October. Yuba's leases were transferred to Yuba Barite & Milling Co., of Bakersfield, and the ground barite plant was transferred to Wilbur Ellis Co. of Fresno. Some exploration and development was done on William S. Hubbard's Leviathan and Silver Bow mines in San Bernardino County. The decline in output was attributed to decreased oil well drilling and increased imports of crude barite.

**Boron Minerals and Compounds.**—Boron mineral and compound sales increased 2 percent in quantity, and 7 percent in value. California continued to be the only domestic source and the principal world source of boron. The bulk of the output came from two locations: United States Borax & Chemical Corp. at Boron, Kern County, and Kerr-McGee Chemical Corp. and Stauffer Chemical Co. at Trona, San Bernardino County. The remainder came from Inyo County.

United States Borax & Chemical Corp. (a 100-percent-owned subsidiary of Rio Tinto-Zinc Corp. Ltd.) continued to mine borax ore ( $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10 \text{H}_2\text{O}$ ) from its deposit near Boron by open pit methods; other boron minerals (ulexite, kernite, colemanite, and borax containing 5 molecules of water) also occur in the deposit. Facilities at Boron included a concentrating plant, a refining plant, and (since 1968) an anhydrous boric acid plant, which produced granulated borax containing 5 molecules and 10 molecules of water, anhydrous borax, anhydrous boric acid, rasorite 46 (sodium borate concentrate), and anhydrous rasorite. United States Borax also manufactured boric acid and other boron chemicals in a plant at Wilmington, Los Angeles County. In 1970 a large rock slide in the Boron open pit buried 2 million tons of ore, requiring the rental of additional trucks to remove the rock. During the year, the capacity of the Boron plant was increased 20 percent, owing to the completion of a new processing line and the addition of two new thickeners. In continuing efforts to reduce dust and improve the local plant environment, United States Borax installed additional scrubbers and dust collectors.

At Searles Lake, Kerr-McGee Chemical Corp. (formerly American Potash & Chemical Corp., Division of Kerr-McGee Corp., which under a corporate reorganization became a unit of the newly formed Kerr-McGee Chemical Corp.) and Stauffer Chemical Co. continued to extract borates from brines pumped from beneath the surface of the dry lake. During the second quarter of the year, a 115-day work stoppage by union employees of Kerr-McGee reduced output; however, the plant was operated continuously throughout the strike by supervisory personnel. Besides borax, the plant recovered and marketed lithium compounds, potash, salt cake, and soda ash as coproducts from the brine. Common salt also was recovered as a by-product and marketed on a royalty basis by Pacific Salt and Chemical Co. Technical improvements were made to the complex during the year, but plant capacity was not increased.

A third lease holder at Searles Lake, Occidental Petroleum Co., continued to operate a full-scale pilot plant to evaluate its solar evaporation process and had constructed prototype solar ponds covering 450

acres. Tenneco Inc. announced its intention to open a large colemanite deposit on patented claims near Death Valley Junction, Inyo County. The operation will be supervised by Tenneco Oil Co. This will be the only mine in the State whose principal product is colemanite ( $\text{Ca}_2\text{B}_6\text{O}_{11}\cdot 5\text{H}_2\text{O}$ ). The raw ore will be calcined in a 150,000-ton-capacity plant in Nevada, just across the State boundary from Death Valley Junction. The product will be marketed primarily for use in the production of textile-grade glass fiber for reinforced plastics, fabrics, electrical insulation, and glass-belted tires. In 1970 colemanite for this purpose was imported from Turkey. The total investment in the mine and plant was estimated at \$8 million to \$10 million.

**Bromine and Bromine Compounds.**—Elemental bromine was recovered from Searles Lake brines by Kerr-McGee Chemical Corp. at Trona, San Bernardino County. Output decreased 41 percent in quantity and 61 percent in value from 1969 figures, owing to a 115-day strike.

**Calcium Chloride.**—Continuing the trend established in 1969, output of calcium chloride in 1970 declined 19 percent in quantity and 27 percent in value. Leslie Salt Co. and National Chloride of America, the only producers, recovered liquid calcium chloride from Bristol Lake brines in San Bernardino County.

**Cement.**—A total of 49.5 million barrels of portland cement was shipped from 14 plants operated by nine companies in nine counties. This was 2 percent less than the quantity reported in 1969, but value increased 1 percent. The decline resulted

mainly from completion and curtailment of public works projects in southern California. About 5.1 million barrels went to customers in 16 States, U.S. Possessions and Territories, and foreign countries. Total consumption of cement in California was 45.4 million barrels and included about 1 million barrels received from producers outside the State. Virtually all companies reported a price increase to meet rising costs.

American Cement Corp. continued to operate the Crestmore plant, Riverside County, and the Oro Grande plant, San Bernardino County. The firm, at its Crestmore plant, produced the only white cement made on the West Coast. Plans were made for installing two sets of portable primary crushers and conveyors in the underground mine at Crestmore to connect with the main conveyor system for transporting the limestone to the surface. This would eliminate hauling the ore to the present central underground crusher and would simplify handling by having the limestone rock move directly from the working face to the surface surge pile. Plans also were made and installation begun on an \$800,000-clinker-cooler bag-house the surface plant that would complement previously installed controls on the feed-end of the kiln and further reduce air pollution.

Calaveras Cement Co., Division of The Flintkote Co., developed new sources of high-grade limestone and clay and a new distribution plant to extend the life of its Kentucky House cement plant in Calaveras County. Beginning in 1971, the limestone was to be transported as a slurry in a 7-

Table 8.—California: Finished portland cement

(Thousand 376-pound barrels and thousand dollars)

District <sup>1</sup>	Active plants	Production	Shipments from mills			Stocks at mills Dec. 31	Apparent consumption <sup>2</sup>
			Quantity	Value			
				Total	Average per barrel		
1969:							
Northern California.....	6	19,527	19,309	\$64,974	\$3.36	1,648	17,733
Southern California.....	8	31,238	31,301	105,638	3.37	1,928	28,781
Total.....	14	50,765	50,610	170,612	3.37	3,576	46,514
1970:							
Northern California.....	6	16,972	16,368	56,694	3.46	2,143	15,174
Southern California.....	8	33,100	33,131	116,432	3.51	1,831	30,316
Total.....	14	50,072	49,499	173,126	3.50	3,974	45,490

<sup>1</sup> Northern and southern California are divided by the northern boundaries of San Luis Obispo and Kern Counties and the western boundaries of Inyo and Mono Counties.

<sup>2</sup> Includes receipts from other States. Excludes imports from foreign countries.

**Table 9.—California: Source and destination of shipments of portland cement**  
(Thousand 376-pound barrels)

Destination	Source				Total	
	Northern California mills		Southern California mills		1969	1970
	1969	1970	1969	1970		
Northern California.....	15,387	12,893	1,264	1,218	16,651	14,111
Southern California.....	537	379	28,221	29,913	28,753	30,292
Nevada.....	176	166	895	935	1,071	1,101
Oregon.....	W	W	W	W	( <sup>1</sup> )	( <sup>2</sup> )
Arizona.....			285	852	285	852
Other.....	* 3,209	* 2,930	* 636	* 213	3,845	3,143
<b>Total.....</b>	<b>19,309</b>	<b>16,368</b>	<b>31,301</b>	<b>33,131</b>	<b>50,610</b>	<b>49,499</b>
Building material dealers, concrete product manufacturers, ready mixed concrete manufacturers.....	15,554	14,206	25,219	26,948	40,773	41,154
Highway contractors and Federal, State, and other Government agencies.....	3,504	1,983	5,250	5,616	8,754	7,599
Miscellaneous (including use by cement companies).....	251	179	832	567	1,083	746
<b>Total.....</b>	<b>19,309</b>	<b>16,368</b>	<b>31,301</b>	<b>33,131</b>	<b>50,610</b>	<b>49,499</b>

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

<sup>1</sup> Included with "Other;" total 1,372,535 barrels shipped from northern and southern California to Oregon.

<sup>2</sup> Included with "Other;" total 1,302,978 barrels shipped from northern and southern California to Oregon.

<sup>3</sup> Includes Alaska, Colorado (1970), Hawaii, Idaho, Oregon, Washington, foreign countries, and U.S. Possessions and Territories.

<sup>4</sup> Includes Colorado, Hawaii, Idaho (1969), Iowa (1969), Michigan (1969), Mississippi, Missouri (1969), New Mexico (1969), Ohio (1969), Oregon, Texas, Utah, Washington, and foreign countries.

**Table 10.—California: Portland cement salient statistics**  
(Thousand 376-pound barrels and thousand dollars)

	Northern California		Southern California		Total	
	1969	1970	1969	1970	1969	1970
Number of active plants.....	6	6	8	8	14	14
Production.....	19,527	16,972	31,238	33,100	50,765	50,072
Shipments from mills:						
Quantity.....	19,309	16,368	31,301	33,131	50,610	49,499
Value.....	\$64,974	\$56,694	\$105,638	\$116,432	\$170,612	\$173,126
Stocks at mills, Dec. 31.....	1,648	2,143	1,928	1,831	3,576	3,974

inch, 17.5-mile pipeline northwestward from the firm's new Cataract quarry to the cement plant. The clay pit at Valley Springs, 10 miles northwest of the plant, began operating in mid-1970. Construction was begun on a 14,000-barrel bulk-cement storage, packaging, and distribution plant in Union City, Alameda County. California Portland Cement Co. operated plants in Colton, San Bernardino County, and near Mojave, Kern County. The Colton plant, new in 1964, was able to meet existing air pollution control standards, and the company was expected to spend \$2.4 million during the next few years to improve dust collection at the Mojave plant. Other planned improvements included another bagging machine and more enclosed storage at Colton, and to increase the plant's capacity, a new finish grinding mill and bulk loading equipment at Mojave. California Portland opened a new plant at

Fremont, Alameda County, to manufacture prestressed floor and roof panels. Near yearend, Ideal Cement Co. announced plans to shut down its two cement plants, the Redwood City plant, San Mateo County, and the San Juan Bautista plant, San Benito County. These plants were considered too old and inefficient to justify expenditures to bring them up to existing air pollution control standards. Cement manufacture ceased at the Redwood City plant in December, but the plant continued to serve as a distribution terminal for cement shipped in by water from Ideal's plant in Seattle. The San Juan Bautista plant later obtained variances from the State air pollution authorities that would permit it to continue production for 1 to 2 years.

Kaiser Cement & Gypsum Corp. continued to operate its Lucerne Valley cement plant near Cushenbury, San Bernardino

County, and its plant at Permanente, Santa Clara County, to manufacture and distribute cement. Kaiser also operated smaller distributing facilities at Long Beach Harbor, Los Angeles County; Redwood City Port, Santa Clara County; and Eureka, Humboldt County.

Pacific Cement and Aggregates Division of Lone Star Cement Corp. completed a 3-mile-long permanent belt conveyor system, the longest in California, at its Davenport mill, Santa Cruz County. The system, at a reported capital cost of \$7 million, included two new crushing plants and two new storage silos to supply the mill with limestone and shale from the new Bonny Doon quarries. The electric railroad system, in use since 1922, was abandoned.

Pacific Western Industries, Inc., whose cement plant at Los Robles, Kern County, had an annual capacity of 3.3 million barrels, was acquired by General Portland Cement Co., Dallas, Tex., on January 30, 1970. Shipments from the Monolith Portland Cement Co. plant at Monolith, Kern County, were about 12 percent below normal expectancy. To comply with requirements of the Kern County Environmental Control Board, the company planned to install a new finish mill in 1971. Plans also included revising of quarry operations in a few years. Southwestern Portland Cement Co. operated a plant at Victorville, San Bernardino County.

**Clays and Shale.**—Total production of clays and shale was 6 percent less in quantity and 13 percent lower in value than in 1969. Fifty-five percent of the output was shale from 23 mines in 16 counties. More than half the shale was processed for lightweight aggregate and one-third was used in the manufacture of portland cement. Ventura County led in shale production, followed by Santa Cruz, Calaveras, Los Angeles, Alameda, and Orange Counties. Together, these six counties accounted for more than 71 percent of the shale total. Miscellaneous clays accounted for 30 percent of the total clays and shale output; fire clay and bentonite, 14 percent; and kaolin and ball clay, 1 percent. Miscellaneous clays (common, undefined and shale, and other clays) were produced at 37 mines in 20 counties; the largest production came from six mines in Riverside County. Other important producing counties, in order of output, were Contra Costa, San Mateo, and Kern. More than half the output of fire

clay was produced at seven mines in Riverside County. Fire clay also came from Amador County with four mines, Placer and Sacramento Counties with two mines each, and Kern County with one mine. Bentonite was produced at two mines in Inyo County and at one mine each in San Bernardino and Imperial Counties. Kaolin was produced from one mine in Mono County and two mines in Orange County. Ball clay came from one mine each in San Bernardino and Stanislaus Counties. During 1970, 47 companies operated 78 clay and shale mines in 28 counties. The State's total tonnage of clays and shale was distributed for use as follows: heavy clay products (33 percent), cement manufacture (30 percent), and lightweight aggregate (29 percent). The remaining 8 percent went into absorbents, refractories, floor and wall tile, filler, pottery, drilling mud, and other minor uses.

Interpace Corp. installed a new rotary kiln at its clay plant in Amador County as part of a \$2.5 million expansion project. Granada Clay Products Co. of Los Angeles acquired the Harbison-Walker plant at Ione. Cannon and Co., a brick company, was reported to be going out of business as a result of the condemnation of its plant site by the State.

**Diatomite.**—Sales of crude and prepared diatomite dropped 3 percent in quantity and 15 percent in value compared with 1969. The average price for all products decreased \$8.97 to \$59.66 per short ton. Johns-Manville Products Corp.'s large open pit mine and processing plant near Lompoc, Santa Barbara County, and Grefco, Inc.'s Tolbert mine and mill southwest of Lompoc were the major producers. Both Johns-Manville and Grefco made products chiefly for filtration, and lesser outputs of products for fillers, insulation, catalytic carriers, and silicate admixtures. Diatomic Chemical Co. produced lesser quantities of calcined and screened diatomite at its plant southeast of Lompoc for absorbents. Basalt Rock Co. Inc., near Napa, Napa County, increased its output of pozzolan from diatomite. Pozzolan Products, Inc., Santa Barbara County, and Shelley Mining Corp., Shasta County, were inactive during 1970.

**Feldspar.**—Combined output of marketable feldspar decreased 21 percent in tonnage but increased 14 percent in value over that of 1969. Owens-Illinois, Inc., and

Wedron Silica Co. (formerly Del Monte Properties Co.) processed feldspathic dune sands near Pacific Grove, Monterey County. Both companies continued to produce feldspar-silica mixtures. Wedron also produced separate silica and feldspar concentrates by flotation.

**Gem Stones.**—Thousands of rockhounds, gem collectors, and weekend prospectors were active and reported new or reopened collecting areas. In San Diego County, production of gems and high-grade specimen material was sizable, the most substantial since the Himalaya mine at Mesa Grande closed in the late 1960's. The largest amounts of this material originated in mines in the Pala area; small amounts were obtained at Ramona and Mesa Grande. Tourmaline predominated, but kunzite, beryl, and garnets also were found.

At Limekiln Creek, south of Lucia, Monterey County, jasper and rhodonite were found. Agate and jasper had been collected in the Calico area, San Bernardino County. Other areas reported for gem collecting were not located by county.

Estimated value of gem stones collected in 1970 was \$200,000.

**Gypsum.**—Production of crude gypsum and gypsite (agricultural gypsum) amounted to 1.1 million tons valued at \$3.3 million. This was 6 percent less in quantity and 2 percent less in value than in 1969. Gypsite was mined by six companies at seven open pit operations, four in Kern County and one each in Imperial, San Bernardino, and San Luis Obispo Counties. About 96 percent came from Kern County, where H. M. Holloway, Inc. at Wasco, was the major producer, followed by Temblor Gypsum Co. at Taft; C. L. Fannin at Wasco; and Superior Gypsum Co. at Lost Hills. In addition, byproduct gypsum was produced in plants producing magnesia and from phosphoric acid plants using imported phosphate rock. The largest producers of byproduct gypsum from phosphoric acid manufacture, were Valley Nitrogen Producers, Inc., Fresno County, and Occidental Chemical Co., San Joaquin County; a small amount was also produced in Contra Costa County. Registered sales of agricultural gypsum in California (including out-of-State and byproduct gypsum) were 553,000 tons.

Only United States Gypsum Co. mined crude gypsum for calcining and use in

plaster and board products. The firm's open pit mine at the Fish Creek Mountain deposit near Plaster City, Imperial County, was the major source of crude gypsum for calcining.

About 823,000 tons of calcined gypsum was produced by four companies at six plants processing crude gypsum from mines in California, Nevada, and Mexico. The Flintkote Co. plant in Alameda County and Kaiser Gypsum Co., Inc., plants in Contra Costa and Los Angeles Counties calcined gypsum. The output, primarily for construction, was 6 percent less than that of 1969.

**Iodine.**—Crude iodine was not produced in 1970. However, Deepwater Chemical Co., Ltd., at Compton, Los Angeles County, produced potassium and silver iodine; potassium, calcium, and silver iodate; and resublimed iodine from imported crude iodine.

**Lime.**—Production of lime and dead-burned dolomite decreased from 585,000 tons in 1969 to 572,000 tons, but output value increased from \$9.7 million to \$9.9 million. About 40 percent of the output was dolomitic lime used in California for precipitating magnesia from sea water. Lime also was received from other States. Total consumption of primary lime in California during 1970 was 767,000 tons, 57,000 tons less than in 1969. About 86 percent of production was quicklime; the rest was hydrated lime. Other uses for lime were in sugar refining, glass manufacturing, soil stabilization, refractories, and construction.

Lime was produced by nine companies at 15 plants in 12 counties. Eight plants produced lime for use in their own sugar refineries in Glenn, Imperial, Monterey, Orange, San Joaquin, Santa Barbara, and Yolo Counties. The U.S. Lime Division of The Flintkote Co. operated lime plants in Contra Costa, Los Angeles, and Tuolumne Counties. Flintkote shut down its plant in Tuolumne County during the year. Also, it sold its underground mine and lime products plant at Sonora and its dolomite quarry at Columbia, to Merck & Co. Merck planned to produce dolomitic lime from the Columbia quarry for use in a sea water-processing plant in south San Francisco, San Mateo County. Flintkote's new lime plant in Los Angeles County was using limestone trucked from near Las Vegas, Nev. The single plants of Diamond Springs



Lime Co., El Dorado County, and Chas. Pfizer & Co., Inc., and Stauffer Chemical Co. in San Bernardino County operated during the year. Kaiser Aluminum & Chemical Corp. produced dead-burned dolomite at its Natividad quarry, Monterey County, for use mostly as a precipitant in its Moss Landing magnesia-from-sea water plant.

**Lithium Compounds.**—Kerr-McGee Chemical Corp. recovered lithium salts from a complex mixture of minerals from Searles Lake brines at Trona, San Bernardino County, and converted them to lithium carbonate. Quantity and value were about 43 percent less than in 1969, attributable in part to a 115-day work stoppage.

**Magnesium Compounds.**—Magnesium compounds sold or used by producers, magnesium oxide equivalent basis, obtained from sea water, brines, and bitterns, decreased 3 percent in quantity but increased 5 percent in value compared with 1969. Kaiser Aluminum & Chemical Corp., using calcined dolomite to react with sea water, produced the bulk of the output as magnesia at its Moss Landing plant, Monterey County. Kaiser consumed most of the magnesia for manufacturing refractories at Moss Landing for use in its own steel and cement operations. Merck & Co., Inc., produced magnesia from sea water, sea water bitterns, and dolomitic lime at its plant in San Mateo County and manufactured magnesium carbonate and magnesium trisilicate. FMC Corp. Inorganic Chemical Division, continued to produce a small quantity of magnesium chloride from salt works bitterns in San Diego County. Other uses for magnesium compounds included pulp and paper, rubber, electrical products, and medicinals.

**Perlite.**—Crude perlite production, all by American Perlite Co., Inyo County, increased in both quantity and value from that of 1969. The crude perlite was sold to expanding plants in Los Angeles County.

Six perlite expansion plants were in operation in the following counties: four in Los Angeles and one each in San Diego and Sonora. Crude perlite, presumably imported from Arizona, Colorado, and Nevada, was expanded in some of the plants. Sales and use of expanded perlite totaled about 24,000 tons. About 53 percent of the expanded perlite was used for filter aid, 14 percent for concrete aggregate, 13 percent for plaster aggregate, and the remaining 20

percent for horticulture aggregates and other uses, including fillers and insulation.

**Phosphate Rock.**—Production and sales of phosphatic shale by Cuyama Phosphate Corp., the State's only producer, increased 40 percent in quantity and 42 percent in value over the 1969 totals. The material averaged about 4 percent phosphorous pentoxide ( $P_2O_5$ ) and was mined from an open pit near New Cuyama, Santa Barbara County. All output was processed for direct application to the soil.

United States Gypsum Co. continued its evaluation of a significant phosphate discovery in the Pine Mountain area of Ventura County. Pilot plant tests on the ore were conducted at Santa Paula, and studies were underway to determine the best method of exploiting this resource. Plans called for an open pit mine and a processing plant at the discovery site.

**Potassium Salts.**—Potassium compounds were produced by Kerr-McGee Chemical Corp. at Trona, San Bernardino County. The company extracted potassium chloride (muriate) from Searles Lake brines and converted part of the output to potassium sulfate. Total production was 13 percent higher in quantity and 65 percent higher in value than in 1969. Sales represented about 95 percent of production.

**Pumice.**—Combined output of pumice, pumicite, scoria, and volcanic cinder declined 43 percent in quantity and 32 percent in value compared with 1969. Less than half the State's total came from Siskiyou and Lassen Counties. Thirty-three operations were reported in 11 counties: seven in Siskiyou, five in Lassen, four each in Mono and Shasta, three each in Kern and Lake, two each in Modoc and Tehama, and one each in Madera, Napa, and San Bernardino. Pumice was produced at three properties in Mono County and one plant each in Napa and Siskiyou Counties. Pumicite was prepared at two plants in Kern County. The remaining 26 operations produced volcanic cinder, scoria, volcanic tuff, and volcanic dust. Production by Federal, State, and county agencies, for road construction, accounted for nearly 55 percent of the total. About 64 percent of the total was used in road construction, 18 percent for concrete aggregate, 11 percent for landscaping, and 7 percent for other uses including abrasives, filler material, insulation, railroad ballast, roofing granules, soil conditioner, and pesticide carrier. Only

Table 11.—California: Pumice<sup>1</sup> sold or used by producers in 1970, by counties

County	Crude		Prepared		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Kern.....	W	W	W	W	W	W
Lake.....	W	W	W	W	W	W
Lassen.....	181,778	\$161,634	W	W	181,778	\$161,634
Madera.....	W	W	W	W	W	W
Modoc.....	48,711	48,711	W	W	48,711	48,711
Mono.....	100	100	W	W	100	100
Napa.....	1,215	4,253	W	W	1,215	4,253
San Bernardino.....	W	W	W	W	W	W
Shasta.....	48,253	55,597	W	W	48,253	55,597
Siskiyou.....	93,175	97,995	W	W	93,175	97,995
Tehama.....	W	W	W	W	W	W
Undistributed.....	52,346	65,777	115,143	\$407,424	167,489	473,201
Total.....	375,578	434,067	115,143	407,424	490,721	841,491

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

<sup>1</sup> Includes pumicite and volcanic cinder.

23 percent of the combined output was crushed, screened, and/or ground before use.

**Salt.**—California salt production declined 13 percent in quantity but increased 4 percent in value compared with 1969. Seven companies and the Metropolitan Water District of Southern California operated 12 plants in seven counties. All recovered salt by solar evaporation. In addition, one of these companies produced rock salt and one produced salt from brine.

Most of the State's salt output was recovered by Leslie Salt Co. from sea water solar evaporating ponds in the San Francisco Bay area—Alameda, San Mateo, and Napa Counties. Leslie also produced salt by the vacuum-pan method and from brines. Pressed blocks, and all grades including table salt were produced at its Alameda County operation. In San Bernardino County, Leslie produced rock salt from Bristol Lake in addition to some solar evaporated salt. Other salt-producing establishments were Western Salt Co., Monterey and San Diego Counties; Long Beach Salt Co., Kern County; Oliver Bros. Salt Co., Alameda County; Pacific Salt and Chemical Co., Standard Salt Co., Southwest Salt Co., San Bernardino County; and the Metropolitan Water District of Southern California.

About half the salt output was consumed in the State. The remainder was shipped to other States and exported, presumably to Japan and Canada. Main uses for salt were in the chemical, water-softening, and food-processing industries.

**Sand and Gravel.**—California's output of sand and gravel continued to rise, setting a new record of 140.3 million tons that exceeded 1969's production by 12 percent. Value of the 1970 production was \$174.2

million, also a 12-percent increase. Sand and gravel were produced in all 58 counties from 674 active operations, eight more than in 1969. Production ranged from 1,000 tons in Marin County to 26.2 million tons in Los Angeles County. More than 10 million tons each was produced in San Bernardino and San Diego Counties.

Production of commercial sand for use mainly in paving and building increased 8 percent.

Increases in gravel for use for fill and paving occurred in Government-and-contractor operations.

New mining operations were begun at Mississippi Bar, on the American River, Sacramento County, and at Cache Creek near Madison, Yolo County. Objections were raised on environmental grounds against the mining of gravel at the mouth of the Russian River near Jenner, Sonoma County, by a new company, Northern California Aggregates Co. In Madera County, Madera Rock Co. operated an aggregate processing plant near the San Joaquin River. Lansden Silica Plant expected to mine and mill quartz cobbles near Bear River, Placer County, for producing nearly pure silica sand for glassmaking, foundry sand, paint filler, enamels, pottery and ceramics, and abrasives. In Contra Costa County, a new specialty sand operation was opened near Byron. The producer, Silica Sand Co., processed quartz-rich sandstone for abrasives, glass, and other special uses. Dredging of fine sand was begun by River Sand Co. from the floor of Suisun Bay, Contra Costa County. The sand was to be marketed for specialty aggregate and fill.

**Sodium Compounds.**—Sales and use of sodium compounds were 10 percent below levels of 1969, and production of both so-

dium carbonate (soda ash) and sodium sulfate (salt cake) declined. United States Borax & Chemical Corp. produced salt cake as a byproduct in the processing of crude borates at its Wilmington refinery, Los Angeles County. The borates were mined in Kern County. Kerr-McGee Chemical Corp. and Stauffer Chemical Co. each produced salt cake and soda ash from Searles Lake brines, San Bernardino County. Stauffer also recovered anhydrous sodium sulfate as a byproduct from processing sodium borates purchased in Kern County in its San Francisco plant.

**Stone.**—Stone production was 46.4 million tons, an increase of 22 percent in quantity and 16 percent in value over that of 1969. The increase was attributed to greater demand for riprap and unspecified aggregate as road-base and paving materials. Material was quarried in 44 counties by 228 operators. The State Highway Division operated nine quarries, cities and

counties operated 14, and three Federal agencies operated 24, most of which were operated by the U.S. Forest Service. Only eight quarries produced 1 million tons or more of rock each. Five were in San Bernardino County (four limestone, one traprock), and one each were in Kern (limestone), San Benito (granite), and Santa Clara (limestone) Counties. Another 96 quarries produced between 25,000 and 1 million tons each, and 121 produced less than 25,000 tons each. San Bernardino County produced more than 17 million tons of stone; Santa Clara and Kern Counties had outputs exceeding 3 million tons each; Alameda, Contra Costa, and Los Angeles Counties yielded more than 2 million tons each; and four other counties each had outputs exceeding 1 million tons. The total stone quarried was comprised of 10 percent granite, 38 percent limestone, 8 percent sandstone, and 44 percent miscellaneous stone.

**Table 12.—California: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Blast .....	263	\$1,288	179	\$1,168
Building .....	22,916	28,988	24,193	32,669
Engine .....	71	184	54	189
Fill .....	3,991	3,854	3,061	2,799
Glass .....	1,366	6,533	1,513	7,446
Paving .....	13,706	15,893	14,973	18,195
Other uses <sup>1</sup> .....	903	1,980	1,118	3,052
<b>Total <sup>2</sup> .....</b>	<b>43,217</b>	<b>58,670</b>	<b>45,095</b>	<b>65,517</b>
<b>Gravel:</b>				
Building .....	24,984	33,190	24,532	34,542
Fill .....	1,479	1,383	1,616	1,302
Paving .....	30,086	38,139	30,979	39,992
Railroad ballast .....	70	92	286	422
Miscellaneous .....	1,441	2,182	345	533
Other uses .....	736	876	874	1,151
<b>Total <sup>2</sup> .....</b>	<b>58,796</b>	<b>75,862</b>	<b>58,631</b>	<b>77,941</b>
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Building .....	209	221	96	157
Fill .....	628	605	363	121
Paving .....	5,773	6,127	8,458	7,345
Other uses .....	4	4	--	--
<b>Total <sup>2</sup> .....</b>	<b>6,614</b>	<b>6,958</b>	<b>8,916</b>	<b>7,623</b>
<b>Gravel:</b>				
Building .....	508	522	124	179
Fill .....	460	446	6,536	2,588
Paving .....	15,123	13,425	20,956	20,370
<b>Total <sup>2</sup> .....</b>	<b>16,091</b>	<b>14,393</b>	<b>27,616</b>	<b>23,138</b>
<b>Total sand and gravel <sup>2</sup> .....</b>	<b>124,718</b>	<b>155,883</b>	<b>140,259</b>	<b>174,221</b>

<sup>1</sup> Includes enamel (1969), fire or furnace, filtration, oil (hydrafac), abrasives, chemical, fill, foundry, pottery, railroad ballast, and other sands.

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

Table 13.—California: Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Alameda	14	11,049	\$14,072	15	9,427	\$12,847
Alpine	1	2	2	1	W	W
Amador	5	W	W	9	776	3,327
Butte	11	713	1,125	7	574	750
Calaveras	4	W	W	10	303	301
Colusa	4	274	164	5	W	W
Contra Costa	5	871	1,037	4	582	759
Del Norte	9	229	237	5	161	191
El Dorado	8	274	332	3	W	W
Fresno	24	3,938	4,569	21	5,594	6,018
Glenn	6	520	460	6	1,240	1,071
Humboldt	18	855	1,119	19	601	912
Imperial	10	1,630	1,843	11	1,664	1,703
Inyo	8	230	378	6	114	227
Kern	22	4,941	7,789	25	9,644	10,033
Kings	3	517	383	2	68	117
Lake	40	501	693	39	374	373
Lassen	6	390	447	6	194	205
Los Angeles	29	22,904	25,371	28	26,206	32,959
Madera	5	70	76	2	W	W
Marin	7	225	132	2	1	1
Mariposa	7	62	81	8	63	87
Mendocino	20	391	658	8	208	315
Merced	11	1,885	2,659	11	1,692	1,570
Modoc	5	161	151	6	184	141
Mono	6	214	203	7	299	346
Monterey	18	864	2,682	15	796	4,246
Napa	6	66	95	5	48	77
Nevada	7	626	1,007	7	637	843
Orange	21	7,678	8,649	22	9,132	11,839
Placer	6	408	728	7	432	758
Plumas	14	360	431	8	44	53
Riverside	31	4,252	6,084	37	3,695	6,112
Sacramento	17	6,387	8,221	14	5,673	6,249
San Bernardino	29	13,175	12,843	46	14,231	13,499
San Diego	36	9,147	16,706	38	10,526	19,504
San Joaquin	23	2,966	3,917	14	2,845	4,192
San Luis Obispo	6	95	153	9	174	392
Santa Barbara	9	1,262	1,537	9	1,120	1,508
Santa Clara	10	3,247	3,652	11	2,301	2,422
Santa Cruz	5	2,200	2,352	6	1,928	2,173
Shasta	22	786	867	21	770	858
Sierra	1	45	47	1	31	34
Siskiyou	12	2,171	1,916	16	1,837	1,916
Solano	4	71	62	9	6,283	2,617
Sonoma	12	2,362	2,937	17	2,285	3,182
Stanislaus	10	1,633	2,126	11	1,784	2,405
Tehama	13	137	276	12	665	1,176
Trinity	8	133	159	7	219	285
Tulare	8	1,361	1,666	14	2,302	2,379
Ventura	12	4,708	4,127	13	6,048	6,648
Yolo	7	2,149	2,266	7	2,509	2,558
Yuba	8	1,125	1,240	9	680	643
Undistributed <sup>1</sup>	23	2,408	5,056	23	1,298	1,398
Total <sup>2</sup>	666	124,718	155,883	674	140,259	174,221

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

<sup>1</sup> Includes San Benito, San Francisco, San Mateo, Sutter, and Tuolumne Counties, and some sand and gravel that cannot be assigned to specific counties.<sup>2</sup> Data may not add to totals shown because of independent rounding.

Principal uses of stone were as follows: 31 percent for manufacturing portland cement and lime; 31 percent for riprap and jetty stone, and 38 percent for all other applications.

Trucks transported 80 percent of the stone; railroads, 7 percent; waterways, 5 percent; and other methods, including conveyor belts, 8 percent.

**Sulfur.**—No sulfur ore was mined in California in 1970. Elemental sulfur was recovered from sour natural gas and refinery gases at 10 plants in four counties by the following nine companies: Monsanto Co., Shell Oil Co., and Union Oil Co. of California; in Contra Costa County; Collier Carbon & Chemical Corp., Douglas Oil Co., Gulf Oil Corp., Powerine Oil Co., and

Stauffer Chemical Co. in Los Angeles County; Union Oil Co. of California; in San Luis Obispo County, and Humble Oil & Refining Co. in Solano County. The Claus or modified-Claus process was used

to recover the sulfur. Sales and consumption rose 14 percent above the 1969 level.

Hydrogen sulfide was produced at six plants by the following five companies: Phillips Petroleum Co. and Standard Oil

**Table 14.—California: Stone sold or used by producers, by kinds**  
(Thousand short tons and thousand dollars)

Kind of stone	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Limestone.....	26	W	27	W
Granite.....	6	\$593	5	\$515
Marble.....	( <sup>1</sup> )	( <sup>1</sup> )	--	--
Sandstone.....	1	2	1	2
Quartzite.....	W	W	W	W
Other stone.....	18	207	7	83
Slate.....	W	W	W	W
Undistributed.....	16	367	16	380
<b>Total.....</b>	<b>67</b>	<b>1,169</b>	<b>56</b>	<b>980</b>
<b>Crushed and broken:</b>				
Limestone.....	17,604	23,519	17,386	22,780
Dolomite.....	W	W	W	W
Granite.....	3,582	4,923	4,526	7,630
Marble.....	21	324	20	401
Sandstone.....	3,564	7,348	3,526	7,405
Quartz.....	( <sup>1</sup> )	W	W	W
Quartzite.....	W	W	297	621
Shell.....	W	W	W	W
Traprock.....	2,207	2,868	2,216	2,998
Other stone.....	9,355	14,092	17,396	20,059
Slate.....	W	W	W	W
Undistributed.....	1,634	3,514	976	4,076
<b>Total.....</b>	<b>37,967</b>	<b>56,588</b>	<b>46,343</b>	<b>65,970</b>
<b>Grand total <sup>2</sup>.....</b>	<b>38,033</b>	<b>57,757</b>	<b>46,399</b>	<b>66,950</b>

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

<sup>1</sup> Less than ½ unit; included with "Undistributed."

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

**Table 15.—California: Stone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension stone:</b>				
Rough construction.....	31	\$247	20	\$143
Other <sup>1</sup> .....	35	922	36	837
<b>Total <sup>2</sup>.....</b>	<b>67</b>	<b>1,169</b>	<b>56</b>	<b>980</b>
<b>Crushed and broken stone:</b>				
Bituminous aggregate.....	2,537	4,672	1,843	3,891
Concrete aggregate.....	2,255	2,948	W	W
Dense graded road base stone.....	10,823	13,609	7,968	11,066
Macadam aggregate.....	41	228	111	273
Surface treatment aggregate.....	51	103	48	110
Unspecified aggregate and roadstone.....	383	538	1,599	2,794
Agricultural purposes.....	204	926	155	916
Cement.....	14,416	14,827	14,171	14,771
Fill.....	1,705	1,757	1,163	1,173
Lime.....	750	2,297	279	1,013
Riprap and jetty stone.....	2,443	4,633	14,602	17,875
Other uses <sup>3</sup> .....	2,260	10,049	4,403	12,085
<b>Total <sup>2</sup>.....</b>	<b>37,967</b>	<b>56,588</b>	<b>46,343</b>	<b>65,970</b>
<b>Grand total <sup>2</sup>.....</b>	<b>38,033</b>	<b>57,757</b>	<b>46,399</b>	<b>66,950</b>

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

<sup>1</sup> Includes stone used for rough architectural, monumental, flagging, and other rough and dressed stone products.

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

<sup>3</sup> Includes whitening substitutes, asphalt and other fillers, glass, sugar refining, railroad ballast, and other crushed and broken stone in smaller quantities.

Table 16.—California: Stone sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1969			1970			Kind of stone produced in 1970
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value	
Alameda.....	5	2,678	\$2,192	4	2,113	\$1,780	Other stone, traprock.
Butte.....	1	( <sup>1</sup> )	( <sup>1</sup> )	--	--	--	
Contra Costa.....	6	3,234	5,281	4	2,608	4,707	Granite, other stone, sandstone.
Del Norte.....	4	18	14	4	W	10	Do.
El Dorado.....	15	535	1,889	7	456	1,759	Limestone, other stone, slate.
Fresno.....	9	301	323	5	W	109	Granite, other stone.
Humboldt.....	7	61	62	9	315	W	Granite, other stone, sandstone, shell, traprock.
Inyo.....	5	W	W	5	W	W	Limestone, marble.
Kern.....	12	3,474	3,882	10	3,051	3,267	Limestone, other stone, quartz, quartzite.
Lake.....	4	1	2	4	1	5	Other stone, sandstone.
Los Angeles.....	11	1,264	1,574	8	2,617	3,987	Granite, other stone.
Mariposa.....	3	2	22	2	W	W	Slate.
Mendocino.....	3	( <sup>1</sup> )	1	3	( <sup>1</sup> )	1	Granite, traprock.
Modoc.....	3	38	59	4	W	W	Other stone, sandstone.
Mono.....	5	10	10	1	W	W	Other stone.
Nevada.....	1	22	22	2	W	54	Granite, quartzite.
Plumas.....	2	16	24	3	42	50	Other stone.
Riverside.....	7	1,604	4,733	10	1,330	2,224	Granite, limestone, other stone, quartzite, traprock.
San Bernardino..	30	6,062	8,885	36	17,200	20,840	Granite, limestone, other stone, quartz, quartzite, sandstone, traprock.
San Diego.....	12	1,325	2,379	11	930	2,027	Granite, other stone, traprock.
San Mateo.....	6	1,330	2,628	6	1,102	2,109	Limestone, sandstone, shell, traprock.
Santa Barbara....	9	5	42	5	W	W	Limestone, other stone, sandstone.
Santa Clara.....	6	6,301	5,318	6	5,241	4,811	Do.
Santa Cruz.....	4	1,133	1,709	4	1,234	1,713	Granite, limestone.
Siskiyou.....	5	126	130	2	W	W	Other stone.
Solano.....	4	W	W	4	705	1,420	Granite, other stone, sandstone, traprock.
Sonoma.....	9	407	894	7	340	W	Other stone, sandstone, traprock.
Tehama.....	1	1	1	1	1	1	Granite.
Trinity.....	4	392	392	3	W	W	Other stone, quartz.
Tulare.....	8	692	706	3	W	W	Granite, other stone.
Tuolumne.....	17	W	W	15	129	585	Dolomite, limestone, marble, other stone, sandstone.
Ventura.....	5	233	774	5	W	W	Limestone, other stone, sandstone.
Undistributed <sup>2</sup> ...	34	6,768	13,809	35	6,984	15,490	
Total <sup>3</sup> .....	257	38,033	57,757	228	46,399	66,950	

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

<sup>1</sup> Less than 1/2 unit.<sup>2</sup> Includes data for Amador (1970), Calaveras, Imperial, Lassen (1970), Madera, Marin, Monterey, Napa, Placer, San Benito, San Luis Obispo, Shasta, and Yuba Counties.<sup>3</sup> Data may not add to totals shown because of independent rounding.

Co. of California in Contra Costa County and Atlantic Richfield Oil Co., Mobil Oil Corp., Shell Oil Co., and Standard Oil Co. of California in Los Angeles County. Four plants used the diethanolamine absorption process and two plants utilized the Girbotol process. American Smelting and Refining Co. produced liquid sulfur dioxide at its Selby smelter in Contra Costa County. Sulfur recovery at all seven plants was virtually the same as in 1969.

**Talc, Soapstone, and Pyrophyllite.**—Combined production of talc, soapstone, and pyrophyllite totaled 185,000 tons, an increase of 27 percent in quantity and 9 percent in value compared with that of 1969. Crude talc was shipped from 17

mines: 10 in Inyo County and seven in San Bernardino County. Shipments were also made from stockpiles at another three properties. Soapstone was shipped from one mine in El Dorado County and one in Los Angeles County. Pyrophyllite was shipped from two mines in San Diego County and from one each in Mono and San Bernardino Counties. Of the combined total output of crude talc, soapstone, and pyrophyllite, 58 percent came from Inyo County and 39 percent came from San Bernardino County.

Grinding plants were operated in the following six counties: Alameda, Inyo, Los Angeles, Sacramento, San Bernardino, and San Diego. Production and sales of ground

material totaled 140,268 short tons in 1970, and, of the total, 36 percent was used in paints, 22 percent in ceramics, 9 percent in insecticides, 9 percent as asphalt filler, 6 percent by the rubber industry, and 18 percent by the cosmetic, rice polishing, foundry, textile, paper, and other industries. Less than 2 percent of the talc was exported.

**Wollastonite.**—No wollastonite was produced in 1970. However, assessment work was reported by Interpace Corp., near Spanish Springs, Inyo County, and by Chas. Pfizer & Co., Inc., near Blythe, Riverside County.

**Other Nonmetals.**—Crude vermiculite, obtained from out-of-State, was exfoliated at plants in Alameda, Los Angeles, and Orange Counties. Production and sales decreased 20 percent below those of 1969. The main uses were for insulation, aggregate, and agricultural products.

Production of natural and manufactured iron oxide pigments in Alameda County by the C. K. Williams Division of Chas. Pfizer & Co. Inc. decreased 9 percent in quantity and 2 percent in value. Most of the output was manufactured red, brown, and yellow oxides.

Fontana Slag Co. processed blast furnace slag at Fontana, San Bernardino County. Production of slag for use in ballast, concrete aggregate, roofing granules, filter media, and road paving materials was about the same as in 1969.

Great Lakes Carbon Corp., in a plant in Antelope Valley, Kern County, manufactured graphite from coal tar pitch. The graphite was used for electrodes and mold stock. Production decreased 8 percent below that of 1969.

## METALS

**Antimony.**—Ford Mining Co. produced and stockpiled 10 tons of antimony ore at its Ford mine, Kern County. Monte Cristo Mining Corp. produced and shipped 4 tons of antimony concentrate valued at \$10,000 from the Apollo mine, San Bernardino County.

Monte Cristo and Consolidated General Corp. began a 50-50 joint venture for antimony near Wheaton Springs, San Bernardino County. A mill near Gorman, Kern County, previously used for tin, was modified for flotation of the antimony ore.

Small and scattered antimony deposits in

the southern Argus Range, Inyo County north of Water Canyon, reportedly were explored by an unidentified operator.

**Copper.**—Copper was recovered as a by-product from the treatment of tungsten ore, gold-silver ore, lead-zinc ore, mine dumps, and mill tailings and from exploration by nine operators in six counties—three in Inyo, one each in San Bernardino, Alpine, Kern, and Shasta, and two at unknown locations. More than 98 percent of the output came from Inyo County where Union Carbide Corp., the largest producer, recovered copper from the treatment of tungsten ore from its Pine Creek mine; the Darwin Group (West Hill Exploration Inc.) recovered copper as a byproduct from the treatment of lead-zinc ores. Production more than doubled in quantity and increased 148 percent in value compared with 1969.

A number of companies explored for copper and related metals. Such projects were underway in Calaveras, Imperial, Plumas, Shasta, Siskiyou, and Yuba Counties.

**Gold.**—Total gold production declined 37 percent from that of 1969, continuing a trend that resulted in a 50-percent drop in 1969 following the cessation of gold dredging late in 1968 by Yuba Consolidated Industries.

Lode gold accounted for 2,735 troy ounces and placer gold accounted for 2,264 ounces of the year's total. Lode gold production was reported by 14 operators—three in Sierra County, two in Inyo County, one each in Alpine, Amador, Kern, Mariposa, Sacramento, San Bernardino, and Shasta Counties, and two operations in unknown locations. Dickey Exploration Co. operated the Oriental mine, Sierra County, and produced 30 percent of the State's lode gold output. Other mines yielding over 100 ounces of gold were the Zaca gold-silver mine, Alpine County, and the Darwin lead-zinc and the Pine Creek tungsten mines in Inyo County.

The bulk of the gold produced at 19 placer operations was recovered as a by-product from 13 sand and gravel operations in seven counties—four in Fresno; two each in Sacramento, Shasta, and Stanislaus; and one each in Los Angeles, Merced, and San Joaquin. The remainder came from six small gold operations, two in Plumas and one each in Del Norte, Mono, Nevada, and Siskiyou Counties. Methods of recovery included one suction

dredge, three small-scale hand and mechanical operations, one dragline dredge, and one drift mine. Seven of the 19 operations recovered more than 100 ounces of gold each, two each in Fresno and Sacramento Counties and one each in San Joaquin, Shasta, and Stanislaus Counties.

During 1970, development and exploration work was performed at the Oriental underground mine, Sierra County. Gold ore was treated by gravity and amalgamation methods, but the mill ran at only one-third of its 100-ton-per-day capacity. Eleven men were employed at the mine and mill. Reportedly because of increasing costs, operations ceased in October.

Dulo Mining Corp. worked a placer mine on Spring Creek in Nevada County by dragline. The gravel was screened, jigged, and tabled, and the tailing washed to a settling pond. No mercury or other chemicals were used in the separation.

A placer mine on the Middle Yuba River, Sierra and Nevada Counties, was leased by B and D Mining Co. Inc. and operated by Mickey Ryan. Equipment included a floating suction dredge, trommel, rotating screen, and riffle. Plans were to mine gravels in the river and older gravels along the river bank where values were expected to run from \$0.50 to \$10 per yard.

Phelps Dodge Corp. was investigating gold-silver mining possibilities in the Bodie mining district, Mono County. Other companies were looking at gold-copper prospects in the Mesquite mining district, Imperial County.

**Iron Ore.**—Although iron ore production increased 6 percent in quantity above that of 1969, shipments of usable iron ore, including direct shipping ore, concentrates, and agglomerates, declined 1 percent in quantity and 3 percent in value. Pacific Western Industries, Inc., produced iron ore in Kern County for use in its cement plant. Kaiser Steel Corp. mined iron ore at its Eagle Mountain mine, Riverside County, beneficiated most of it, and shipped the usable iron products to its steel plant at Fontana, to the Los Angeles harbor for export, and to cement plants.

Looking forward to the time when the open pits will reach their economic limit, Kaiser Steel Corp. planned work on an experimental underground mine at Eagle Mountain. The underground work will be done on the Black Eagle property near the northwest end of the magnetite-hematite

ore deposit. Two haulage adits 3,000 feet long will provide access to development workings at deep levels of the Black Eagle ore body and will permit removal of development ore. Underground mining will be done using sublevel caving, the method probably most effective on the ore body and on the overlying wall rock. When development is completed, caving tests will be made to determine effectiveness and to develop details of mining methodology.<sup>4</sup> Kaiser Steel Corp.'s Silver Lake mine in San Bernardino County was inactive.

**Lead.**—Lead production decreased 30 percent in quantity, but only 26 percent in value from 1969, reflecting a rise in metal price. Lead output was reported by six operators in four counties, two in Inyo and one each in San Bernardino, Alpine, and Kern. The location of the sixth producer was not reported. Most of the lead was produced in Inyo County.

Lead also was recovered from two secondary sources in Los Angeles County, slag from a scrap-lead reverberatory furnace and flue dust from a steel furnace.

**Mercury.**—California production was 18,593 flasks, less than 1 percent below the 1969 figure. The value, however, decreased 19 percent. The number of mines reporting production fell from 72 to 51. Production declined at the New Idria mine, the largest producer of mercury in the State and Nation, because of lower demand and falling prices. Some of the large mines at which production ceased were the Juniper, El Capitan, and Gambonini mines.

The most important increases in output were from the Abbott, Aetna, Altoona, Culver-Baer, Manhattan-One-Shot, New Almaden, and Old Guadalupe mines; significant decreases were reported at the Knoxville and Oat Hill mines.

Production from eight California mines was 1,000 flasks or more in 1970, three yielded 500 to 999 flasks each, and five yielded 100 to 499 flasks each. Output from mines producing 100 flasks or more accounted for all but 4 percent of total California output. The six leading producers, with a combined output comprising about two-thirds of the total State production were as follows: New Idria Mining & Chemical Co., San Benito County; Buena Vista Mines, Inc., San Luis Obispo County; Sonoma Mines, Inc., Sonoma County;

<sup>4</sup> California Division of Mines and Geology, California Geology, V. 24, No. 9, September 1971, p. 165.



Table 17.—California: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by counties

County	Mines producing		Material sold or treated <sup>1</sup> (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1968, total.....	34	11	76,400	15,682	\$615,674	597,961	\$1,282,887
1969, total.....	27	14	111,485	7,904	328,097	491,927	880,879
1970:							
Del Norte.....	--	1	--	2	73	--	--
Kern.....	1	--	95	20	728	1,205	2,134
Los Angeles.....	--	(?)	--	99	3,603	--	--
Mariposa.....	1	--	50	25	910	5	9
Nevada.....	--	1	--	42	1,528	--	--
Plumas.....	--	2	--	42	1,528	--	--
San Bernardino.....	1	--	90	36	1,310	91	161
Sierra.....	3	--	850	887	32,278	215	380
Siskiyou.....	--	1	--	1	36	--	--
Undistributed <sup>3</sup> .....	9	1	104,112	3,845	139,918	449,634	796,221
Total <sup>4</sup> .....	15	6	105,197	4,999	181,912	451,150	798,905
Copper							
Lead							
Zinc							
	Short tons	Value	Short tons	Value	Short tons	Value	Total value
1968, total.....	1,182	\$989,263	4,001	\$1,057,224	3,525	\$951,750	\$4,896,298
1969, total.....	1,129	1,073,317	2,518	750,113	3,327	971,485	4,008,891
1970:							
Del Norte.....	( <sup>5</sup> )	--	( <sup>5</sup> )	--	--	--	73
Kern.....	--	231	--	31	( <sup>5</sup> )	77	3,201
Los Angeles.....	--	--	--	--	--	--	3,603
Mariposa.....	--	--	--	--	--	--	919
Nevada.....	--	--	--	--	--	--	1,528
Plumas.....	--	--	--	--	--	--	1,528
San Bernardino.....	( <sup>5</sup> )	58	( <sup>5</sup> )	78	( <sup>5</sup> )	15	1,622
Sierra.....	--	--	--	--	--	--	32,658
Siskiyou.....	--	--	--	--	--	--	36
Undistributed <sup>3</sup> .....	2,308	2,663,085	1,771	553,272	3,514	1,076,635	5,229,131
Total <sup>4</sup> .....	2,308	2,663,374	1,772	553,381	3,514	1,076,727	5,274,299

<sup>1</sup> Does not include gravel washed or precipitates shipped.<sup>2</sup> Byproduct.<sup>3</sup> Includes the following number of lode mines: Alpine (1), Amador (1), Fresno (byproduct), Inyo (2), Merced (byproduct), Mono (1), Sacramento (1), San Joaquin (byproduct), Shasta (1), Stanislaus (byproduct), and Unknown (3); combined to avoid disclosing individual company confidential data.<sup>4</sup> Data may not add to totals shown because of independent rounding.<sup>5</sup> Less than ½ unit.

Table 18.—California: Mine production of gold, silver, copper, lead, and zinc in 1970, by types of material processed and methods of recovery, in terms of recoverable metals

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Amalgamation: Ore.....	25	5	--	--	--
Smelting of concentrates: Ore <sup>1</sup> .....	1,688	437,431	2,265	1,627	3,451
Direct smelting:					
Ore.....	867	13,477	4	145	63
Cleanup and precipitates.....	155	55	39	--	--
Total.....	1,022	13,532	43	145	63
Total lode material.....	2,735	450,968	2,308	1,772	3,514
Placer.....	2,264	182	--	--	--
Grand total.....	4,999	451,150	2,308	1,772	3,514

<sup>1</sup> Includes byproduct recovery from tungsten ore concentrates.

**Table 19.—California: Mine production of gold, silver, copper, lead, and zinc in 1970, by classes of ore or other source materials, in terms of recoverable metals**

Source	Number of mines <sup>1</sup>	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
<b>Lode ore:</b>							
Dry gold.....	5	990	948	311	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )
Dry gold-silver.....	3	3,279	1,128	42,645	1	3	2
<b>Total.....</b>	<b>8</b>	<b>4,269</b>	<b>2,076</b>	<b>42,956</b>	<b>1</b>	<b>3</b>	<b>2</b>
Copper.....	2	62	1	61	2	--	--
Lead-zinc.....	2	100,846	361	350,573	71	1,768	3,512
<b>Total.....</b>	<b>4</b>	<b>100,908</b>	<b>362</b>	<b>350,634</b>	<b>73</b>	<b>1,768</b>	<b>3,512</b>
<b>Other lode material:</b>							
Gold cleanup, copper precipitates, and tungsten <sup>3</sup> .....	3	484	297	57,378	2,234	--	--
<b>Total lode material.....</b>	<b>15</b>	<b>105,261</b>	<b>2,735</b>	<b>450,968</b>	<b>2,308</b>	<b>1,772</b>	<b>3,514</b>
<b>Placer.....</b>	<b>6</b>	<b>--</b>	<b>2,264</b>	<b>182</b>	<b>--</b>	<b>--</b>	<b>--</b>
<b>Total all sources.....</b>	<b>21</b>	<b>105,261</b>	<b>4,999</b>	<b>451,150</b>	<b>2,308</b>	<b>1,772</b>	<b>3,514</b>

<sup>1</sup> Data may not add to totals shown because some mines produce more than one class of material.

<sup>2</sup> Less than ½ unit.

<sup>3</sup> Combined to avoid disclosing individual company confidential data.

<sup>4</sup> Excludes tungsten ore tonnage.

<sup>5</sup> Data may not add to total shown because of independent rounding.

Guadalupe Mining Co., Santa Clara County; Sunbird Mines, Inc., Santa Barbara County; and International Resources, Inc., Lake County.

Production by furnacing alone was reported at 19 mines and by retorting alone at 32 mines. Some mercury was recovered from mine dumps during the year, either by flotation of cinnabar and retorting or by direct furnacing of the low-grade material. Producing properties of record were distributed by the following counties. Sonoma (10); Napa and Lake (six each); Santa Clara and San Luis Obispo (five each); Marin and San Benito (three each); Inyo, Santa Barbara, and Monterey

(two each); and Fresno, Kings, Colusa, and Trinity (one each). Locations of three other properties remained undetermined.

Development continued on properties acquired by New Idria Mining & Chemical Co. in the Almaden area of Santa Clara County, southwest of San Jose. A new 100-ton-per-day rotary furnace that would increase the company's production by 200 flasks per month became operational in 1970. The company also trucked ore from the Old Guadalupe mine near New Almaden to the new furnace. Work was completed on an exploration project at the New Idria mine conducted under an Office of Minerals Exploration loan. Exploration

**Table 20.—California: Mercury production, by method of recovery**

Year	Operating mines	Recovery method					Total 76-pound flasks	Value <sup>3</sup>
		Furnaced <sup>1</sup>		Retorted		Unclassified <sup>2</sup> (76-pound flasks)		
		Ore treated (short tons)	76-pound flasks	Ore treated (short tons)	76-pound flasks			
1966.....	72	136,693	13,714	16,292	2,344	12	16,070 \$7,100,047	
1967.....	78	184,656	13,942	67,895	2,438	5	16,385 8,018,164	
1968.....	53	176,502	19,494	40,380	1,918	5	21,417 11,470,089	
1969.....	72	215,495	16,093	37,199	2,387	W	18,480 9,333,139	
1970.....	51	212,895	14,677	24,605	3,457	459	18,593 7,581,668	

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

<sup>1</sup> Includes ore and mercury from dumps not separable.

<sup>2</sup> Includes mercury recovered from old surface ores, dumps, and placers.

<sup>3</sup> Value calculated at average New York price.

continued at the Reed mine in Yolo County in a joint program by Franciscan Mining Co. and Earth Resources Co.

At the Oat Hill mine, Napa County, ore that was mined from an open pit was crushed and the cinnabar concentrated using four gravity tables. The water was ponded and recycled after clarification. The One Shot Mining Co. mined ore from an open pit and also processed some tailings at its Manhattan mine in Napa County. The concentration mill and furnace at the Buena Vista mine, San Luis Obispo County, was redesigned during the year to reduce air pollution. Exploration was in progress by New Idria Mining & Chemical Corp. at four locations within the New Almaden mine property, Santa Clara County. Construction of a 60-ton-per-day rotary furnace was begun by Guadalupe Mining Co. at the Guadalupe mine, Santa Clara County.

**Molybdenum.**—Molybdenite and powellite were recovered by Union Carbide Corp. as byproducts in the processing of tungsten ores from the Pine Creek underground mine, Inyo County. Recovery of both oxides (powellite) and sulfides (molybdenite) was higher than in 1969. Shipments of both oxides and sulfides also were higher. Total shipments, all to domestic consumers, increased 18 percent in quantity and 15 percent in value.

**Pig Iron and Ferrous Scrap.**—All of the pig iron produced in California came from four blast furnaces at the Kaiser Steel Corp. integrated steel plant near Fontana, San Bernardino County. Production was above that of 1969, but consumption was down slightly. In Los Angeles County, United States Steel Corp. at Torrance and Bethlehem Steel Corp. at Vernon used pig iron shipped from other States to mix with iron and steel scrap to make steel in open-hearth and electric-arc furnaces. Kaiser used pig iron and scrap at its Fontana plant to make steel in open-hearth furnaces and in the State's only basic-oxygen furnace. The following six smaller plants in the State operated on ferrous scrap alone: Armco at Torrance, Southwest Steel Rolling Mills at Watts, and Soule Steel Co. at Long Beach, Los Angeles County; Judson Steel Corp. at Emeryville and Pacific States Steel Corp. at Union City, Alameda County; and Etiwanda Steel Producers, Inc., San Bernardino County. Pacific States Steel Corp. operated open-hearth furnaces;

all the other plants operated electric-arc furnaces.

**Rare-Earth Minerals.**—In 1970, Molybdenum Corp. of America (Molycorp), the only producer of rare-earth elements in California and the largest producer of rare-earth elements in the world, produced 10,037 tons of rare-earth oxides (REO) from bastnaesite at its Mountain Pass mine, San Bernardino County, a 26-percent reduction from that of 1969. Ore processed totaled 204,400 tons. The lower production rate corresponded to reduced company sales during the year. However, output of rare-earth compounds at the Mountain Pass solvent extraction plant increased 13 percent in terms of REO content.<sup>5</sup>

The Mountain Pass mill and chemical plant were operated at only 45 percent of capacity because of a decline in U.S. and world demand for rare-earth oxides.

The rare-earth concentrates and chemicals produced at Mountain Pass were marketed by Molycorp's Chemicals and Rare Earths Division. Prices quoted for bastnaesite (per pound REO; f.o.b. Mountain Pass by truck; Nipton, Calif., by rail; in 100-pound bags or 55-gallon steel drums, and truckload or carload lots) were as follows: unleached (55–60 percent REO), \$0.30; leached (68–72 percent REO), \$0.35; and calcined (85–90 percent REO), \$0.40.

Molycorp stated in its annual report that a drilling program increased proven ore reserves at Mountain Pass to 6.5 million tons averaging 8.6 percent REO. Probably reserves were estimated to be much larger. Exploratory drilling continued in the mine area.

**Silver.**—Production of silver declined 8 percent in quantity and 9 percent in value from that of 1969. The bulk of the silver was produced in Inyo County as a byproduct of treatment of lead-zinc ores and tungsten ore. Silver output was reported from 11 lode mines in seven counties, three each in Inyo and Sierra, and one each in Alpine, Amador, Kern, Mariposa, and San Bernardino. Three other lode mines of unknown location also yielded silver.

Production of 10,000 or more ounces each was reported from the following: the Darwin Group, the largest producer (lead-zinc mine); Pine Creek (tungsten mine); and Santa Rosa (lead mine) all in

<sup>5</sup> Molybdenum Corp. of America. 1970 Annual Report. Mar. 26, 1971, 12 pp.

Inyo County; and Zaca (gold-silver mine), Alpine County. A small amount of silver was recovered from gold placers.

In San Bernardino County (Calico region) exploration continued during 1970 by American Smelting and Refining Co. at the Waterloo mine. This property and the nearby Superior Oil Co. property have proven reserves of more than 125 million ounces of silver. Bunker Hill Co. and Geodata Systems, Inc., also held property in the region.

**Tungsten.**—Production of scheelite ore increased 50 percent in quantity; treatment and shipment of concentrates increased 9 percent in quantity and 13 percent in value compared with 1969. The number of producers increased from 15 in 1969 to 17, two each in Inyo, San Bernardino, and Tulare Counties; one in Madera County; and 10 at undetermined locations. The Pine Creek underground mine in Inyo County, owned by Union Carbide Corp.,

was the Nation's largest tungsten producer. Union Carbide purchased concentrates from smaller mine operators in California, Arizona, Nevada, and Utah and from the U.S. Government stockpile. A few producers in Inyo, San Bernardino, and Tulare Counties sent concentrates to Kennametal Inc., in Nevada. Two mines that had reported production in 1969 were idle—one each in Inyo and San Bernardino Counties.

**Zinc.**—Zinc production increased 6 percent in quantity but rose 11 percent in value above that of 1969. Zinc was produced by five operators in four counties: two in Inyo and one each in San Bernardino, Alpine, and Kern. Virtually all of the zinc was produced in Inyo County by the Darwin Group, the largest producer, and the Santa Rosa mine operated by Bare & Sherrod.

A small quantity of secondary zinc was recovered from steel-furnace flue dust and scrap-lead reverberatory furnace slag.

Table 21.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Asbestos:</b>			
Atlas Asbestos Co.....	P.O. Box 805 Coalinga, Calif. 93210	Open pit mine.....	Fresno.
Coalinga Asbestos Co.....	P.O. Box 1045 Coalinga, Calif. 93210	....do.....	Do.
Pacific Asbestos Corp.....	P.O. Box 127 Copperopolis, Calif. 95228	....do.....	Calaveras.
Union Carbide Corp.....	P.O. Box K King City, Calif. 93903	....do.....	San Benito.
<b>Barite:</b>			
Yuba Minerals & Milling Co..	P.O. Box 1478 Bakersfield, Calif. 93302	....do.....	Shasta.
<b>Boron minerals and compounds:</b>			
Kerr-McGee Chemical Corp..	OMB-508, Kerr-McGee Bldg. Oklahoma City, Okla. 73102	Dry lake brines.....	San Bernardino.
Stauffer Chemical Co.....	636 California St. San Francisco, Calif. 94119	....do.....	Do.
United States Borax & Chemical Corp.	P.O. Box 75128, Stanford Station Los Angeles, Calif. 90005	Open pit mine.....	Inyo and Kern.
<b>Bromine and bromine compounds:</b>			
Kerr-McGee Chemical Corp..	OMB-508, Kerr-McGee Bldg. Oklahoma City, Okla. 73102	Dry lake brines.....	San Bernardino.
<b>Calcium magnesium chloride:</b>			
Leslie Salt Co.....	P.O. Box 364 Newark, Calif. 94560	....do.....	Do.
National Chloride Co. of America.	Suite 803, Wilflower Bldg. 615 South Flower St. Los Angeles, Calif. 90017	....do.....	Do.
<b>Carbon dioxide:</b>			
Standard Oil Co.....	225 Bush St. San Francisco, Calif. 94120	Natural gasoline processing plant.	Kern.
<b>Cement:</b>			
American Cement Corp.....	2404 Wilshire Blvd. Los Angeles, Calif. 90057	Dry process portland cement plants.	Riverside and San Bernardino.
Calaveras Cement Co., Div. The Flintkote Co.	215 Market St. San Francisco, Calif. 94104	Wet and dry process portland cement plants.	Calaveras and Shasta.
California Portland Cement Co.	612 South Flower St., Mobil Bldg. Los Angeles, Calif. 90017	Dry process portland cement plants.	Kern and San Bernardino.

Table 21.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Cement—Continued			
Ideal Cement Co., Div. Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	Wet process portland cement plants.	San Benito and San Mateo.
Kaiser Cement & Gypsum Corp.	Permanente Rd. Permanente, Calif. 95104	---do-----	San Bernardino and Santa Clara.
Monolith Portland Cement Co.	Box 65677, Glassell Station Los Angeles, Calif. 90065	---do-----	Kern.
Pacific Cement & Aggregates Division, Lone Star Cement Corp.	400 Alabama St. San Francisco, Calif. 94110	Dry process portland cement plant.	Santa Cruz.
Pacific Western Industries, Inc.	3810 Wilshire Blvd. Los Angeles, Calif. 90005	---do-----	Kern.
Southwestern Portland Cement Co.	1034 Wilshire Blvd. Los Angeles, Calif. 90017	Wet and dry process portland cement plant.	San Bernardino.
Clays:			
American Cement Corp.-----	P.O. Box 832 Riverside, Calif. 92501	Open pit mine.-----	Orange, Riverside, San Bernardino.
Atkinson Brick Co.-----	13633 South Central Ave. Los Angeles, Calif. 90059	---do-----	Los Angeles.
Basalt Rock Co., Inc.-----	8th and River St. Napa, Calif. 94458	---do-----	Napa.
Calaveras Cement Div., The Flintkote Co.	San Andreas, Calif. 95249.---	---do-----	Amador, Calaveras, Shasta.
California Non-Metallics-----	P.O. Box 328 Trabuco Canyon, Calif. 92678	---do-----	Orange.
Corona Clay Co.-----	628 Lancer Lane Corona, Calif. 91720	---do-----	Riverside.
Crestlite Inc., Div. of Susquehanna-Western, Inc.	Camino De Estrella San Clemente, Calif. 92672	---do-----	Orange.
Davidson Brick Co.-----	4701 East Floral Ave. Los Angeles, Calif. 90022	---do-----	Los Angeles.
Excel Mineral Co.-----	3451 East 26th St. Los Angeles, Calif. 90023	---do-----	Kern.
Ideal Cement Co., Div. Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	---do-----	San Mateo and Santa Cruz.
Interpace Corp.-----	2901 Los Feliz Blvd. Los Angeles, Calif. 90039	---do-----	Amador, Placer, Riverside, San Bernardino, Sutter, Yuba.
Kaiser Industries Corp.-----	300 Lakeside Dr. Oakland, Calif. 94612	---do-----	Alameda.
Lightweight Processing Co.---	650 South Grand Ave. Los Angeles, Calif. 90017	---do-----	San Bernardino and Ventura.
Lincoln Clay Products.-----	P.O. Box 367 Lincoln, Calif. 95648	---do-----	Placer.
L.P. McNear Brick Co.-----	P.O. Box 1380 San Rafael, Calif. 94902	---do-----	Marin.
Mission Valley Brick Co.-----	P.O. Box 3217 San Diego, Calif. 92103	---do-----	San Diego.
Monolith Portland Cement Co.	Box 65677, Glassell Station Los Angeles, Calif. 90065	---do-----	Kern.
Pacific Cement & Aggregates.	400 Alabama St. San Francisco, Calif. 94110	---do-----	Santa Cruz.
Pacific Clay Products.-----	1255 West 4th St. Los Angeles, Calif. 90017	---do-----	Amador, Orange, Riverside.
Port Costa Products Co.-----	P.O. Box 5 Port Costa, Calif. 94569	---do-----	Contra Costa.
Coal (lignite):			
Alpco Div. of Interpace Corp.	P.O. Box 787 Ione, Calif. 95640	Strip mine.-----	Amador.
Copper:			
Union Carbide Corp., Mining & Metals, Div. West Hill Exploration Inc., T.A.C. Darwin Mines Dept.	270 Park Ave., 38th Floor New York, N.Y. 10017 Lone Pine, Calif. 93545.---	Underground mine.---	Inyo.
		---do-----	Do.
Diatomite:			
GREFCO, Inc.-----	630 Shatto Pl. Los Angeles, Calif. 90005	Open pit mine.-----	Santa Barbara.
Johns-Manville Products Corp.	Lompoc, Calif. 93436.-----	---do-----	Do.

Table 21.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Feldspar:</b>			
Wedron Silica Co.....	P.O. Box 150 Pacific Grove, Calif. 93950	Open pit mine.....	Monterey.
Owens-Illinois Glass Co.....	P.O. Box 1035-1036 Toledo, Ohio 43601	...do.....	Do.
<b>Gold:</b>			
Dickey Exploration Co.....	Alleghany, Calif. 95901.....	Underground mine.....	Sierra.
Heavy Metals Tech. Corp.....	406 Wilshire Blvd., Suite 204 Santa Monica, Calif. 90401	...do.....	San Bernardino.
Claude B. Lovestedt.....	P.O. Box 1496 Carson City, Nev. 89701	...do.....	Alpine.
West Hill Exploration, Inc., T.A.C. Darwin Mines Dept.	Long Pine, Calif. 93545.....	...do.....	Inyo.
<b>Gypsum:</b>			
H.M. Holloway, Inc.....	714 6th St. Wasco, Calif. 93280	Open pit mine.....	Kern.
Temblor Gypsum Co.....	Carrisa Plains, Star Rte. Box 80 Santa Margarita, Calif. 93453	...do.....	Do.
United States Gypsum Co....	101 South Wacker Dr. Chicago, Ill. 60606	Open pit mine and calcining plant.	Imperial.
Iron Ore: Kaiser Steel Corp.....	P.O. Box 158 Eagle Mtn., Calif. 92241	...do.....	Riverside.
<b>Lead:</b>			
Bare & Sherrod.....	P.O. Box 538 Lone Pine, Calif. 93545	Underground mine....	Inyo.
West Hill Exploration Inc., T.A.C. Darwin Mines Dept.	Lone Pine, Calif. 93545.....	...do.....	Do.
<b>Lime:</b>			
American Crystal Sugar Co... Diamond Springs Lime Co....	Box 419 Denver, Colo. 80201	Shaft kiln.....	Yolo.
The Flintkote Co.....	P.O. Box 407 Diamond Springs, Calif. 95619	Rotary kiln and continuous hydrator.	El Dorado.
Holly Sugar Corp.....	P.O. Box 57387 Flint Station Los Angeles, Calif. 90057	Shaft and rotary kilns, continuous hydrator.	Contra Costa and Tuolumne.
Kaiser Aluminum & Chemical Corp.	Box 1052 Colorado Springs, Colo. 80901	Shaft kilns and continuous hydrator.	Glenn, Imperial, Orange, San Joaquin, Monterey.
Chas. Pfizer & Co., Inc.....	Moss Landing, Calif. 95039..	Rotary kiln and continuous hydrator.	San Bernardino.
Spreckels Sugar Co.....	P.O. Drawer AD Victorville, Calif. 92392	Fluidized-bed kiln and continuous hydrator.	San Bernardino.
Stauffer Chemical Co.....	2 Pine St. San Francisco, Calif. 94111	Shaft and rotary kilns.	Monterey and Yolo.
Union Sugar Div.....	636 California St. San Francisco, Calif. 94119	Rotary kiln and continuous hydrator.	San Bernardino.
Lithium minerals:	230 California St. San Francisco, Calif. 94111	Shaft kiln.....	Santa Barbara.
Kerr-McGee Chemical Corp..	OMB-508, Kerr-McGee Bldg. Oklahoma City, Okla. 73102	Dry lake brines.....	San Bernardino.
<b>Magnesium compounds:</b>			
FMC Corp.....	P.O. Box 344 Newark, Calif. 94560	Salt works bitterns...	San Diego.
Kaiser Aluminum & Chemical Corp.	Moss Landing, Calif. 95039..	Sea water processing..	Monterey.
Merck & Co., Inc.....	Rahway, N.J. 07065.....	...do.....	San Mateo.
<b>Mercury:</b>			
Buena Vista Mines, Inc.....	P.O. Box 753 Paso Robles, Calif. 93446	Underground mine....	San Luis Obispo.
Buttes Gas & Oil Co.....	2150 Franklin St. Oakland, Calif. 94612	Open pit mine.....	Marin.
Guadalupe Mining Co.....	14900 Guadalupe Mine Rd. San Jose, Calif. 95120	Underground mine....	Santa Clara.
Hugh C. Ingle, Jr.....	P.O. Box 553 Middletown, Calif. 95461	Open pit and under- ground mines.	Napa.
International Resources, Inc..	2225 Hillside Dr. Santa Rosa, Calif. 95404	...do.....	Colusa, Lake, Sonoma.
Lansdowne Mining & Manufacturing Co.	P.O. Box 144 Lower Lake, Calif. 95457	Open pit mine.....	Napa.
Mercury Fox, Ltd.....	415 7th St. Petaluma, Calif. 94952	...do.....	Marin.
New Idria Mining & Chem. Co.	3457 South Cedar Fresno, Calif. 93745	Open pit and under- ground mines.	San Benito and Santa Clara.
New Klau Mining & Con- struction Co.	Adelaide Rd. Paso Robles, Calif. 93446	Open pit mine.....	San Luis Obispo.
One-Shot Mining Co.....	755 Mathilda Ave. Sunnyvale, Calif. 94086	...do.....	Napa.

Table 21.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Mercury—Continued			
Quad Metals Corp.....	827 Lincoln Bldg. Spokane, Wash. 99201	Underground mine....	Inyo.
Sonoma Mines, Inc.....	P.O. Box 226 Guerneville, Calif. 95446	---do-----	Sonoma.
Sulphur Creek Mining.....	201 Ridge Rd. Ukiah, Calif. 95482	---do-----	Do.
Sunbird Mines, Ltd.....	1018-A Anacapa St. Santa Barbara, Calif. 93101	Open pit mine.....	Santa Barbara.
Molybdenum:			
Union Carbide Corp., Mining & Metals Div.	270 Park Ave., 38th Floor New York, N.Y. 10017	Underground mine....	Inyo.
Natural gas:			
Amerada Div. Amerada Hess Corp.	Box 417 Rio Vista, Calif. 94571	Gasfield.....	Contra Costa, Sacramento, San Joaquin, Solano.
Occidental Petroleum Corp.---	10889 Wilshire Blvd. Los Angeles, Calif. 90024	---do-----	Colusa, Contra Costa, Sacramento, San Joaquin, Solano, Sutter, Yolo.
Shell Oil Co.....	1008 West 6th St. Los Angeles, Calif. 90017	---do-----	Contra Costa, Fresno, Kern, Kings, Madera, Santa Barbara, Solano, Tulare, Yolo.
Signal Oil and Gas Co.....	1010 Wilshire Blvd. Los Angeles, Calif. 90017	---do-----	Contra Costa, Sacramento, San Joaquin, Solano, Yolo.
Standard Oil Co. of California.	225 Bush St. San Francisco, Calif. 94120	---do-----	Butte, Contra Costa, Glenn, Kern, Kings, Los Angeles, Sacramento, San Joaquin, Santa Barbara, Solano, Sutter, Tulare, Ventura, Yolo.
Texaco, Inc.....	3350 Wilshire Blvd. Los Angeles, Calif. 90005	---do-----	Fresno, Glenn, Humboldt, Kern, Madera, Sacramento, San Joaquin, Santa Barbara, Solano, Sutter, Tehama.
Union Oil Co. of California.---	461 South Boylston Los Angeles, Calif. 90017	---do-----	Contra Costa, Kern, Sacramento, San Joaquin, Solano.
Natural gas liquids:			
Atlantic Richfield Co.....	445 South Figueroa St. Los Angeles, Calif. 90054	Natural gasoline plants.	Kern, Santa Barbara, Ventura.
Getty Oil Co.....	P.O. Box 54050 Los Angeles, Calif. 90005	---do-----	Kern and Ventura.
Mobil Oil Co.....	612 South Flower St. Los Angeles, Calif. 90054	---do-----	Los Angeles.
Shell Oil Co.....	1008 West 6th St. Los Angeles, Calif. 90054	---do-----	Kern, Los Angeles, Santa Barbara, Ventura.

Table 21.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Natural gas liquids—Continued Standard Oil Co. of California.	225 Bush St. San Francisco, Calif. 94120	Natural gasoline plants.	Fresno, Kern, Kings, Los Angeles, Orange, Santa Barbara, Ventura.
Texaco, Inc.....	3350 Wilshire Blvd. Los Angeles, Calif. 90005	---do---	Los Angeles, Santa Barbara, Ventura.
Union Oil Co. of California....	P. O. Box 7600 Los Angeles, Calif. 90054	---do---	Fresno, Kern, Los Angeles, Orange, Santa Barbara, Ventura.
Peat:			
Peter J. Gambetta.....	Route 1, Box 78 Brentwood, Calif. 94513	Reed-sedge bog.....	Contra Costa.
R. W. McClellan, Jr.....	151 Commercial Way Costa Mesa, Calif. 92627	Humus bog.....	Orange.
Vita-Peat Co., Inc.....	P. O. Box 428 Bethel Island, Calif. 94511	Reed-sedge bog.....	Contra Costa.
Perlite:			
American Perlite Co.....	11831 Vose St. North Hollywood, Calif. 91605	Open pit mine.....	Inyo.
Petroleum:			
Atlantic Richfield Co.....	5900 Cherry Ave. Long Beach, Calif. 90805	Oilfields.....	Kern, Los Angeles, Orange, San Luis Obispo, Santa Barbara, Ventura.
Belridge Oil Co.....	1300 West 4th St. Los Angeles, Calif. 90017	---do---	Kern and Santa Barbara.
Chanslor-Western Oil & Development Co.	4549 Produce Plaza Los Angeles, Calif. 90058	---do---	Kern, Los Angeles, Orange, Ventura.
Getty Oil Co.....	3810 Wilshire Blvd. Los Angeles, Calif. 90005	---do---	Fresno, Kern, Los Angeles, Monterey, Orange, Riverside, San Bernardino, Santa Barbara, Ventura.
Gulf Oil Corp.....	5400 Rosedale Hwy. Bakersfield, Calif. 93302	---do---	Fresno, Kern, Los Angeles, Orange, Santa Barbara, Ventura.
Humble Oil & Refining Co....	1800 Avenue of the Stars Los Angeles, Calif. 90067	---do---	Do.
Long Beach (City of) Dept. of Oil Properties.	925 Harbor Plaza Long Beach, Calif. 90801	---do---	Los Angeles.
Mobil Oil Corp.....	612 South Flower St. Los Angeles, Calif. 90017	---do---	Fresno, Kern, Kings, Los Angeles, Monterey, Orange, San Benito, San Luis Obispo, Santa Barbara, Ventura.
Occidental Petroleum Corp....	10889 Wilshire Blvd. Los Angeles, Calif. 90024	---do---	Contra Costa, Kern, Los Angeles, Orange.
Phillips Petroleum Co.....	1306 Santa Barbara St. Santa Barbara, Calif. 93104	---do---	Santa Barbara.



Table 21.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Petroleum—Continued</b>			
Shell Oil Co.....	1008 West 6th St. Los Angeles, Calif. 90017	Oilfields.....	Contra Costa, Fresno, Kern, Los Angeles, Orange, San Benito, San Santa Barbara, Ventura.
Signal Oil and Gas Co.....	1010 Wilshire Blvd. Los Angeles, Calif. 90017	---do.....	Fresno, Kern, Los Angeles, Orange, San Luis Obispo, Santa Barbara, Ventura.
Standard Oil Co. of California.	225 Bush St. San Francisco, Calif. 94120	---do.....	Contra Costa, Fresno, Kern, Kings, Los Angeles, Orange, San Luis Obispo, Santa Barbara, Ventura.
Texaco, Inc.....	3350 Wilshire Blvd. Los Angeles, Calif. 90005	---do.....	Fresno, Kern, Los Angeles, Monterey, Orange, Santa Barbara, Ventura.
Union Oil Co. of California...	461 South Boylston Los Angeles, Calif. 90017	---do.....	Fresno, Kern, Los Angeles, Orange, San Luis Obispo, Santa Barbara, Ventura.
Union Pacific Railroad Co....	5480 Ferguson Dr. Los Angeles, Calif. 90022	---do.....	Los Angeles and Ventura
<b>Phosphate:</b>			
Cuyama Phosphate Corp.....	Box 164 Bakersfield, Calif. 93301	Open pit mine.....	Santa Barbara.
<b>Potassium salts:</b>			
Kerr-McGee Chemical Corp..	OMB-508, Kerr-McGee Bldg. Oklahoma City, Okla. 73102	Dry lake brines.....	San Bernardino.
<b>Pumice:</b>			
Aiken Builders Products.....	P.O. Box 878 Las Vegas, Nev. 89101	Open pit mine.....	Do.
Cinder Products Co.....	3450 Lakeshore Ave. Oakland, Calif. 94610	---do.....	Lake.
Alvin Lindgren.....	Redding Highway Alturas, Calif. 96101	---do.....	Siskiyou.
Red Lava Products of California.	Star Rte. Clearlake, Calif. 95423	---do.....	Lake.
Shastalite Cinder Co.....	P.O. Box 341 Weed, Calif. 96094	---do.....	Siskiyou.
<b>Rare-earth metals:</b>			
Molybdenum Corp. of America.	Mountain Pass via Nipton, Calif. 92366	---do.....	San Bernardino.
<b>Salt:</b>			
Leslie Salt Co.....	505 Beach St. San Francisco, Calif. 94111	Solar evaporation and open pit mine.	Alameda, Napa, San Bernardino, San Mateo.
Metropolitan Water Dist. of Southern California.	P.O. Box 54153 Los Angeles, Calif. 90054	Solar evaporation.....	San Bernardino.
Pacific Salt & Chemical Co....	4262 Wilshire Blvd. Los Angeles, Calif. 90021	---do.....	Do.
Standard Salt Co.....	Suite 803 Wilflower Bldg. 615 South Flower St. Los Angeles, Calif. 90017	---do.....	Do.
Western Salt Co.....	P.O. Box 149 San Diego, Calif. 92112	---do.....	Kern, Orange, San Diego.
<b>Sand and gravel:</b>			
Azusa Western, Inc.....	P.O. Box 575 Azusa, Calif. 91702	Open pit mine.....	Los Angeles.
Baldwin Contracting Co., Inc.	P.O. Box 311 Marysville, Calif. 95901	---do.....	Butte and Yuba.
Basalt Rock Co., Inc.....	P.O. Box 2540 Napa, Calif. 94558	---do.....	Sonoma.

Table 21.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Blue Diamond Concrete Materials Div., The Flintkote Co.	P.O. Box 2678 Los Angeles, Calif. 90054	Open pit mine	Los Angeles and Orange.
California Materials Co.	P.O. Box 845 Sun Valley, Calif. 91352	do	Los Angeles.
Chandler's Palos Verdes Sand & Gravel Co.	P.O. Box 295 Lomita, Calif. 90717	do	Do.
Consolidated Rock Products Co.	Box 2950 Terminal Annex Los Angeles, Calif. 90054	do	Los Angeles, Orange, San Bernardino, Ventura, San Diego.
H. G. Fenton Material Co.	702 Washington St. San Diego, Calif. 92112	do	San Diego.
Granite Construction Co.	7218 Perkins Branch Sacramento, Calif. 95940	do	Sacramento and Yolo.
Hartman Concrete Materials Co.	P.O. Box 1632 Bakersfield, Calif. 93302	do	Kern.
Kaiser Industries Corp.	300 Lakeside Dr. Oakland, Calif. 94612	do	Alameda, Contra Costa, Glenn, Santa Clara, Santa Cruz, Sonoma.
Kern Rock Co.	P.O. Box 3329 Bakersfield, Calif. 93305	do	Kern.
Livingston-Graham, Inc.	5500 North Peck Rd. El Monte, Calif. 91731	do	Los Angeles, Orange, San Bernardino, Ventura.
Manning Bros. Rock & Sand Co.	P.O. Box 204 Irwindale, Calif. 91706	do	Los Angeles.
Massey Sand & Rock Co.	P.O. Drawer P Indio, Calif. 92201	do	Riverside.
Nelson & Sloan	P.O. Box 488 Chula Vista, Calif. 92012	do	San Diego.
Niles Sand & Gravel Co., Inc.	P.O. Box 2248 Fremont, Calif. 94536	do	Alameda.
Owens-Illinois Glass Co.	P.O. Box 1035 Toledo, Ohio 43601	do	Amador, Monterey, Riverside.
Owl Rock Products Co.	P.O. Box 47 Irwindale, Calif. 91707	do	Fresno, Orange, Riverside.
Owl Service Rock Co.	P.O. Box 309 Riverside, Calif. 92501	do	San Bernardino.
Pacific Cement & Aggregates, Div. of Lone Star Cement Corp.	400 Alabama St. San Francisco, Calif. 94110	do	Alameda, Fresno, Monterey, Sacramento, San Joaquin, San Mateo, Santa Cruz, Tulare, Yolo.
Pacific Rock & Gravel Co.	P.O. Box 844 La Habra, Calif. 90631	do	San Bernardino.
A. J. Raisch Paving Co.	99 Pullman Way San Jose, Calif. 95111	do	Santa Clara.
Rhodes & Jamieson Ltd.	P.O. Box 118 Oakland, Calif. 94604	do	Alameda.
San Diego Consolidated Co.	P.O. Box 3093 San Diego, Calif. 92103	do	San Diego.
Southern Pacific Milling Co.	3555 Vineyard Ave. Oxnard, Calif. 93030	do	Santa Barbara and Ventura.
Standard Materials Co.	P.O. Box 3171 Modesto, Calif. 95350	do	Merced and Stanislaus.
Sully-Miller Contracting Co.	P.O. Box 432 Orange, Calif. 92669	do	Orange.
Teichert Aggregates	P.O. Box 15002 Sacramento, Calif. 95813	do	Butte, Nevada, Sacramento, San Joaquin, Yolo, Yuba.
Triangle Rock Products, Inc.	P.O. Box 2083 San Bernardino, Calif. 92406	do	Los Angeles, Riverside, San Bernardino.
Silver:			
Bare and Sherrod	P.O. Box 538 Lone Pine, Calif. 93545	Underground mine	Inyo.
Claude B. Lovestedt	P.O. Box 1496 Carson City, Nev. 89701	do	Alpine.

Table 21.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Silver—Continued			
Union Carbide Corp., Mining & Metals Div.	270 Park Ave., 38th Floor New York, N. Y. 10017	Underground mine...	Inyo.
West Hill Exploration, Inc., T.A.C. Darwin Mines Dept.	Lone Pine, Calif. 93545	---do-----	Do.
Sodium compounds:			
Kerr-McGee Chemical Corp.	OMB-508, Kerr-McGee Bldg. Oklahoma City, Okla. 73102	Dry lake brines.....	San Bernardino.
Stauffer Chemical Co.	Box 3050, Rincon Ave. San Francisco, Calif. 94108	---do-----	Do.
United States Borax & Chemical Corp.	P.O. Box 75128, Sanford Station Los Angeles, Calif. 90005	Open pit mine.....	Kern.
Stone:			
American Cement Corp.	P.O. Box 832 Riverside, Calif. 92501	Open quarry and underground mine.	Los Angeles, Riverside, San Bernardino.
Guy F. Atkinson, Co.	P.O. Box 593 San Francisco, Calif. 94080	Open quarry.....	Ventura.
Basalt Rock Co., Inc.	P.O. Box 2540 Napa, Calif. 94558	---do-----	Marin, Napa, Sonoma.
Calaveras Cement Div., The Flintkote Co.	San Andreas, Calif. 95249	---do-----	Calaveras and Shasta.
California Portland Cement Co	612 South Flower St. Los Angeles, Calif. 90017	---do-----	Kern and San Bernardino.
Connolly-Pacific Co.	1925 Water St. Long Beach, Calif. 90802	---do-----	Los Angeles.
Diamond Springs Lime Co.	P.O. Box 407 Diamond Springs, Calif. 95619	Open quarry and underground mine.	El Dorado.
Dumbarton Quarry Associates.	P.O. Box 487 Fremont, Calif. 94537	Open quarry.....	Alameda.
East Bay Excavating Co.	28814 Mission Blvd. Hayward, Calif. 94544	---do-----	Do.
El Dorado Limestone Co.	P.O. Box 8 Shingle Springs, Calif. 95682	Underground mine...	El Dorado.
Felton Quarry	326 Fall Creek Dr. Felton, Calif. 95018	Open quarry.....	Santa Cruz.
Gallagher & Burke	344 High St. Oakland, Calif. 94601	---do-----	Alameda.
Granite Rock Co.	P.O. Box 151 Watsonville, Calif. 95076	---do-----	San Benito.
Hein Bros. Basalt Rock Co.	P.O. Box 162 Petaluma, Calif. 94952	---do-----	Sonoma.
Hillsdale Rock Co., Inc.	500 Hillsdale Ave. San Jose, Calif. 95123	---do-----	Santa Clara.
Ideal Cement Co., Div., Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	Open quarry and dredge.	San Benito and San Mateo.
Kaiser Aluminum & Chemical Corp.	Moss Landing, Calif. 95039	Open quarry.....	Monterey.
Kaiser Cement & Gypsum Corp.	Permanente Rd. Permanente, Calif. 95014	---do-----	San Bernardino and Santa Clara.
Kaiser Industries Corp.	300 Lakeside Dr. Oakland, Calif. 94612	---do-----	Contra Costa.
Minerals, Pigments & Metals Div., Chas. Pfizer & Co., Inc.	P.O. Drawer AD Victorville, Calif. 92394	---do-----	San Bernardino.
Monolith Portland Cement Co.	Box 65677, Glassell Station Los Angeles, Calif. 90065	---do-----	Kern.
Neary Rock Quarry, Inc.	11920 Stonebrook Ave. Los Altos, Calif. 94022	---do-----	Santa Clara.
Pacific Cement & Aggregates.	400 Alabama St. San Francisco, Calif. 94110	---do-----	Contra Costa, San Mateo, Santa Cruz.
Pacific Western Industries, Inc.	3810 Wilshire Blvd. Los Angeles, Calif. 90005	---do-----	Kern.
Page Mill Quarry Corp.	P.O. Box 11487 Palo Alto, Calif. 94306	---do-----	Santa Clara.
Quarry Products, Inc.	P.O. Box 1147 Richmond, Calif. 94802	---do-----	Contra Costa.
South Coast Asphalt Co., Inc.	P.O. Box 218 Carlsbad, Calif. 92008	---do-----	San Diego.
Southwestern Portland Cement Co.	1034 Wilshire Blvd. Los Angeles, Calif. 90017	---do-----	San Bernardino.
Stauffer Chemical Co.	636 California St. San Francisco, Calif. 94119	---do-----	Inyo.
Stringfellow Constructors, Inc.	P.O. Box 6 Riverside, Calif. 92502	---do-----	Riverside and Solano.

Table 21.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Syar & Harms Industries, Inc.	P.O. Box 1272 Vallejo, Calif. 94590	Open quarry-----	Solano.
Vinnell Mining & Materials Corp.	1145 Westminster Ave. Alhambra, Calif. 91802	----do-----	San Bernardino.
Talc, pyrophyllite, soapstone: L. Grantham Corp.-----	1915 South Coast Hwy. Laguna Beach, Calif. 92651	Underground mine....	Inyo.
Minerals, Pigments & Metals Div., Chas. Pfizer & Co., Inc.	P.O. Drawer AD Victorville, Calif. 92394	Open pit and underground mines.	Inyo and San Bernardino.
Pomona Tile Manufacturing Co.	216 South Reservoir St. Pomona, Calif. 91766	Underground mine....	San Bernardino.
Bill Tonkin-----	Box 113 Lone Pine, Calif. 93545	Open pit mine-----	Inyo.
The United Sierra Div., Cyprus Mines Corp.	P.O. Box 1201 Trenton, N.J. 08606	Open pit and underground mines.	Inyo and San Bernardino.
Western Talc Co.-----	Box 368 Yermo, Calif. 92398	Open pit and underground mine.	San Bernardino.
Tungsten:			
Mines Exploration, Inc.-----	P.O. Box 27 Red Mountain, Calif. 92374	Underground mine....	Do.
Union Carbide Corp., Mining & Metals Div.	270 Park Ave., 38th Floor New York, N.Y. 10017	----do-----	Inyo.
Zinc:			
Bare & Sherrod-----	P.O. Box 538 Lone Pine, Calif. 93545	----do-----	Do.
West Hill Exploration, Inc., T.A.C. Darwin Mines Dept.	Lone Pine, Calif. 93545-----	----do-----	Do.



# The Mineral Industry of Colorado

By Andrew Kuklis<sup>1</sup>

Mineral production in Colorado in 1970 was valued at \$389.8 million, a record for the State; the previous high was \$368.5 million in 1969. The total value increased primarily because of substantial increases in molybdenum, coal, copper, and zinc production. Colorado continued to be the leading State in the Nation for the production of molybdenum, tin, and vanadium.

Of the 33 mineral commodities produced in the State, 18 registered increases, 14 declined, and one was unchanged in value compared with that of 1969. Of the commodities produced, 20 had values exceeding \$1 million.

**Employment and Injuries.**—Final 1969 statistics and preliminary data for 1970 on employment and injuries in the mineral industry, excluding the petroleum industry, are given in table 4.

**Legislation and Government Programs.**—Colorado was the second State to enter a cooperative Federal-State agreement in the mine inspection program under the 1970 Federal Mine Health and Safety Act. Under the agreement, the Colorado Bureau of Mines will enforce safety regulations established by the Secretary of the Interior. To qualify for this joint program, Colorado met several conditions specified in the act. These conditions included submission of a proposed agreement by the State agency that would have responsibility for administering the law, assurance that the State agency has adequate legal authority, funds, and qualified personnel to enforce health and safety standards; and submission of mine inspection reports to the Secretary of the Interior. The U.S. Bureau of Mines will make at least one inspection per year at every mine in the State.

The Colorado School of Mines received a \$117,000 grant from the Colorado State Department of Natural Resources to con-

duct a state land-use and resource inventory. The project, the first of its kind in Colorado and second in the Nation, will be conducted through the Colorado School of Mines Basic Engineering Department.

The Atomic Energy Commission (AEC) extended for 5 years the present guaranteed purchase price of uranium enriched in the isotope U<sup>233</sup>. Without this extension, the guaranteed price for uranium U<sup>233</sup> would have expired on December 31, 1970. The present action extends the price through December 31, 1975. The isotope U<sup>233</sup> is produced during operation of a nuclear reactor from the nonfissionable element thorium present in the reactor.

The Office of Mineral Exploration awarded a contract to Colorado Geneva Industries Inc. for gold, copper, and silver exploration. A total of \$34,360 was provided by the federal agency. Company officials stated that exploration drilling will be conducted from the Copper King tunnel, 6 miles east of Marble, Colo.

The chemical industry of Colorado made a significant contribution to the economy of the State; since 1960 it has grown more than 50 percent. The chemical plants enhanced raw material values of their products to more than \$66.6 million in 1970, an increase from an estimated \$62.6 million in 1969. In the chemical industry, there are now 1,752 employees, and the payroll exceeds \$15.2 million up from \$14.6 million in 1969. Colorado ranks 33 among the 50 States in size of its chemical industry.

Heavy construction projects such as roads and dams, financed by Federal, State, county, and municipal funds, consumed much of the production of cement, stone, and sand and gravel. Contracts totaling \$73.0 million were submitted for the year, an increase of

<sup>1</sup> Mining engineer, Division of Ferrous Metals.

Table 1.—Mineral production in Colorado 1

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate..... short tons.....	46	W	W	W
Carbon dioxide (natural)..... thousand cubic feet.....	175,787	\$30	W	W
Clays..... thousand short tons.....	732	1,619	<sup>2</sup> 637	<sup>2</sup> \$1,503
Coal (bituminous)..... do.....	5,530	29,121	6,025	35,243
Copper (recoverable content of ores, etc.)..... short tons.....	3,598	3,421	3,749	4,326
Feldspar..... long tons.....	358	3	426	3
Gem stones.....	NA	122	NA	120
Gold (recoverable content of ores, etc.)..... troy ounces.....	25,777	1,070	37,114	1,351
Gypsum..... thousand short tons.....	94	339	W	W
Lead (recoverable content of ores, etc.)..... short tons.....	21,767	6,484	21,855	6,827
Lime..... thousand short tons.....	127	2,449	119	1,613
Molybdenum (content of concentrate)..... thousand pounds.....	62,411	105,346	W	W
Natural gas (marketed)..... million cubic feet.....	118,754	17,219	105,804	15,553
Natural gas liquids:				
LP gases..... thousand 42-gallon barrels.....	1,782	2,762	1,542	2,529
Natural gasoline and cycle products..... do.....	1,076	2,798	745	1,937
Peat..... thousand short tons.....	26	160	34	210
Petroleum (crude)..... thousand 42-gallon barrels.....	28,294	88,277	24,723	78,619
Pumice..... thousand short tons.....	42	232	50	268
Pyrites..... thousand long tons.....	24	120	W	W
Sand and gravel..... thousand short tons.....	19,877	27,266	22,261	24,190
Silver (recoverable content of ores, etc.)..... thousand troy ounces.....	2,599	4,653	2,933	5,194
Stone..... thousand short tons.....	2,245	5,079	3,552	8,076
Tin (content of concentrate)..... long tons.....	44	119	W	W
Tungsten concentrate (60-percent WO <sub>3</sub> basis)..... short tons.....	1,941	4,440	W	W
Uranium (recoverable content U <sub>3</sub> O <sub>8</sub> )..... thousand pounds.....	2,736	<sup>3</sup> 16,935	2,727	15,832
Zinc (recoverable content of ores, etc.)..... short tons.....	53,715	15,685	56,694	17,370
Value of items that cannot be disclosed: Cement, fluorspar, iron ore, scrap mica (1970), perlite, rare-earth metal concentrate (1969), salt, vanadium, and values indicated by symbol W.....	XX	32,745	XX	169,025
Total.....	XX	368,494	XX	389,789
Total 1967 constant dollars.....	XX	347,969	XX	<sup>p</sup> 352,759

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

<sup>1</sup> Production as measured by mine shipments, sales, or marketable production.

<sup>2</sup> Excludes bentonite, included with "Value of items that cannot be disclosed."

<sup>3</sup> Value estimated on \$5.86 per pound for sales to the Atomic Energy Commission and an assumed price of \$6.10 per pound for commercial sales; includes value of U<sub>3</sub>O<sub>8</sub> obtained from New Mexico ores processed at an out-of-State mill.

Table 2.—Value of mineral production in Colorado, by counties (Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Adams.....	\$5,309	\$7,319	Petroleum, sand and gravel, natural gas, lime, gold, stone.
Alamosa.....	190	W	Sand and gravel, peat.
Arapahoe.....	1,806	3,798	Sand and gravel, petroleum.
Archuleta.....	606	W	Petroleum, natural gas, sand and gravel.
Baca.....	1,260	1,401	Natural gas, sand and gravel, petroleum, stone.
Bent.....	60	W	Sand and gravel, natural gas, petroleum.
Boulder.....	3,635	8,592	Cement, sand and gravel, fluorspar, stone, lime, clays, peat, petroleum, gold.
Chaffee.....	1,111	W	Stone, sand and gravel, peat.
Cheyenne.....	1,389	1,954	Petroleum, stone, sand and gravel.
Clear Creek.....	12,657	W	Molybdenum, sand and gravel, copper, silver, lead, gold, zinc, mica.
Conejos.....	99	65	Silver, gold, sand and gravel, copper, zinc.
Costilla.....	W	W	Pumice, sand and gravel.
Crowley.....	80	W	Sand and gravel, stone.
Custer.....	228	93	Perlite, sand and gravel, stone, clays.
Delta.....	3,170	5,023	Coal, sand and gravel, lime, stone.
Denver.....	W	W	Sand and gravel.
Dolores.....	W	1,338	Zinc, lead, silver, copper, stone, gold, sand and gravel.
Douglas.....	687	755	Sand and gravel, clays, stone.
Eagle.....	9,686	11,257	Zinc, lead, sand and gravel, silver, copper, gold, stone, pumice.
Elbert.....	365	102	Petroleum, clays, sand and gravel.
El Paso.....	2,071	2,159	Sand and gravel, stone, clays.
Fremont.....	11,379	12,137	Cement, stone, coal, gypsum, clays, petroleum, sand and gravel, uranium, feldspar, beryllium.

Table 2.—Value of mineral production in Colorado, by counties—Continued  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Garfield.....	\$3,395	\$3,400	Vanadium, uranium, sand and gravel, stone, natural gas, coal.
Gilpin.....	58	W	Sand and gravel, stone, peat, gold.
Grand.....	58	W	Sand and gravel, stone.
Gunnison.....	4,885	6,471	Coal, sand and gravel, zinc, lead, stone, silver, copper.
Hinsdale.....	W	50	Sand and gravel, silver, zinc, lead.
Huerfano.....	289	199	Coal, sand and gravel, clays, stone.
Jackson.....	1,976	W	Fluorspar, petroleum, sand and gravel, natural gas.
Jefferson.....	W	W	Uranium, sand and gravel, clays, stone, gold.
Kiowa.....	3,760	3,713	Petroleum, natural gas, sand and gravel.
Kit Carson.....	870	W	Sand and gravel, stone.
Lake.....	97,772	109,820	Molybdenum, tungsten, sand and gravel, tin, pyrites, stone, peat, gold, silver, copper, lead.
La Plata.....	7,613	7,515	Natural gas, natural gas liquids, sand and gravel, coal, petroleum, stone.
Larimer.....	8,128	8,397	Cement, stone, petroleum, sand and gravel, lime, gypsum, natural gas liquids, natural gas, mica.
Las Animas.....	6,729	6,186	Coal, sand and gravel, clays, stone.
Lincoln.....	255	W	Sand and gravel.
Logan.....	8,500	W	Petroleum, natural gas liquids, natural gas, sand and gravel, lime.
Mesa.....	8,243	W	Vanadium, uranium, sand and gravel, natural gas, natural gas liquids, coal, stone.
Mineral.....	W	W	Silver, lead, zinc, copper, gold, sand and gravel.
Moffat.....	10,525	9,822	Petroleum, natural gas, coal, sand and gravel, stone.
Montezuma.....	1,640	1,081	Petroleum, natural gas, sand and gravel, carbon dioxide, stone.
Montrose.....	13,594	13,471	Vanadium, uranium, coal, sand and gravel, stone, salt.
Morgan.....	5,929	W	Petroleum, natural gas liquids, natural gas, sand and gravel, lime.
Otero.....	W	379	Lime, sand and gravel, stone.
Ourray.....	1,925	W	Zinc, copper, lead, silver, gold, sand and gravel.
Park.....	164	163	Sand and gravel, peat, stone, zinc, beryllium, gold, silver.
Phillips.....	96	W	Sand and gravel.
Pitkin.....	6,433	W	Coal, iron ore, sand and gravel, natural gas.
Prowers.....	248	W	Sand and gravel, petroleum.
Pueblo.....	2,441	2,314	Sand and gravel, lime, clays, stone.
Rio Blanco.....	50,686	41,254	Petroleum, natural gas, natural gas liquids, sand and gravel, coal, stone.
Rio Grande.....	305	W	Sand and gravel.
Routt.....	6,639	7,823	Coal, petroleum, sand and gravel, pumice.
Saguache.....	322	57	Sand and gravel, stone, pumice, clays.
San Juan.....	4,979	W	Zinc, lead, copper, gold, silver, sand and gravel.
San Miguel.....	18,225	18,518	Vanadium, uranium, zinc, copper, lead, silver, gold, natural gas, sand and gravel, stone, iron ore.
Sedgwick.....	549	725	Sand and gravel, lime, natural gas, stone.
Summit.....	325	855	Sand and gravel.
Teller.....	158	347	Sand and gravel, peat, stone.
Washington.....	13,976	W	Petroleum, sand and gravel, natural gas, natural gas liquids.
Weld.....	7,250	8,295	Stone, petroleum, coal, sand and gravel, natural gas, lime.
Yuma.....	76	W	Sand and gravel.
Undistributed <sup>1</sup> .....	13,686	82,935	
Total <sup>2</sup> .....	368,494	389,789	

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

<sup>1</sup>Includes gem stones, gold, silver, lead, zinc, and stone that cannot be assigned to specific counties and values indicated by symbol W.

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

13 percent over the amount awarded in 1969. Expenditures for the National System of Interstate and Defense Highways increased by nearly \$2 million.<sup>2</sup> The additional funds should result in higher pro-

duction levels for construction materials in 1971.

<sup>2</sup>Engineering News Record. State Highway Departments' Construction Contracting Plans for 1970 and Budgets for Maintenance. V. 184, No. 16, Apr. 30, 1970, pp. 12-13.



Table 3.—Indicators of Colorado business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total labor force..... thousands ..	882.2	917.7	+4.0
Employment..... do ..	856.0	887.3	+3.7
Unemployment..... do ..	26.2	30.4	+16.0
Wholesale and retail trade..... do ..	168.8	173.7	+2.9
Finance, insurance, and real estate..... do ..	37.8	40.1	+6.1
Mining..... do ..	13.5	14.0	+3.7
Construction..... do ..	38.1	40.1	+5.2
Government..... do ..	165.3	173.1	+4.7
Services..... do ..	124.3	130.3	+4.8
Transportation and public utilities..... do ..	50.8	52.1	+2.6
<b>Personal income:</b>			
Total..... millions ..	\$7,569	\$8,331	+10.1
Per capita..... do ..	\$3,495	\$3,751	+7.3
<b>Construction activity:</b>			
New housing units authorized..... do ..	23,781	30,837	+29.7
Value of nonresidential construction..... millions ..	\$139.2	\$187.7	+34.8
Highway construction contracts awarded..... do ..	\$64.8	\$71.5	+10.3
Cement shipments to and within the State..... do ..			
Farm marketing receipts..... thousand 376-pound barrels ..	5,009	5,535	+10.5
Mineral production..... millions ..	\$1,015.8	\$1,071.1	+5.4
..... do ..	\$368.5	\$389.8	+5.8

Sources: Area Trends in Employment and Unemployment; Employment and Earnings; Survey of Current Business; Farm Income Situation; Construction Review; Roads and Streets; and U.S. Bureau of Mines.

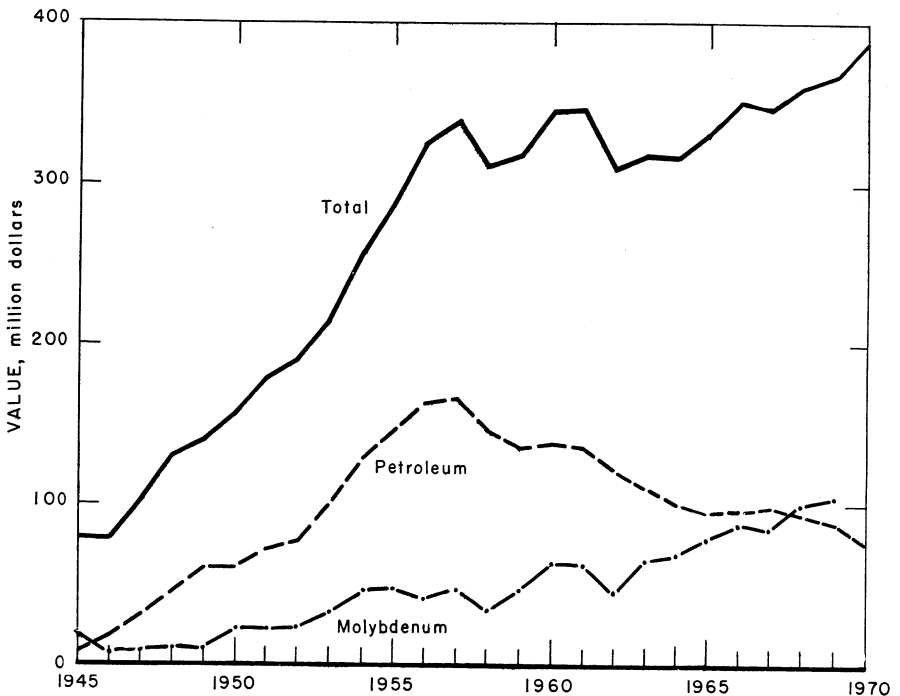


Figure 1.—Value of molybdenum, petroleum, and total value of mineral production in Colorado.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1969:								
Coal.....	1,325	225	298	2,339	4	68	30.78	11,332
Peat.....	25	109	13	17	--	1	58.28	466
Metal.....	4,416	256	1,131	9,010	13	392	44.95	10,405
Nonmetal.....	459	207	95	762	--	20	26.23	1,507
Sand and gravel.....	1,494	207	310	2,530	1	49	19.76	2,835
Stone.....	525	226	119	973	--	9	9.25	282
Total <sup>1</sup> .....	8,244	237	1,955	15,633	18	539	35.63	8,243
1970: <sup>p</sup>								
Coal.....	1,470	229	337	2,624	--	97	36.97	1,368
Peat.....	22	125	3	18	--	--	--	--
Metal.....	4,515	266	1,201	9,618	6	449	47.31	6,020
Nonmetal.....	515	221	114	908	2	56	63.85	17,525
Sand and gravel.....	1,410	203	286	2,369	1	39	16.88	3,039
Stone.....	590	253	149	1,232	--	16	12.99	188
Total <sup>1</sup> .....	8,525	245	2,089	16,769	9	657	39.72	5,059

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### METALS

**Beryllium.**—Colorado was one of four States in the Nation that produced beryllium concentrate. Output for 1970 was lower than that of the previous year. U.S. Beryllium Corp. operated its mill and the Boomer mine near Lake George. Beryl Ores Co. continued to purchase beryl from out-of-State mine operators and process it into beryllium compounds at its plant near Arvada.

**Cadmium, Indium, and Thallium.**—Cadmium, indium, thallium metal, and thalious sulfate were recovered from flue dust, dross, and byproduct materials at the Globe smelter of the American Smelting and Refining Co. (Asarco), in Denver. The materials were from out-of-State smelters. The output was not included in the State mineral production because the origin of the processed materials could not be determined.

**Copper.**—Copper production increased 4 percent in quantity and 26 percent in value. The greater percent increase in value reflected an increase in the average price, which rose from 47.5 cents per pound to 57.7 cents per pound. The Idarado mine of the Idarado Mining Co., Ouray and San Miguel counties, yielded 67 percent of the State output, compared with 74 percent in 1969. The drop was the result of less ore

milled and the lower copper content of the ore. During the year, 27 operations in 11 counties yielded copper, compared with 34 operations in 15 counties during 1969.

Construction and development work continued at the Summitville mine, Rio Grande County, jointly owned by Union Pacific Railroad Co., Cleveland-Cliffs Iron Co., and W. S. Moore Co. The 300-ton-per-day mill, reportedly costing \$500,000, was to be completed in early 1971, according to company officials. High-grade copper ore containing silver and gold values is mined and milled at the Summitville property. The ore currently mined is stockpiled, and is estimated to average about 3.5 percent copper.

Base Metals Mining and Milling Inc., a newly formed Colorado corporation, initiated construction of an ore processing plant near Colona, Colo. The mill, which has a 100-ton-per-day capacity, will process ore from the Poughkeepsie and Imogene mines near Ouray. The company acquired a 13-year lease on the property and is investing \$2 million to \$3 million on a mine and mill. Ore will be mined principally for copper, bismuth, and silver, but lead, zinc, and gold also will be recovered as byproducts of milling operations. The ore will be hauled to the mill by truck, and the concentrate will be shipped by rail to smelters in Utah and Texas. The operating

schedule will include three two-man shifts at the mill and two shifts at the mine.

**Gold.**—Gold production increased significantly over that of 1969. Reported output totaled 37,114 troy ounces, or 11,337 ounces more than in 1969. Although the average price per ounce of gold declined from \$41.51 to \$36.39 in 1970, value of production rose 26 percent over 1969 figures.

Output was reported from 28 lode and 2 placer mines in 14 counties, compared

with 32 and 10, respectively, in 19 counties in 1969. Of the placer operations, which accounted for less than 5 percent of the State's output, only two were primarily for gold; the rest were sand and gravel pits. Ten lode mines yielded more than 100 ounces of gold.

Idarado Mining Co. operations accounted for nearly 50 percent of the total output in 1970. Other important lode mines with output exceeding 500 troy ounces were the

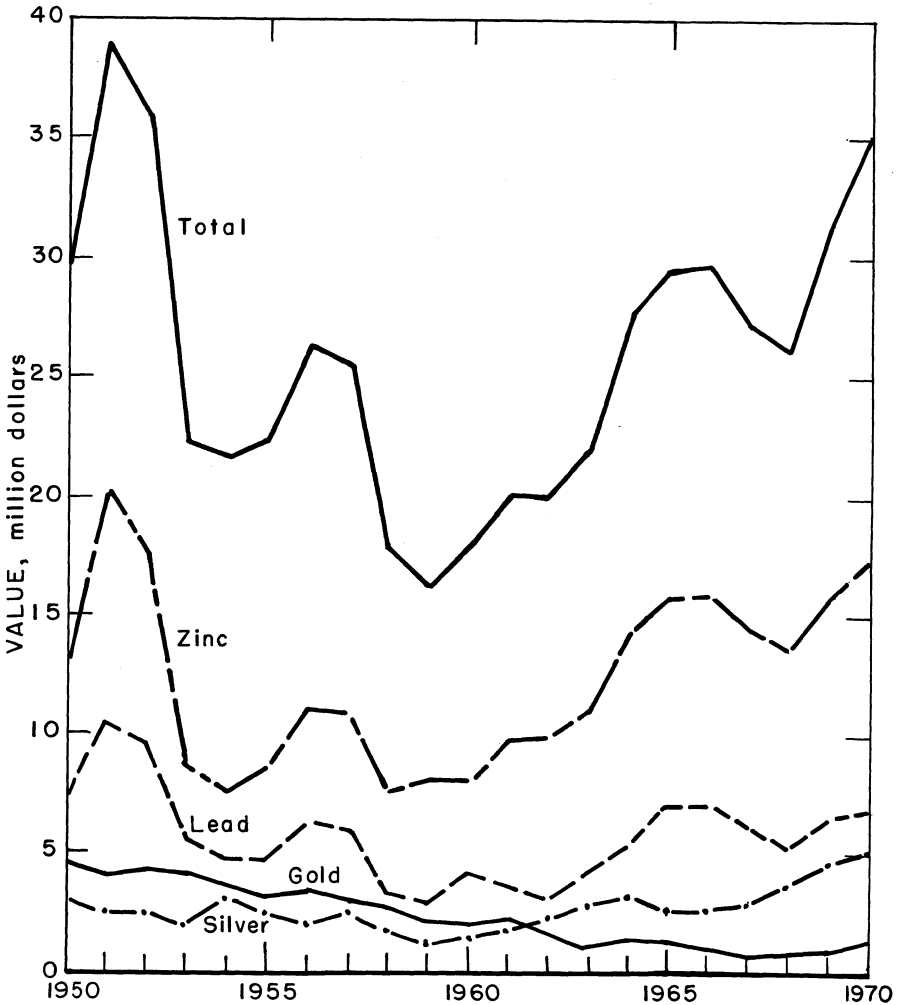


Figure 2.—Value of mine production of gold, silver, lead, and zinc, and total value of these minerals (including copper) in Colorado.

Mammoth Revenue Mine of Coronado Silver Corp., the Eagle mine of New Jersey Zinc Co., the Sunnyside and Belle Creole mines of Standard Metals Corp., the Emperius mine of Emperius Mining Co., and the Camp Bird mine of Federal Resources Corp.

**Iron Ore.**—The output of iron ore was 7 percent below that of 1969, mainly because of lower production at the Copper Basin mine of Pitkin Iron Corp., Pitkin County. The magnetite ore from the mine was shipped to the Pueblo plant of CF&I Steel Corp. A small quantity of brown iron ore was mined in San Miguel County and

shipped to Chas. Pfizer & Co., Inc., East St. Louis, Ill., for use as paint pigment. Allied Chemical Corp. produced iron sinter at its Denver Works plant in processing pyrite concentrates to sulfuric acid.

**Lead.**—Output of lead approximated that of 1969, but the value of production was up 5 percent because of an increase in the average price of lead. The average price increased 0.72 cent, or from 14.89 cents per pound in 1969 to 15.61 cents per pound in 1970. There were 28 producing mines in 10 counties. The 10 mines that had production in excess of 500 tons accounted for nearly 98 percent of the State output.

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

County	Mines producing <sup>1</sup>		Material sold or treated <sup>2</sup> (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
<b>Total:</b>							
1968	56	15	1,056,126	22,638	\$888,768	1,646,283	\$3,530,619
1969	37	10	1,090,329	25,777	1,070,003	2,598,563	4,653,169
<b>1970:</b>							
Adams	--	--	--	850	30,932	115	204
Clear Creek	6	--	11,631	214	7,787	8,166	14,460
Eagle	1	--	295,464	661	24,054	134,025	237,334
Hinsdale	1	--	20	--	--	500	885
Jefferson	--	--	--	621	22,598	88	156
Lake	1	--	53	1	36	317	561
Park	1	1	74	54	1,965	67	119
San Juan	7	--	242,695	14,884	541,628	271,758	481,236
San Miguel	1	--	258,371	13,603	495,013	439,908	778,998
Undistributed <sup>3</sup>	10	1	324,912	6,226	226,566	2,078,419	3,680,505
<b>Total <sup>4</sup></b>	<b>28</b>	<b>2</b>	<b>1,133,220</b>	<b>37,114</b>	<b>1,350,579</b>	<b>2,983,363</b>	<b>5,194,458</b>
	<b>Copper</b>		<b>Lead</b>		<b>Zinc</b>		<b>Total value</b>
	Short tons	Value	Short tons	Value	Short tons	Value	
<b>Total:</b>							
1968	3,451	\$2,888,280	19,778	\$5,226,139	50,258	\$13,569,661	\$26,103,467
1969	3,598	3,420,547	21,767	6,484,389	53,715	15,684,780	31,312,888
<b>1970:</b>							
Adams	--	--	--	--	--	--	31,136
Clear Creek	107	122,901	27	8,512	( <sup>5</sup> )	61	153,721
Eagle	24	27,126	2,391	746,776	31,456	9,637,489	10,672,779
Hinsdale	--	--	3	1,062	3	812	2,759
Jefferson	--	--	--	--	--	--	22,754
Lake	( <sup>5</sup> )	58	1	297	--	--	952
Park	( <sup>5</sup> )	58	1	328	3	904	3,374
San Juan	693	799,722	6,569	2,051,869	8,727	2,673,748	6,548,203
San Miguel	1,854	2,139,805	5,097	1,592,232	7,652	2,344,267	7,850,315
Undistributed <sup>3</sup>	1,071	1,236,397	7,767	2,426,101	8,854	2,712,738	10,282,307
<b>Total <sup>4</sup></b>	<b>3,749</b>	<b>4,326,067</b>	<b>21,855</b>	<b>6,827,177</b>	<b>56,694</b>	<b>17,370,019</b>	<b>35,068,300</b>

<sup>1</sup> Revised.

<sup>2</sup> Operations at old mill or miscellaneous cleanups, and gold and silver recovered as byproduct from sand and gravel operations (1970) not counted as producing mines.

<sup>3</sup> Does not include gravel washed.

<sup>4</sup> Includes Boulder, Conejos, Dolores, Gilpin, Gunnison, Mineral, and Ouray Counties combined to avoid disclosing individual company confidential data.

<sup>5</sup> Data may not add to totals shown because of independent rounding.

<sup>6</sup> Less than ½ unit.

**Table 6.—Colorado: Mine production of gold, silver, copper, lead, and zinc in 1970, by classes of ore or other source materials, in terms of recoverable metals**

Source	Number of mines <sup>1</sup>	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
<b>Lode ore:</b>							
Dry silver.....	4	107,912	599	1,649,586	83	1,905	1,365
Copper.....	1	9,600	111	1,125	104	--	( <sup>2</sup> )
Copper-lead-zinc.....	2	361,002	18,439	643,176	2,583	7,180	10,553
Lead.....	6	1,429	102	6,397	1	37	2
Lead-zinc.....	14	357,247	15,590	497,315	955	10,337	13,315
Zinc.....	1	295,321	653	132,347	21	2,391	31,456
Total <sup>3</sup> .....	24	1,024,599	34,895	1,280,360	3,664	19,945	55,327
<b>Other lode material:</b>							
Lead tailings and lead-zinc cleanup <sup>4</sup> .....	1	709	7	3,214	2	5	3
Total lode material <sup>3</sup> .....	28	1,133,220	35,501	2,933,160	3,749	21,855	56,694
Placer.....	2	--	1,613	203	--	--	--
Total all sources <sup>3</sup> .....	30	1,133,220	37,114	2,933,363	3,749	21,855	56,694

<sup>1</sup> Detail may not add to total because some mines produce more than one class of material.

<sup>2</sup> Less than ½ unit.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

<sup>4</sup> Combined to avoid disclosing individual company confidential data.

**Table 7.—Colorado: Mine production of gold, silver, copper, lead, and zinc in 1970, by types of material processed and methods of recovery, in terms of recoverable metals**

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
<b>Lode:</b>					
Amalgamation: Ore.....	3,925	1,175	--	--	--
<b>Smelting of concentrates from:</b>					
Ore.....	31,553	2,925,149	3,744	21,834	56,684
Tailings.....	3	1,597	2	4	--
Total.....	31,556	2,926,746	3,746	21,838	56,684
<b>Direct Smelting of:</b>					
Ore.....	16	3,622	2	16	8
Cleanup.....	4	1,617	--	2	3
Total.....	20	5,239	2	18	11
Placer.....	1,613	203	--	--	--
Grand total <sup>1</sup> .....	37,114	2,933,363	3,749	21,855	56,694

<sup>1</sup> Data may not add to totals shown because of independent rounding.

The Idarado mine in Ouray and San Miguel Counties yielded 32 percent of total output. Other important operations, in order of output, were the Sunnyside mine in San Juan County, Eagle mine in Eagle County, Bulldog and Emperius mines in Mineral County, Belle Creole mine in San Juan County, and Rico Argentine mine in Dolores County.

The Resurrection Mining Co., a joint venture of Asarco and Newmont Mining Co., announced that the Black Cloud shaft in the Iowa Gulch was bottomed at 1,654

feet. Sinking of the shaft, a three-compartment unit, was started in early 1969 and completed at midyear. Stations and loading pockets were excavated at five levels, and a spill pocket below the bottom level was partially completed. Mine development work and shaft sinking were contracted by Harrison Western Inc., mine development specialists. Access to the lead-zinc ore body will be from two shafts, the Irene and the Black Cloud. These shafts are approximately 8,000 feet apart and are connected by a tunnel. The Irene shaft was sunk in 1951.

A flotation mill, having a capacity of 700 tons of ore per day, was under construction by Stearns-Roger Corp., Denver. Initial production at the facility was scheduled for March 1971.

According to Asarco's annual report, ore reserves were estimated at 2.4 million tons, averaging 15 percent combined lead and zinc, and having significant quantities of silver and gold.

Camp Bird Colorado, Inc., a subsidiary of Federal Resources Corp., commenced operating the Camp Bird mine near Ouray at midyear. The ore, which contained lead, zinc, silver, copper, and gold, was processed in a 500-ton-per-day mill located on the property. A substantial ore body was discovered by diamond drilling in 1968. Its ultimate size will be determined by mining operations now underway. Unlike the vein deposits formerly mined in the area, the ore body is a flat bedded replacement deposit of multimineral ore and hence amenable to mechanized mining. As a consequence, high-production, trackless equipment was used for drilling and hauling. A three-compartment winze was collared in the Camp Bird tunnel and was sunk 700 feet to the mineral deposit. The ore was hauled by truck to the mill via the tunnel.

**Molybdenum.**—Molybdenum production in 1970, was the highest on record and exceeded the previous high of 62.4 in 1969. All output came from the Climax mine in Lake County and the Urad mine in Clear Creek County, both are owned and operated by American Metal Climax, Inc. (AMAX).

Development work continued at the AMAX Henderson molybdenum project. At midyear, the board of directors approved expenditures of \$44.3 million for the next work phase on the project. The money will provide for driving a 10-mile ore haulage tunnel, millsite preparation, and the continuation of engineering, geology, and administration. A total of over \$103 million has been obligated for the new molybdenum mine. Completion of the project was scheduled for the mid-1970's.

**Rare-Earth Metals.**—Monazite, a combination of rare-earth phosphates, was recovered as a byproduct from mill tailings by AMAX at the Climax mine. Value of output was 28 percent lower than that of 1969.

**Silver.**—Silver production increased nearly 334,000 ounces, or 13 percent over 1969 figures. Output came from 28 lode mines, two placers, and some cleanup operations. The

average price of silver dropped from \$1.79 per troy ounce in 1969, to \$1.77 per troy ounce in 1970. Mines with production exceeding 100,000 troy ounces, in order of output, were the Bulldog of Homestake Mining Co., Idarado of Idarado Mining Co., Sunnyside of Standard Metal Corp., Eagle of New Jersey Zinc Co., and the Emperius of Emperius Mining Co. The five mines accounted for 91 percent of the State total. As with gold, most of the silver was obtained from processing base-metal ores.

Supplying 90 percent of the output, leading counties in silver production in order of output were, Mineral, San Miguel, San Juan, and Ouray. The Leadville Corp. continued an exploration and mine development program in the Iowa Gulch area, 6 miles east of Leadville. Through 1970 the company excavated 3,500 feet of tunnel for ore haulage purposes, a shop, and a general storage area near the tunnel entrance. It was expected that sufficient ore would be developed to operate at a production rate of 1,000 tons per day. A 1-year smelting contract was reportedly negotiated with Asarco.

Construction of Homestake Mining Co.'s 300-ton-per-day mill was completed in April 1970. Flotation and gravity methods of recovery were incorporated in the mill design. The facility processes copper, lead, and zinc ore to a concentrate. The material was shipped by rail to an Asarco smelter in El Paso, Tex. Appreciable quantities of silver also are recovered from the ore.

**Tin.**—Colorado and Alaska were the only States in the Nation with tin production; Colorado's output exceeded that reported in 1969. The source of tin was the AMAX molybdenum mine in Lake County. The tin concentrate was produced from treating mill tailings thence sold to Fred H. Lenway and Co., Inc., for upgrading at its mill near Boulder.

**Tungsten.**—The State production of tungsten concentrate was higher than in 1969, and surpassed in output only by California. All of the output was obtained as a byproduct of milling molybdenum ore at the Climax mine of AMAX. The Eureka mine of Canyon Mining Co. and the Adam mine of Domain Minerals, Inc., were closed during the year.

**Uranium.**—Output of uranium oxide ( $U_3O_8$ ) approximated that of 1969. The average grade of ore mined was 0.25-percent  $U_3O_8$ , slightly higher than the average of

0.24 percent in 1969. Colorado ranked third in the Nation in production and supplied 10 percent of the total output.

Mine production came from 147 operations in six counties, compared with 158 operations in seven counties in 1969. Montrose County had the largest production, 32 percent of the State output, and most of the operations, 93.

The four primary producers, in order of output, were Union Carbide Corp., Cotter Corp., Cloeghorn & Washburn Mining Co., and Shiprock, Ltd. These companies accounted for 90 percent of the ore and recoverable  $U_3O_8$ .

The three uranium mills active during the year were the Uravan and Rifle mills of Union Carbide Corp., and the Canon City mill of Cotter Corp.

AMAX closed its uranium mill in early 1970 because of slower than expected development of nuclear power generating plants, substantial increases in production costs, and the existence of a large supply of processed uranium in stock. As a consequence, more than one-quarter of the uranium mines in San Miguel and Montrose Counties were closed. Many became uneconomical to operate when the only mill in the immediate area was closed and the shipping distance and costs to Union Carbide Corp.'s Uravan and Rifle mills were prohibitive.

Pinnacle Exploration Inc., a subsidiary of Callahan Mining Corp., utilized a solution mining technique at the Pitch uranium mine. The company shipped uranium oxide (yellow cake), valued at \$250,000, by railroad to a nuclear reactor in Metropolis, Ill., for use in generating electricity.

The sales represented 3 years of work at the mine. The company currently is studying the feasibility of mining the uranium deposit by open pit mining and/or leaching methods.

W. R. Grace and Co. agreed to spend \$1.5 million for exploration drilling on mineral leases owned by Silver Bell Industries, Inc., at Ophir, Colo., and in the Red Desert-Crooks Gap area of Wyoming. Should drilling prove commercially minable minerals, the two companies will jointly develop the ore deposits.

According to a survey conducted by AEC, the Colorado uranium-mining industry completed about 30 million feet of exploration drilling in 1969. However, the industry expected to drill only 24 million feet in 1970, a decrease of 20 percent compared with that of 1969.

The Al Johnson Construction Co. initiated work on a new two-compartment shaft at the Schwartzwalder mine of Cotter Corp. When the new shaft is completed, the present production shaft will be used for service purposes. The mine, located 8 miles north of Golden, Colo., produced 300 tons of uranium ore per day and employed 89 workers. The ore was truck-hauled to the company's mill at Cannon City, Colo., a distance of 100 miles.

**Vanadium.**—Vanadium; output, declined nearly 9 percent from that of 1969. The vanadium, in the form of fused vanadium oxide ( $V_2O_5$ ), was recovered at the uranium mills of Union Carbide Corp. in Rifle and Uravan, Climax Uranium Co. in Grand Junction, Foote Mineral Co. in Shiprock, N. Mex., and Atlas Corp. in Moab, Utah.

**Table 8.—Colorado: Mine production of uranium ( $U_3O_8$ ), by counties, in terms of recoverable content**

County	1969			1970		
	Number of operations	Pounds	Value <sup>1</sup> (thousands)	Number of operations	Pounds	Value <sup>2</sup> (thousands)
Fremont <sup>3</sup> .....	7	662,945	\$4,020	6	963,257	\$5,513
Mesa .....	30	511,842	3,071	20	372,482	2,192
Montrose .....	98	1,026,181	6,668	93	871,365	5,092
San Miguel .....	23	535,515	3,176	28	519,881	3,034
Total .....	158	2,736,483	16,935	147	2,726,985	15,831

<sup>1</sup> Value estimated, based on \$5.86 per pound for sales to the Atomic Energy Commission and an assumed price of \$6.10 per pound for commercial sales; includes value of  $U_3O_8$  obtained from Colorado ores processed at out-of-State mills.

<sup>2</sup> Value estimated, based on \$5.78 per pound for sales to the Atomic Energy Commission and an assumed price of \$6.20 per pound for commercial sales; includes value of  $U_3O_8$  obtained from Colorado ores processed at out-of-State mills.

<sup>3</sup> Includes Garfield, Jefferson, and Saguache (1969) Counties to avoid disclosing individual company confidential data.

Leading counties with mine production, in order of output, were San Miguel, Montrose, Mesa, and Garfield.

**Zinc.**—Output of zinc was 5 percent higher in quantity and 11 percent higher in value than reported in 1969. The average price of zinc was 15.3 cents per pound in 1970, an increase of 0.7 cent from that of 1969. Of the 17 producing mines, seven had output of at least 1,500 tons of zinc. The leading mines, in order of output, were the Eagle mine in Eagle County, Idarado mine in Ouray and San Miguel Counties, Sunnyside mine in San Juan County, Camp Bird mine in Ouray County, Belle Creole mine in San Juan County, Emperous mine in Crede County, and Rico Argentine mine in Dolores County. The seven mines yielded 98 percent of the State output.

Eagle County, which contributed about 56 percent of the State output, led the 11 counties with zinc production. Other prin-

cipal counties, in order of output, were San Juan, San Miguel, and Ouray.

**MINERAL FUELS**

**Carbon Dioxide.**—Output of carbon dioxide dropped sharply from the 175.8 million cubic feet reported in 1969. Carbon dioxide production was marketed from the McElmo field in Montezuma County.

**Coal (Bituminous).**—Coal production increased 9 percent over that of 1969, and exceeded 5 million tons for the fifth consecutive year. The value of output was the third highest of all mineral commodities produced in the State.

Forty-eight producing mines were operated in 14 counties, the same as during the previous year. Seven of the counties had production exceeding 100,000 tons. Routt County, with four mines, had the largest production—one-third of the State output. Of the 48 mines with production, eight were

**Table 9.—Colorado: Bituminous coal production, by type of mine and counties**

(Excludes mines producing less than 1,000 short tons per year)

County	Number of mines			Production (thousand short tons)		
	Under-ground	Strip	Total	Under-ground	Strip	Total
<b>1969:</b>						
Delta .....	W	W	W	W	W	W
Fremont .....	11	3	14	198	21	219
Garfield .....	1	--	1	2	--	2
Gunnison .....	4	--	4	569	--	569
Huerfano .....	2	--	2	25	--	25
La Plata .....	4	1	5	16	3	19
Las Animas .....	2	--	2	766	--	766
Mesa .....	3	1	4	40	45	85
Moffat .....	2	--	2	383	--	383
Montrose .....	W	W	W	W	W	W
Pitkin .....	3	--	3	667	--	667
Rio Blanco .....	2	--	2	5	--	5
Routt .....	1	3	4	14	1,777	1,791
Weld .....	4	--	4	572	--	572
Undistributed <sup>1</sup> .....	4	1	5	357	69	426
<b>Total .....</b>	<b>43</b>	<b>9</b>	<b>52</b>	<b>3,614</b>	<b>1,915</b>	<b>5,529</b>
<b>1970:</b>						
Delta .....	W	W	W	W	W	W
Fremont .....	9	3	12	179	106	285
Garfield .....	1	--	1	2	--	2
Gunnison .....	6	--	6	680	--	680
Huerfano .....	2	--	2	23	--	23
La Plata .....	4	--	4	23	--	23
Las Animas .....	1	--	1	602	--	602
Mesa .....	1	--	1	14	--	14
Moffat .....	3	--	3	469	--	469
Montrose .....	W	W	W	W	W	W
Pitkin .....	3	--	3	827	--	827
Rio Blanco .....	2	--	2	3	--	3
Routt .....	1	3	4	12	1,990	2,002
Weld .....	3	--	3	581	--	581
Undistributed <sup>1</sup> .....	4	2	6	443	70	513
<b>Total .....</b>	<b>40</b>	<b>8</b>	<b>48</b>	<b>3,858</b>	<b>2,166</b>	<b>6,024</b>

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



strip mines and the rest were underground mines.

The average price of coal produced increased \$0.58 per ton, from \$5.27 to \$5.85.

Sixteen mines had an output between 1,000 and 10,000 tons, 20 between 10,000 and 100,000 tons, seven between 100,000 and 500,000 tons, and five between 500,000 and 1,000,000 tons. The five operations with the largest production were, in order of output, the Somerset underground mine of U.S. Steel Corp., Gunnison County; Edna strip mine of Pittsburg and Midway Coal Mining Co., Routt County; Energy strip mine of Energy Coal Co., Routt County; Allen mine of CF&I, Las Animas County; and the Seneca strip mine of Seneca Coals, Ltd., Routt County.

Of the 6.0 million tons of coal produced, 1.5 million tons was captive production and 4.5 million tons was sold on the open market. Nearly all of the captive production was used for making steel in Colorado and Utah. The principal purchasers and consumers of coal were the electric utility industry; most of the steam-generating plants in the State use coal for electric power generation.

Public Service Co. of Colorado announced a long-term agreement to purchase 425,000 tons of coal for use at the Cameo steam-generation plant. The coal will be furnished by the Bear Coal Co., the Juanita Coal and Coke Co., and the Reliable Coal and Mining Co. Of the total, 375,000 tons will be supplied by the Bear Coal Co. over a 5-year period, starting January 1, 1970.

**Natural Gas.**—Marketed natural gas declined 11 percent in quantity and 10 percent in value compared with 1969 figures. According to the Colorado Oil and Gas Conservation Commission, production of natural gas during the year was 113.8 billion cubic feet, 5.1 billion cubic feet less than in 1969.<sup>3</sup>

Leading counties for marketing natural gas were La Plata (31.1 billion cubic feet), Moffat (23.5 billion cubic feet), and Rio Blanco (21.4 billion cubic feet). The three counties accounted for nearly 72 percent of the State's output.

The American Gas Association, Inc., (AGA) and the American Petroleum Institute (API) estimated that gas reserves in the State totaled 1.6 trillion cubic feet, an increase of 2 percent over 1969 figures.<sup>4</sup> New fields, revisions, and extensions added 132.1 billion cubic feet, and was 25 percent

in excess of marketed natural gas for the year.

The State's five gas storage projects were Asbury Creek, Fort Morgan, House Creek, Leyden mine, and Springdale. At yearend, the projects had in storage 19.0 billion cubic feet. A net change of 3.0 billion cubic feet in storage was reported for 1970 from the 16.0 billion cubic feet in 1969. This quantity represented the difference between injected and withdrawn gas from underground storage reservoirs.

Again, the Fort Morgan reservoir was the most active with 4.3 billion cubic feet injected and 2.5 billion cubic feet withdrawn. The second most active reservoir was the Leyden mine, a converted coal mine south of Denver, Colo., which had 2.3 billion cubic feet injected and 1.9 billion cubic feet withdrawn. The Springdale reservoir ranked fourth in activity with 1.2 billion cubic feet injected and 1.1 billion cubic feet withdrawn.

As in the past year, the Ignacio-Blanco field, La Plata County, with an output of 28.8 billion cubic feet, was the principal producer of dry gas. The productive horizons were Cretaceous in age: the Dakota, Fruitlands-Pictured Cliffs, and Mesaverde Formations. Second most productive field was the Piceance Creek, Rio Blanco County, 9.4 billion cubic feet of dry gas; Dragon Trail, Rio Blanco County, 7.5 billion cubic feet was third; and West Hiawatha, and Powder Wash, Moffat County, ranked fourth and fifth respectively, with 7.0 and 5.0 billion cubic feet.

The Wilson Creek, Rio Blanco County, reservoir yielded the largest quantity of wet gas. All of the output (3.0 billion cubic feet) was processed for removal of liquids, and 2.1 billion cubic feet was returned to the reservoir for pressure maintenance. Of the 2.9 billion cubic feet produced at Rangely-Weber, Rio Blanco County, 33.9 million cubic feet were returned to the reservoir.

Colorado had 14 new gas discoveries in 1970. On the basis of initial potential, the most significant was the Weld County dis-

<sup>3</sup> Colorado Department of Natural Resources. Oil and Gas Conservation Commission. Oil and Gas Statistics 1970, Production review p. 10; all natural gas and petroleum production data cited in the manuscript are from this publication.

<sup>4</sup> American Gas Association, Inc., American Petroleum Institute, and Canadian Petroleum Association. Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States and Canada and United States productive capacity as of Dec. 31, 1970. V. 25, May 1971, p. 11.

covery of the Wattenburg field by Tom Vessels. The discovery well, Grenemyer No. 1, Sec. 26, T1N, R67W, was completed and flows 26.6 million cubic feet per day from the "J" sand formation (Cretaceous). The discovery created considerable interest in the area and resulted in increased drilling activity. It was estimated that the new producing horizon will cover about 600,000 acres. In Montezuma County, southwestern Colorado, the discovery of the Papoose Canyon field was the most important find since 1964, when the Cache field was discovered in the area. The Pribble discovery well flowed 2.3 million cubic feet per day from the Desert Creek formation.

Production testing of gas liberated from fractured rock was begun at Project Rulison when the chimney was penetrated by drilling. According to AEC, the quantity of radioactive tritium produced in the Project Rulison gas experiment was only one-fortieth of that generated in a smaller gas buggy blast in New Mexico. Tritium is found in gas released from subsurface rock formations by nuclear explosions.

**Natural Gas Liquids.**—Total output of natural gas liquids decreased 20 percent in quantity and 20 percent in value compared with that of 1969. Liquid petroleum gases decreased 13 percent and natural gasoline and cycle products decreased 31 percent in quantity.

The State reported that natural gas throughput of 10 gasoline plants was 94.5 billion cubic feet for the year; output was 2.6 million barrels of product. Gas input increased nearly 5 percent, but output was down 21 percent compared with that of 1969.

Associated Programs, Inc., sold the Loveland and Vallery plants to Vallery Corp., and sold the Yenter plant to Excelsior Oil Corp.

**Petroleum.**—Output of petroleum totaling 24.7 million barrels was nearly 13 percent lower than in 1969 because discoveries of new reserves failed to keep pace with production.

Rio Blanco County, with two top-ranking fields in the State, yielded nearly 47 percent of total crude oil production. Washington and Logan Counties again ranked second and third, with 15.2 and 8.5 percent respectively, of the production.

The Rangely-Weber field continued to dominate Colorado's oil production. It accounted for over 40 percent of State output and had a cumulative yield at year-end of 437.6 million barrels of oil. Production from the field was down 1.8 million barrels in 1970.

During the year, 45 fluid-injection projects were operative in 42 fields. Of these, 39 were water flood projects, five were combined water and gas-injection projects, and one was a gas-injection project. The two water-flood injection projects started in 1970 were Azure-East "D" sandstone, on August 10, and Badger Creek-West "J" sandstone, on November 28. Two projects inactive in 1970 were the Azure "D" sandstone and Danforth Hills in the Morrison Formation. The total water injected in all water-flood projects was 140.6 million barrels, of which the Rangely-Weber field received more than 62 percent, or 87.5 million barrels of water. Data on the quantity of water injected does not differentiate between

**Table 10.—Colorado: Gas input and products at natural gas liquids extraction plants in 1970**

Plant	County	Owner	Gas input (million cubic feet)	Products (thousand barrels)
Adena	Morgan	Union Oil Company of Calif.	4,026	384
Fruita	Mesa	Continental Oil Co.	5,738	119
Loveland	Larimer	Vallery Corp.	127	12
McClave	Kiowa	Fleetwood Drilling Co.	968	28
Piceance Creek	Rio Blanco	Chadbourne Corp.	9,280	120
Rangely	do	Chevron Oil Co.	2,854	249
San Juan	La Plata	El Paso Natural Gas Co.	54,845	1,069
Vallery	Morgan	Vallery Corp.	911	73
Wilson Creek	Rio Blanco	Texaco, Inc.	3,013	325
Yenter	Logan	Excelsior Oil Corp.	1,891	198

Source: Colorado Department of Natural Resources, Oil and Gas Conservation Commission, Oil and Gas Statistics 1970. Plant Intake and Products, pp. 101-103.

"new" water and water produced with the crude oil and recycled.

Estimates by API and AGA credited the State, as of December 31, 1970, with crude oil reserves of 389.0 million barrels, a decrease of 11.5 million barrels, or nearly 3 percent from yearend 1969 figures.<sup>5</sup> An additional 51.9 million barrels are considered economically available by fluid injection. New fields and new pools added 6.8 million barrels, revisions and extensions added 7.4 million barrels.

Total drilling activity decreased by 104 wells from 814 wells in 1969. Most of the decline was in development-well drilling, which was down more than 15 percent from the 276 wells completed in 1969. Exploration drilling in 1970 decreased by 62 wells and was nearly 12 percent less than in 1969. The success ratio for wildcat wells was nearly 9 percent, far below the 11 percent recorded for 1969.

Adams County was the leader in drilling activity with 108 completions, compared

with only 25 in 1969. Washington County, the leading county in drilling activities for 1969, was second with 102 completions at yearend. The third ranking county in drilling activities in 1970 was Arapahoe County with 90 completions, a significant increase from the 12 reported in 1969. Other counties, in order of amount of drilling activity were Logan, Weld, Rio Blanco, Cheyenne, and Elbert.

There were 26 new oil discoveries for the year. The most significant of these was the Peoria field in Arapahoe County. At yearend, the field had 39 wells which produced nearly 500,000 barrels of crude oil. Production was from the "J" sandstone of Cretaceous age. The Peoria oilfield was the second largest oil discovery in eastern Colorado. Oil production was expected to reach approximately 10,000 barrels per day.

At yearend, the State had three operating refineries, one less than in 1969. The General Real Estate and Resource Trust Co.

<sup>5</sup> Reference cited in footnote 4.

Table 11.—Colorado: Crude petroleum production by counties

(Thousand 42-gallon barrels)

County	Production		Principal fields in 1970, in order of production
	1969	1970	
Adams.....	553	1,229	Mocassin, Nile, Middlemist, Roman Nose, <sup>1</sup> Badger Creek.
Arapahoe.....	220	615	Black Jack, Roman Nose. <sup>2</sup>
Archuleta.....	51	49	Price Gramps.
Baca.....	75	61	Flank, Greenwood.
Bent.....	1	( <sup>3</sup> )	McClave, Lubers.
Boulder.....	1	1	Boulder.
Cheyenne.....	417	614	Golden Spike, Ladder Creek, Cheyenne Wells.
Elbert.....	7	19	Ironhorse.
Fremont.....	33	28	Florence-Canon City.
Garfield.....	( <sup>3</sup> )	--	Mam Creek.
Jackson.....	179	168	McCallum, Battleship.
Kiowa.....	1,101	1,097	Brandon.
La Plata.....	23	23	Red Mesa.
Larimer.....	261	211	Wellington, Loveland.
Logan.....	2,399	2,094	Saber, Northwest Graylin, West Padroni, Mount Hope, Ramrod, Yenter.
Moffat.....	1,636	1,149	Maudlin Gulch, Powder Wash, Iles.
Montezuma.....	317	257	Cache, Marble Wash, Flodine Park.
Morgan.....	947	715	Adena, Boxer, Peterson, Sand River, Roundup.
Prowers.....	1	4	Comanche.
Rio Blanco.....	14,428	11,540	Rangely, Wilson Creek, Nine Mile.
Routt.....	85	79	Grassy Creek, North Sage Creek, Tow Creek.
San Miguel.....	3	2	Andy's Mesa.
Washington.....	4,389	3,762	Westfork, Rush Willadel, Plum Bush Creek, Belle, Cimarron, Big Beaver, Bison.
Weld.....	1,167	1,006	Black Hollow, Pierce, Sleeper, Border.
Miscellaneous.....	--	( <sup>3</sup> )	
Total.....	28,294	24,723	

<sup>1</sup> Partly in Arapahoe County.

<sup>2</sup> Partly in Adams County.

<sup>3</sup> Less than ½ unit.

Source: Colorado Department of Natural Resources. Oil and Gas Conservation Commission. Oil and Gas Statistics 1970. Oil and Gas Statistics by counties, pp. 11.

Table 12.—Principal oilfields in 1970

Field	County	Production		Cumulative production to Jan. 1, 1971	
		Oil (barrels)	Gas (thousand cubic feet)	Oil (barrels)	Gas (thousand cubic feet)
Rangely (Weber)	Rio Blanco	9,945,460	2,807,349	437,637,829	665,451,213
Wilson Creek	do.	1,176,263	3,013,123	68,305,573	50,181,074
Brandon	Kiowa	816,503	466	3,738,790	1,702
Nile	Adams	727,408	656,640	804,249	690,095
Maudlin Gulch	Moffat	498,817	55,775	5,330,022	957,959
Peoria	Arapahoe	486,184	455,383	486,184	455,383
Rush Willadel	Washington	345,764	--	3,183,929	12,464
Rangely (Mancos)	Rio Blanco	300,411	--	11,850,289	646
Golden Spike	Cheyenne	299,524	50	551,270	250
Black Hollow	Weld	273,842	12,155	9,286,156	288,156
Cavalry	Kiowa	262,464	12,894	378,408	18,163
Cimarron	Washington	253,402	--	754,320	--
Adena	Morgan	247,950	1,515,461	60,064,018	80,246,160
Pierce	Weld	247,177	--	6,975,860	266,219
Ladder Creek	Cheyenne	246,272	15,250	352,440	21,250
Saber	Logan	205,879	1,143,068	1,622,749	8,978,699
Plum Bush Creek	Washington	218,805	29,341	17,693,127	2,014,553
Bison	do.	217,863	--	3,683,264	2,467
Westfork	do.	204,062	--	3,172,105	888,049
Belle	do.	158,806	69,301	425,358	125,021

Source: Colorado Department of Natural Resources, Oil and Gas Conservation Commission, Oil and Gas Statistics, Production by Leases pp. 12-36.

Table 13.—Colorado: Oil and gas well drilling completions in 1970, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
Adams	9	2	9	9	1	78	108	735,853
Arapahoe	33	1	10	4	--	42	90	588,430
Archuleta	--	--	--	--	--	1	1	2,043
Baca	--	4	2	--	1	4	11	40,309
Bent	--	--	1	--	--	3	4	22,563
Cheyenne	11	--	8	--	--	11	30	166,019
Delta	--	--	--	--	--	1	1	3,020
Douglas	--	--	--	--	--	1	1	3,465
Elbert	--	--	--	2	1	23	26	171,980
El Paso	--	--	--	--	--	1	1	8,040
Fremont	--	--	--	--	--	1	1	624
Garfield	--	1	--	--	--	1	2	13,684
Grand	--	--	--	--	--	1	1	2,129
Gunnison	--	--	--	--	--	1	1	3,392
Huerfano	--	--	--	--	--	7	7	24,967
Kiowa	5	2	1	1	--	12	21	109,588
Kit Carson	--	--	--	--	--	12	12	69,300
La Plata	1	2	--	--	--	1	4	25,559
Las Animas	--	--	--	--	--	3	3	5,635
Lincoln	--	--	--	--	--	7	7	32,854
Logan	6	--	14	--	2	49	71	366,589
Mesa	--	--	1	--	--	1	2	10,392
Moffat	6	6	4	--	--	7	23	143,720
Motuzuma	2	--	1	--	1	11	15	60,432
Montrose	--	--	--	--	--	1	1	8,430
Morgan	1	--	4	2	1	14	22	125,844
Otero	--	--	--	--	--	2	2	12,625
Phillips	--	--	--	--	--	1	1	3,836
Prowers	--	--	--	--	--	7	7	38,384
Rio Blanco	23	13	10	1	2	5	54	253,140
Routt	1	--	1	--	--	2	4	21,228
Washington	11	--	15	5	1	70	102	474,055
Weld	7	1	5	2	5	48	68	488,094
Yuma	--	--	--	--	--	6	6	19,159
Total	116	32	86	26	15	435	710	4,055,382

Source: American Petroleum Institute.

refinery, leased to King Resources in 1969, was shut down because of the lack of crude. Total refining capacity in the State rose from 42,900 to 49,700 barrels of crude per day, an increase of nearly 16 percent compared with that of 1969.

Colorado refineries processed 14.5 million barrels of crude oil; 12.5 million was from out-of-State sources. Wyoming supplied most of the interstate receipts (8.9 million barrels). The two other States that shipped oil into Colorado were Montana and Utah. A shipment of 1.2 million barrels of crude from Canada was the first on record. Of the 24.7 million barrels of oil produced in Colorado, 23.5 million was shipped out of the State. Utah received 13.7 million barrels, chiefly from the Rangely and other northwest Colorado oil fields. Other recipients included Illinois, 4.2 million barrels; Oklahoma, 1.5 million barrels; Ohio, 1.2 million barrels; Indiana, 1.1 million barrels; and Kansas, 1.0 million barrels.

#### NONMETALS

**Cement.**—Compared with those of 1969, shipments of portland cement increased 45 percent and masonry cement increased 1 percent. The cement was produced by Ideal Basic Industries, Inc. at its Boettcher and Portland plants, and Dewey Rocky Mountain Cement Co. at its Lyons plant.

A total of 91 percent of portland cement and 95 percent of masonry cement was consumed in Colorado. Ready-mix concrete companies were the largest customers, purchasing 70 percent of the portland cement marketed in the State. Other consumers, in order of quantity purchased, were concrete product manufacturers, building material suppliers, highway contractors, and miscellaneous customers.

The newly opened cement plant at Lyons of Dewey Rocky Mountain Cement Co., a division of Martin Marietta Corp., was a target of numerous complaints about air pollution. As a result, the company planned to spend more than \$3 million for dust control and air pollution abatement. The plant has a capacity of 2.5 million barrels of cement per year. It represents a \$22 million investment and has a payroll of \$1 million per year. The limestone used at the plant contains kerogen, a form of oil shale having an unwanted oil content from 1.3 percent to nearly 3 percent. A new

roasting process was developed to remove the kerogen without polluting the air.

**Clays.**—Clay output decreased 13 percent in quantity and 7 percent in value. Of the total clay production, 62.5 percent was miscellaneous clay and shale, and 37.5 percent was fire clay, compared with 60.5 and 39.5 percent, respectively, in 1969. Of the total output, one-third was produced and sold as raw material; the balance was captive production. Twenty-one producers from 56 operations were responsible for the output, compared with 24 producers from 53 operations in 1969. Twenty-one operations were in Jefferson County, seven each in Pueblo, Douglas, and Fremont Counties, six in Boulder County, two each in Elbert, El Paso, and Las Animas Counties, and one each in Huerfano and Custer Counties.

Jefferson County produced 66 percent of the State output. The largest operator was the Idealite Co., a division of Ideal Basic Industries, Inc., in Jefferson County. The company mined shale for lightweight aggregate. Other leading producers were Robinson Brick and Tile Co., and Wesley Conda.

Fire clay was used in the manufacture of heavy clay products (building brick and sewer pipe) and refractories; common clay and shale were used for building brick, lightweight aggregate, and pottery.

Idealite, which has only one mine, was the only operator producing more than 100,000 tons. Twelve operators had production between 10,000 and 100,000 tons, seven between 1,000 and 10,000 tons, and one less than 1,000 tons.

The average unit price for miscellaneous clay and shale was \$1.39 per ton and fire clay was \$3.98 per ton, compared with \$1.22 and \$3.72 per ton, respectively, for 1969.

**Feldspar.**—Output of feldspar increased 68 tons in 1970, and was nearly 19 percent over that of 1969. It was produced by Lockhart and Sons from the Mica Lode in Fremont County. The product was used for decorative aggregate.

**Fluorspar.**—Shipments of fluorspar, up 54 percent from 1969, came from two mines located in Boulder and Jackson Counties. Except for a small quantity of fluxing gravel used in steelmaking, the product was acid grade used for making hydrofluoric acid.

The largest fluorite discovery in the United States in 25 years was made in the Unaweep Canyon area, south of Grand Junction. The deposit consists of three fluorite veins covering an area ranging in

Table 14.—Principal oil and gas discoveries in 1970

County and field	Well	Operator	Location			Producing formation	Barrels of oil per day	Thousand cubic feet of gas per day	Remarks
			Section	Town-ship	Range				
Adams:									
Bennet	No. 1 Callahan	Tom Vessels	20	3S	63W	J sandstone	389	320 Flowing.	
Jamboree	No. 1 Hartnagle	do	34	1S	64W	do	212	9,325 Pumping.	
Hombre	No. 1 Colomacow Farms	Pan American Petroleum Corp.	32	2N	61W	do	8,584	6,042 Flowing.	
Ringer	No. 1 Beltz 'A'	Tom Vessels	10	1S	63W	do	611	15 Do.	
Arapahoe:									
Byers	No. 26 UPRR	Pan American Petroleum Corp.	1	4S	62W	do	2,642	1,310 Pumping.	
Peoria	No. 1 Price	Tom Vessels	14	4S	60W	do	4,702	2,000 Do.	
Peoria-North	No. 1 Price-Brothe	do	15	4S	60W	do	1,711	7,100 Do.	
Elbert:									
Dull Knife	No. 1 Bishop	do	20	6S	60W	do	1,711	-- Do.	
Morgan:									
Echo Canyon	No. 1 Twist	Dunwick Co.	35	6N	58W	D sandstone	12,650	20,590 Flowing.	
Pleasant Ridge	No. 1 Hough 'B'	Plain Exploration Co.	18	1N	56W	J sandstone	3,007	9,000 Do.	
Montezuma:									
Papoose Canyon	No. 1 Pribble	Cherokee and Pittsburg Coal Mining Co.	31	39N	19W	Desert Creek	180	2,289 Pumping.	
Washington:									
Point Bar	No. 1 M. M. Snyder	Westgate Oil Co.	17	3N	50W	D sandstone	3,741	-- Do.	
Scout	No. 1 Hokr	Alfred Ward & Son	27	3N	52W	do	11,664	-- Do.	
Weld:									
Fury	No. 1 Peters	Todd Gross	33	12N	61W	J sandstone	6,190	Do.	
Shivaree	No. 1 Sono-State	Dunwick Co.	36	9N	61W	do	2,352	4,500 Flowing.	
Watfenberg	No. 1 Grenemyer	Tom Vessels	26	1N	67W	do	484	26,630 Do.	

Source: Colorado Department of Natural Resources, Oil and Gas Conservation Commission. Oil and Gas Statistics, 1970. Production by Leases, pp. 12-86.

Table 15.—Clay sold or used by producers, by counties

County	1969		1970 <sup>1</sup>	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Bent.....	W	W	--	--
Boulder.....	W	W	25,800	\$44
Custer.....	--	--	W	W
Douglas.....	63,893	\$194	W	W
Elbert.....	W	W	W	W
El Paso.....	W	W	W	W
Fremont.....	28,573	85	28,790	92
Huerfano.....	W	W	W	W
Jefferson.....	468,646	658	418,217	696
Las Animas.....	W	W	W	W
Pueblo.....	95,226	W	78,796	427
Saguache.....	W	W	--	--
Undistributed.....	75,193	682	84,977	244
Total.....	731,531	1,619	636,580	1,503

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

<sup>1</sup> Excludes bentonite.

length from 1.5 miles to 3 miles. About 70 claims have been staked.

**Gypsum.**—Gypsum production decreased below that of 1969. The output came from four mines, three in Fremont County and one in Larimer County. All mines were open pit operations. Twelve percent of the output was calcined and then used in manufacturing gypsum building products. Uncalcined gypsum was used as a portland cement retarder and as a soil conditioner.

**Lime.**—Lime output, down 6 percent from 1969, came from 11 plants, one less than was operated last year. Ten of the 11 plants were at sugar beet refining facilities. The Great Western Sugar Co. had eight plants, and the Holly Sugar Corp. and American Crystal Sugar Co. had one each. CF&I produced lime at its Pueblo steel plant for use as a refractory material and as a flux in the basic oxygen steelmaking process. During the year, the company added another kiln to increase production capacity. The plant of Basic Chemical Corp. did not operate in 1970.

**Perlite.**—Persolite Products Inc., the only producer of crude perlite in Colorado, reported a 13 percent increase in output from its Rosita mine in Custer County. Part of the production was sold and part sent to the company's expanding plant in Florence. Crude perlite imported from New Mexico also was expanded at the plants of Grefco, Inc., and W. R. Grace and Co.

**Pumice.**—Four counties reported production of pumice materials; output totaled 50,000 tons, or a 19-percent increase over that of 1969. The higher production was due primarily to a greater demand for

pumice-type material for concrete aggregate and railroad ballast. Other uses were for roofing granules, road construction, and rock gardens.

**Pyrites.**—AMAX produced pyrite concentrate as a byproduct of the molybdenum ore mined at the Climax mine in Lake County. The output was more than in 1969, and was sold for use in manufacturing sulfuric acid.

**Salt.**—Output of salt, lower than in 1969, was obtained by Union Carbide Corp. from a brine well in Montrose County. The product was used at the company's Uravan mill in processing uranium-vanadium ores.

**Sand and Gravel.**—Sand and gravel, sold and used, increased 12 percent compared with that of 1969. The value of output represented 6 percent of the total value of the State's mineral production. Sand and gravel ranked fourth in value after molybdenum, petroleum, and coal.

Eighty percent of the sand and gravel output was gravel; 20 percent was sand. The average price for gravel was \$1.07 per ton; that for sand was \$1.14. The overall average for sand and gravel was \$1.09 per ton. Only 1.2 million tons of sand and gravel was unprocessed or pit-run material. The balance (23.0 million tons) was either washed, crushed, screened, or a combination thereof.

The number of sand and gravel operations decreased from 304 in 1969 to 300 in 1970. Of these operations, 162 were Government-and-contractor and 138 were classed as commercial.

Sand and gravel used for road construction and maintenance totaled 15.1 million

Table 16.—Colorado: Sand and gravel sold or used by producers, by counties  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Adams.....	20	2,582	\$3,263	15	2,794	\$3,096
Alamosa.....	2	151	189	4	W	W
Arapahoe.....	14	858	1,117	10	1,562	1,842
Archuleta.....	5	282	437	2	W	W
Baca.....	2	55	130	3	W	W
Bent.....	1	40	50	2	W	W
Boulder.....	8	1,770	2,469	7	1,596	1,920
Chaffee.....	4	W	W	3	W	114
Cheyenne.....	2	54	87	1	W	W
Clear Creek.....	3	W	W	4	359	464
Conejos.....	3	69	99	1	W	W
Costilla.....	1	1	1	2	W	W
Crowley.....	3	48	79	2	W	W
Custer.....	3	122	180	1	W	33
Delta.....	3	W	W	6	206	223
Douglas.....	7	407	456	4	611	W
Eagle.....	5	90	163	7	495	545
El Paso.....	15	1,285	1,512	10	1,453	1,303
Elbert.....	3	218	290	2	W	W
Fremont.....	5	53	92	6	105	65
Garfield.....	7	358	627	4	W	W
Gilpin.....	1	20	24	1	W	W
Grand.....	3	W	W	8	288	353
Gunnison.....	9	W	W	5	117	90
Hinsdale.....	1	9	16	1	30	47
Huerfano.....	4	48	79	1	W	W
Jackson.....	2	11	19	3	55	W
Jefferson.....	16	2,191	3,122	19	2,228	2,434
Kiowa.....	3	37	61	2	W	W
La Plata.....	8	W	W	10	483	689
Lake.....	3	W	W	1	152	W
Larimer.....	11	678	887	11	676	659
Las Animas.....	6	W	W	5	W	274
Lincoln.....	5	307	255	5	315	W
Logan.....	5	90	114	4	W	87
Mesa.....	7	721	1,164	10	848	1,387
Mineral.....	1	59	99	1	( <sup>1</sup> )	( <sup>1</sup> )
Moffat.....	8	355	562	10	332	486
Montezuma.....	4	W	W	5	90	107
Montrose.....	6	W	W	5	281	266
Morgan.....	6	260	356	7	279	184
Otero.....	6	483	697	3	W	W
Ouray.....	2	46	41	1	120	48
Park.....	1	42	70	2	W	W
Phillips.....	3	54	96	2	W	W
Pitkin.....	3	W	W	10	286	338
Pueblo.....	12	943	1,352	10	1,299	1,432
Routt.....	2	W	W	3	140	W
Saguache.....	2	72	121	4	W	W
San Miguel.....	1	84	100	2	57	W
Sedgwick.....	5	461	372	7	440	W
Summit.....	5	W	W	6	493	855
Teller.....	5	106	78	5	151	W
Washington.....	3	58	61	4	W	W
Weld.....	11	545	635	10	668	553
Yuma.....	2	72	76	3	W	W
Undistributed <sup>2</sup> .....	16	3,702	5,568	18	3,253	4,296
Total <sup>3</sup> .....	304	19,877	27,266	300	22,261	24,190

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

<sup>1</sup> Less than ½ unit.

<sup>2</sup> Includes Denver (1970), Dolores (1970), Kit Carson, Prowers, Rio Blanco, Rio Grande and San Juan (1970) Counties, and some sand and gravel that cannot be assigned to specific counties.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

tons and that for building construction 6.2 million tons. The remaining 2.9 million tons was used as industrial sand (blast, engine, filtration, fire and furnace, and hydrafracing), for fill, railroad ballast, and miscellaneous uses.

Denver, Dolores, and San Juan Counties reported production in 1970, but did not in 1969. Adams County had the highest output (2.8 million tons) followed, in order of quantity, by Jefferson, Boulder, Arapahoe, El Paso, and Pueblo Counties,



**Table 17.—Colorado: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building .....	2,184	\$2,620	2,438	\$2,951
Fill .....	202	143	129	105
Paving .....	874	877	661	453
Other uses <sup>1</sup> .....	117	201	358	577
Total <sup>2</sup> .....	3,377	3,840	3,586	4,086
<b>Gravel:</b>				
Building .....	2,942	4,819	3,275	5,252
Fill .....	377	365	523	516
Paving .....	3,645	4,619	7,438	7,176
Miscellaneous .....	215	303	114	146
Other uses <sup>3</sup> .....	125	152	423	652
Total <sup>2</sup> .....	7,305	10,257	11,773	13,742
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Building .....	5	16	78	16
Fill .....	30	37	2	3
Paving .....	434	650	722	897
Other uses .....	2	1	--	--
Total <sup>2</sup> .....	471	704	802	915
<b>Gravel:</b>				
Building .....	28	75	384	14
Fill .....	313	647	1,429	499
Paving .....	7,883	11,742	4,224	4,910
Other uses .....	--	--	62	24
Total <sup>2</sup> .....	8,724	12,464	6,099	5,447
Total sand and gravel <sup>2</sup> .....	19,877	27,266	22,261	24,190

<sup>1</sup> Includes blast, fire or furnace (1969), engine, filtration, oil (hydrafrac), and other sands.

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

<sup>3</sup> Includes railroad ballast.

all of which had production of over 1 million tons. Output of the six counties was 49 percent of the State total. Twenty-one counties had yields between 100,000 and 1 million tons; 36 had less than 100,000 tons.

**Stone.**—Stone output increased 1.3 million tons, or 58 percent over that of 1969. Stone was quarried at 157 operations in 45 counties. Six counties had output exceeding 100,000 tons. In order of output, these were Fremont, Chaffee, Boulder, Dolores, El Paso, and Larimer.

Limestone and granite accounted for 59 percent and 3 percent, respectively, of the State stone production. The balance was comprised of basalt, marble, sandstone, and miscellaneous stone (unclassified as to kind). Limestone was used chiefly for making cement and lime, concrete and road-base aggregate, and as a flux in making steel. Granite was used for dam embankment and as building and monumental dimension stone. Sandstone was used for concrete and

road-base aggregate, building dimension stone and for making cement. Marble was used for terrazzo and building dimension stone. Basalt was used as riprap, and miscellaneous stone was used as concrete and road-base aggregate, and riprap.

**Sulfur.**—Continental Oil Co. recovered sulfur at its Denver oil refinery from crude oil supplied by out-of-State sources. Output at the plant totaled 1,638 long tons. The facility, a \$6.5 million investment, completed its first full year of operation, having been placed on stream in mid-1969. The production was not included as part of the mineral production of the State because it is considered a secondary product.

**Vermiculite.**—Crude vermiculite from Montana was exfoliated by W. R. Grace & Co. at its plant in Denver. The product was sold for use as loose-fill insulation, concrete and plaster aggregate, soil conditioning, and fire base.

Table 18.—Colorado: Stone sold or used by producers, by counties  
(Thousand short tons and thousand dollars)

County	1969			1970			Kind of stone produced in 1970
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value	
Adams.....	2	2	\$3	2	W	W	Granite.
Alamosa.....	1	( <sup>1</sup> )	( <sup>1</sup> )	--	--	--	
Arapahoe.....	2	1	2	--	--	--	
Archuleta.....	1	1	3	--	--	--	
Boulder.....	9	12	76	9	228	W	Limestone, traprock, sandstone.
Chaffee.....	4	W	W	5	360	\$1,105	Granite, limestone, other stone, marble.
Cheyenne.....	1	1	1	1	W	W	Other stone.
Crowley.....	1	1	1	1	W	W	Do.
Dolores.....	1	114	57	1	W	54	Sandstone.
Douglas.....	6	11	36	6	15	54	Dolomite, limestone, other stone, quartz.
Elbert.....	1	1	1	--	--	--	
Fremont.....	15	W	W	14	W	1,574	Dolomite, granite, limestone, marble, other stone, quartz, quartzite, sandstone.
Grand.....	5	2	4	2	W	W	Granite, other stone.
Gunnison.....	2	7	29	2	W	W	Do.
Huerfano.....	1	1	4	1	W	W	Granite.
Jackson.....	2	1	4	--	--	--	
Jefferson.....	13	89	245	16	W	387	Granite, other stone, quartz, quartzite.
La Plata.....	1	4	11	--	--	--	
Lake.....	--	--	--	1	W	62	Other stone.
Larimer.....	28	521	1,265	23	W	1,438	Granite, limestone, quartz, sandstone.
Las Animas.....	2	5	8	2	W	W	Granite.
Logan.....	2	1	4	--	--	--	
Mesa.....	1	( <sup>1</sup> )	8	3	W	33	Granite, sandstone.
Moffat.....	1	13	33	3	W	W	Granite, other stone.
Montrose.....	2	16	91	1	15	90	Traprock.
Morgan.....	1	( <sup>1</sup> )	( <sup>1</sup> )	--	--	--	Do.
Otero.....	1	( <sup>1</sup> )	( <sup>1</sup> )	1	W	W	Granite.
Phillips.....	1	( <sup>1</sup> )	( <sup>1</sup> )	--	--	--	
Prowers.....	1	1	1	--	--	--	
Rio Blanco.....	2	68	138	2	W	W	Granite, other stone.
Rio Grande.....	1	( <sup>1</sup> )	( <sup>1</sup> )	--	--	--	
Saguache.....	1	( <sup>1</sup> )	1	1	1	8	Quartz.
San Miguel.....	1	6	W	1	W	16	Limestone.
Sedgwick.....	1	( <sup>1</sup> )	( <sup>1</sup> )	1	W	W	Granite.
Summit.....	1	( <sup>1</sup> )	4	--	--	--	
Undistributed <sup>2</sup> .....	15	1,368	3,048	58	2,933	3,256	Various.
Total <sup>3</sup> .....	130	2,245	5,079	157	3,552	8,076	

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

<sup>1</sup> Less than ½ unit.

<sup>2</sup> Includes Baca (1970), Custer, Delta (1970), Eagle (1970), El Paso, Garfield, Gilpin, Kit Carson (1970), Montezuma (1970), Park, Pueblo (1970), Teller and Weld (1970), Counties and counties for which no county breakdown is available.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

**Table 19.—Colorado: Stone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars unless otherwise specified)

Use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension stone:</b>				
<b>Rough:</b>				
Irregular-shaped stone and rubble.....	5	\$81	4	\$68
Architectural.....thousand cubic feet...	34	36	--	--
Monumental.....do.....	11	31	126	126
Other.....do.....	48	55	39	45
<b>Dressed:</b>				
Architectural.....do.....	2	16	29	79
Monumental.....do.....	--	--	216	2145
Flagging.....do.....	15	33	--	--
Total (approximate thousand short tons).....	13	252	13	4362
<b>Crushed and broken stone:</b>				
Surface treatment aggregates.....	223	262	248	240
Unspecified aggregate and roadstone.....	W	W	1,176	2,530
Lime.....	234	557	W	W
Metallurgical.....	W	W	W	W
Riprap and jetty stone.....	126	353	155	324
Terrazzo.....	14	164	24	222
Other <sup>5</sup> .....	1,635	3,491	1,936	4,398
Total.....	2,232	4,827	3,539	7,714
<b>Grand total.....</b>	<b>2,245</b>	<b>5,079</b>	<b>3,552</b>	<b>8,076</b>

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

<sup>1</sup> Rough monumental and architectural stone combined to avoid disclosing individual company confidential data.

<sup>2</sup> Dressed monumental and stone for flagging combined to avoid disclosing individual company confidential data.

<sup>3</sup> Flagging and house stone veneer combined to avoid disclosing individual company confidential data.

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

<sup>5</sup> Data includes stone used in cement, stone sand, mine dusting, refractories, roofing aggregates, soil conditioners, railroad ballast (1970), and other unspecified uses.

**Table 20.—Colorado: Stone sold or used by producers, by kinds**  
(Thousand short tons and thousand dollars)

Kind of stone	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Limestone.....	(1)	W	(1)	W
Dolomite.....	(1)	W	(1)	W
Granite.....	W	W	W	W
Marble.....	(1)	\$6	--	--
Sandstone.....	12	205	11	\$220
Quartz.....	(1)	(1)	(1)	(1)
Traprock.....	(1)	3	--	--
Undistributed.....	1	38	2	142
Total.....	13	252	13	362
<b>Crushed and broken:</b>				
Limestone.....	1,723	3,556	2,100	4,542
Dolomite.....	W	W	133	399
Granite.....	W	148	103	164
Marble.....	W	W	W	W
Sandstone.....	150	177	W	113
Quartz.....	16	192	26	241
Quartzite.....	W	W	W	W
Traprock.....	W	W	W	W
Other stone.....	56	151	562	753
Undistributed.....	287	603	615	1,502
Total.....	2,232	4,827	3,539	7,714
<b>Grand total.....</b>	<b>2,245</b>	<b>5,079</b>	<b>3,552</b>	<b>8,076</b>

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

<sup>1</sup> Less than 1/2 unit included with "Undistributed."

Table 21.—Principal producers

Commodity and company	Address	Type of activity	County
Beryllium: U.S. Beryllium Corp.....	303 Bon Durant Bldg. Pueblo, Colo. 81003	Open pit mine and mill...	Park.
Carbon Dioxide, natural: Tenneco Oil Co.	Box 2410 Denver, Colo. 80201	Well in McElmo field....	Montezuma.
Cement: Ideal Basic Industries, Inc....	Box 231 Florence, Colo. 81226	Wet process, 2-rotary-kiln plant.	Fremont.
	Box 579 Fort Collins, Colo. 80521	Dry process, 2-rotary-kiln plant.	Larimer.
Clays:			
The Idealite Co., a division of Ideal Basic Industries, Inc.	Box 1140 Boulder, Colo. 80302	Open pit mine and expanding plant.	Jefferson.
Robinson Brick & Tile Co.....	Box 1619 Denver, Colo. 80223	Underground mine and 3 open pit mines.	Douglas.
		Open pit mine.....	Elbert.
		do.....	El Paso.
		Open pit mine and 2 underground mines.	Jefferson.
Coal, bituminous:			
CF&I Steel Corp.....	Box 316 Pueblo, Colo. 81002	Underground mine.....	Las Animas.
Energy Coal Co.....	2850 North Meridian St. Indianapolis, Ind. 46208	Strip mine and crushing plant.	Routt.
Mid-Continent Coal and Coke Co.	Carbondale, Colo. 81623...	3 underground mines; cleaning and thermal drying plant.	Pitkin.
Peabody Coal Co.....	301 North Memorial Drive St. Louis, Mo. 63102	Strip mine and crushing plant.	Montrose.
	Ten Main Center Kansas City, Mo. 64105	do.....	Routt.
The Pittsburg & Midway Coal Mining Co.	Box 807 Dragerton, Utah 84520	Strip mine; crushing and oil treatment plant.	Do.
United States Steel Corp. Western District-Coal.		Underground mine; cleaning and crushing plant.	Delta and Gunnison.
Copper: Idarado Mining Co.....	Ouray, Colo. 81427.....	See Zinc.....	Ouray and San Miguel.
Fluorspar:			
Industrial Chemicals Division, Allied Chemical Corp.	Box 228 Boulder, Colo. 80202	Underground mine and plant.	Boulder.
Ozark-Mahoning Co.....	Box O Cowdrey, Colo. 80434	do.....	Jackson.
Gold:			
Idarado Mining Co.....	Ouray, Colo. 81427	See Zinc.....	Ouray and San Miguel.
Standard Metals Corp.....	Telluride, Colo. 81435 Box 247 Silverton, Colo. 81433	do.....	San Juan.
Gypsum: Johns-Manville Product Corp.	Box 80 Coaldale, Colo. 81222	Open pit mine and wall-board plant.	Fremont.
Iron ore: Pitkin Iron Corp.....	105 W. Adams St. Chicago, Ill. 60603	Open pit mine.....	Pitkin.
Lead:			
Emperius Mining Co.....	Creede, Colo. 81130.....	See Zinc.....	Mineral.
Homestake Mining Co.....	Box 98 Creede, Colo. 81130	See Silver.....	Do.
Idarado Mining Co.....	Ouray, Colo. 81427	See Zinc.....	Ouray and San Miguel.
	Telluride, Colo. 81435	do.....	Eagle.
The New Jersey Zinc Co.....	Gilman, Colo. 81634.....	do.....	Dolores.
Rico Argentine Mining Co.....	Box 158 Rico, Colo. 81332	do.....	
Standard Metals Corp.....	Box 2471 Silverton, Colo. 81433	do.....	San Juan.
Lime:			
The Great Western Sugar Co....	Box 5308 Denver, Colo. 80217	Pot-kiln plant.....	Adams.
		2 pot-kiln plants.....	Boulder.
		do.....	Larimer.
		Pot-kiln plant.....	Logan.
		Shaft-kiln plant.....	Morgan.
		Pot-kiln plant.....	Sedgwick.
		2 pot-kiln plants.....	Weld.
CF&I Steel Corp.....	Box 316 Pueblo, Colo. 81002	Natural-frequency-vibrating kiln plant.	Pueblo.
Molybdenum:			
American Metal Climax, Inc.....	Mines Park Golden, Colo. 80401	Underground mine and mill.	Clear Creek.
Climax Molybdenum Co.....	Climax, Colo. 80429.....	Underground mine, mill, and byproducts plant.	Lake.
Natural gas and petroleum:			
Bright & Schiff.....	107 Mercantile Continental Bldg. Dallas, Tex. 75201	Crude oil and gas wells: Saber field.	Logan.

Table 21.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Natural gas and petroleum—Continued			
Champlin Petroleum Co.....	Box 9365 Fort Worth, Tex. 76107	Crude oil and gas wells: Boxer field.	Morgan.
		Crude oil and gas wells: Bison, Ramp, and Westfork fields.	Washington.
Chevron Oil Co., Western Division.	Box 599, 1700 Broadway Denver, Colo. 80201	Crude oil and gas wells: Black Hollow and Pierce fields.	Weld.
		Crude oil and gas wells, and gas processing plant: Rangely field.	Rio Blanco.
Clinton Oil Co.....	6810 West Highway 54 Wichita, Kans. 67209	Crude oil and gas wells: Belle field.	Washington.
Continental Oil Co.....	Box 2197 Houston, Tex. 77001	Crude oil and gas wells: McCallum field.	Jackson.
		Crude oil and gas wells: Big Beaver, Bobcat, Little Beaver, and Plum Bush Creek fields.	Washington.
		Refinery.....	Adams.
Don M. Rounds Co.....	925 Petroleum Club Bldg. Denver, Colo. 80202	Crude oil wells: Cimar- ron field.	Washington.
El Paso Natural Gas Co.....	Box 1492 El Paso, Tex. 79999	Gas processing plant.....	La Plata.
International Nuclear Corp.....	308 Lincoln Tower Bldg. Denver, Colo. 80203	Crude oil wells: Brandon field.	Kiowa.
Monsanto Co., Hydrocarbons & Polymers Division.	800 North Lindbergh Blvd. St. Louis, Mo. 63116	Crude oil wells: Battle- ship field.	Jackson.
		Crude oil and gas wells: Marble Wash field.	Montezuma.
		Crude oil and gas wells: Little East Beaver and Nugget fields.	Washington.
Pan American Petroleum Corp....	Box 591 Tulsa, Okla. 74102	Crude oil and gas wells: Black Jack field.	Arapahoe.
		Crude oil and gas wells: Cache field.	Montezuma.
		Crude oil and gas wells: Big Beaver field.	Washington.
King Resources Co.....	1616 Glenarm St. Denver, Colo. 80202	Refinery.....	Adams.
Texaco Inc.....	Box 2100 Denver, Colo. 80201	Crude oil and gas wells: Danforth Hills and Maudlin Gulch fields.	Moffat.
		Crude oil and gas wells and gas processing plant: Wilson Creek field.	Rio Blanco.
Union Oil Co. of California, Northern Division.	1860 Lincoln St. Denver, Colo. 80203	Crude oil and gas wells and gas processing plant: Adena field.	Morgan.
Union Texas Petroleum.....	3000 Richmond Ave. Houston, Tex. 77001	Crude oil wells: Blade, Lindon, Ranger, Ring, and Rush Willadel fields.	Washington.
Peat:			
Alpen Meadows, Inc.....	Box 1074 Colorado Springs, Colo. 80901	Bog.....	Teller.
McCoy & Jensen, Inc.....	Rte 1, Box 252 Morrison, Colo. 80465	Bog.....	Park.
Clarence C. Reiff.....	109 East Eagle Ave. Kremmling, Colo. 80459	Bog.....	Lake.
Universal Peat Co.....	5926 West Arizona Ave. Denver, Colo. 80226	Bog.....	Park.
Perlite: Persolite Products, Inc.....	Box 105 Florence, Colo. 81226	Open pit mine.....	Custer.
		Expanding plant.....	Fremont.
Pumice:			
Colorado Aggregate Co., Inc.....	Box 106 Mesita, Colo. 81142	Open pit mine and plant..	Costilla.
Dotsero Block Co., Inc.....	Box 933 Glenwood Springs, Colo. 81601	...do.....	Eagle.
McCoy Aggregates Co.....	Box 575 McCoy, Colo. 80463	...do.....	Routt.
Pyrites: Climax Molybdenum Co.....	Climax, Colo. 80429	See Molybdenum.....	Lake.
Rare-earths, monazite: Climax Molybdenum Co.	...do.....	...do.....	Do.

Table 21.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Sand and gravel (commercial):</b>			
Asphalt Paving Co.....	14802 West 44th Ave. Golden, Colo. 80401	Pit and plant..... .....do.....	Douglas. Garfield. Jefferson.
The Brannan Sand & Gravel Co	4800 Brighton Blvd. Denver, Colo. 80216	Pit and plant..... Pit and 4 plants..... Pit and plant.....	Lincoln. Adams. Arapahoe.
Broderick & Gibbons, Inc.....	Box 2167 Colorado Springs, Colo. 80901	4 pits and plant.....	Jefferson. El Paso.
Cooley Gravel Co.....	Box 313 Pueblo, Colo. 81002	7 pits and plant.....	Pueblo.
Flatiron Sand & Gravel Co.....	5631 Tennyson St. Arvada, Colo. 80002	Pit and plant.....	Adams.
Pre-Mix Sand and Gravel Co.....	Box 229 Boulder, Colo. 80302	2 pits and plants..... Pit and plant.....	Arapahoe. Boulder.
	7620 Madison St. Denver, Colo. 80204	.....do..... .....do.....	Adams. Douglas.
<b>Silver:</b>			
American Smelting and Refining Co. (McFarland & Hullinger, lessee.)	120 Broadway New York, N.Y. 10005	See Zinc.....	Gunnison.
Emperius Mining Co.....	Creede, Colo. 81130	.....do.....	Mineral.
Homestake Mining Co.....	Box 98 Creede, Colo. 81130	Underground mine and mill.	Do.
Idarado Mining Co.....	Ouray, Colo. 81427	See Zinc.....	Ouray and San Miguel.
The New Jersey Zinc Co.....	Telluride, Colo. 81435	.....do.....	Eagle.
Rico Argentine Mining Co.....	Box 158 Rico, Colo. 81332	.....do.....	Dolores.
Silver Bell Industries, Inc.....	Box 247 Silverton, Colo. 81433	Underground mine and mill.	Do.
Standard Metals Corp.....	Box 749 Salida, Colo. 81201	See Zinc.....	San Juan.
U.S. Silver Mining Co.....	Salida, Colo. 81201	Underground mine and mill.	Saguache.
<b>Stone:</b>			
Castle Concrete Co.....	Box 2379 Colorado Springs, Colo. 80901	2 quarries and plants.....	El Paso.
CF&I Steel Corp.....	Box 489 Salida, Colo. 81201	Quarry and plant.....	Chaffee.
	Box 847 Canon City, Colo. 81212	.....do.....	Fremont.
Dolores County Highway Department.	Dove Creek, Colo. 81324	.....do.....	Dolores.
Frank H. Norberg Co.....	418 Guaranty Bank Bldg. Denver, Colo. 80202	.....do..... 2 quarries and plants.....	Garfield. Larimer.
Ideal Basic Industries, Inc.....	Box 231 Florence, Colo. 81226	Quarry and plant.....	Fremont.
	Box 579 Fort Collins, Colo. 80521	.....do.....	Larimer.
Tin: Climax Molybdenum Co.....	Fort Collins, Colo. 80521	See Molybdenum.....	Lake.
Tungsten: Climax Molybdenum Co.....	Climax, Colo. 80429	.....do.....	Do.
<b>Uranium:</b>			
Climax Uranium Co.....	Box 1629 Grand Junction Colo. 81501	Underground mines and mill.	Mesa, Montrose, and San Miguel.
Cotter Corp.....	Box 468 Golden, Colo. 80401	.....do.....	Fremont and Jefferson.
Union Carbide Corp, Mining and Metals Div.	Box 43, Rt 1 Rifle, Colo. 81650	.....do.....	Garfield, Montrose, and San Miguel.
<b>Vanadium:</b>			
Climax Uranium Co.....	Box 1629 Grand Junction, Colo. 81501	See Uranium.....	Mesa, Montrose, and San Miguel.
Union Carbide Corp, Mining and Metals Div.	Box 43, Rt 1 Rifle, Colo. 81650	.....do.....	Garfield, Montrose, and San Miguel.
<b>Zinc:</b>			
American Smelting and Refining Co. (McFarland & Hullinger, lessee.)	120 Broadway New York, N.Y. 10005	Underground mine and mill.	Gunnison.
Emperius Mining Co.....	Creede, Colo. 81130	.....do.....	Mineral.

Table 21.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Zinc—Continued</b>			
Homestake Mining Co.-----	Box 98 Creede, Colo. 81130	See Silver-----	Mineral.
Idarado Mining Co.-----	Ouray, Colo. 81427-----	Underground mine and mill.	Ouray.
The New Jersey Zinc Co.-----	Telluride, Colo. 81426----- Gilman, Colo. 81634-----	do-----	San Miguel. Eagle.
Rico Argentine Mining Co.-----	Box 158 Rico, Colo. 81332	do-----	Dolores.
Standard Metals Corp.-----	Box 247 Silverton, Colo. 81433	3 underground mines and mill.	San Juan.

# The Mineral Industry of Connecticut

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

By Robert A. Clifton <sup>1</sup>

Mineral production in Connecticut increased 2 percent in value in 1970, from \$27.8 million to \$28.4 million. Greater production of stone and higher prices of most products accounted for the increase.

Sand and gravel and stone continued to be the principal minerals produced in the State. Their output accounted for 92 percent of the value of all minerals produced. The combined production of these commodities was down about 8 percent. There was an apparent decrease in the building

of roads, bridges, buildings, dams, and recreation facilities by the State Department of Highways and the Department of Public Works.

During 1970, the Geological and Natural History Survey published Report No. 25, a map of the Torrington quadrangle. The U.S. Geological Survey published one surficial map, GQ-791, Marlborough quadrangle.

<sup>1</sup> Chemist, Division of Nonmetallic Minerals.

Table 1.—Mineral production in Connecticut <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays.....thousand short tons..	197	\$341	171	\$386
Gem stones.....	NA	8	NA	8
Sand and gravel.....thousand short tons..	8,857	10,359	6,765	9,202
Stone.....do.....	7,562	15,325	8,338	16,915
Value of items that cannot be disclosed:				
Feldspar, lime, and mica (scrap).....	XX	1,734	XX	1,872
Total.....	XX	27,767	XX	28,383
Total 1967 constant dollars.....	XX	26,220	XX	25,687 <sup>p</sup>

<sup>p</sup> Preliminary. 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.—Value of mineral production in Connecticut, by counties

(Thousand dollars)

County	1969	1970	Minerals produced in 1970 in order of value
Fairfield.....	\$1,164	\$936	Sand and gravel.
Hartford.....	8,978	8,801	Stone, sand and gravel, clays.
Litchfield.....	3,195	3,486	Stone, sand and gravel, lime.
Middlesex.....	1,801	1,747	Feldspar, sand and gravel, clays, mica, stone.
New Haven.....	9,167	9,679	Stone, sand and gravel, clays.
New London.....	1,264	1,310	Stone, sand and gravel.
Tolland.....	W	W	Sand and gravel.
Windham.....	W	W	Stone, sand and gravel.
Undistributed <sup>1</sup> .....	2,200	2,424	
Total.....	<sup>2</sup> 27,767	28,383	

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

<sup>1</sup> Includes sand and gravel and gem stones that cannot be assigned to specific counties, and values indicated by symbol W.

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



Table 3.—Indicators of Connecticut business activity

	1969	1970 <sup>p</sup>	Change, percent
<b>Employment and labor force, annual average: <sup>1</sup></b>			
Total labor force.....	1,359.4	1,391.8	+2.4
Manufacturing.....	475.0	448.1	-5.7
Durable goods.....	353.0	329.0	-6.8
Nondurable goods.....	122.0	118.2	-3.1
Nonagricultural.....	1,193.1	1,194.8	+1
Unemployment.....	3.9	5.6	+43.6
<b>Personal income: <sup>2</sup></b>			
Total.....	\$13,784	\$14,647	+6.2
Per capita.....	\$4,595	\$4,807	+4.6
<b>Construction activity:</b>			
New building permits <sup>3</sup> .....	1,978	1,696	-14.3
Cement shipments to and within Connecticut.....	4,425	4,435	+2
<b>Business activity:</b>			
New incorporations <sup>3</sup> .....	328	297	-9.5
Electric power sales <sup>3</sup> .....	447	442	-1.1
Mineral production value.....	\$27,767	\$28,383	+2.2

<sup>p</sup> Preliminary.<sup>1</sup> New England Economic Indicators.<sup>2</sup> Employment and Earnings, U.S. Department of Labor-Bureau of Labor Statistics, v. 17, No. 11, May 1971.<sup>3</sup> Connecticut Economic Indicators.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Nonmetal.....	86	259	22	182	-----	4	21.99	896
Sand and gravel.....	505	221	112	912	-----	19	20.84	230
Stone.....	399	266	106	894	-----	17	19.02	616
Total <sup>1</sup> .....	990	242	240	1,987	-----	40	20.13	488
<b>1970: <sup>p</sup></b>								
Nonmetal.....	75	250	19	145	1	6	48.31	45,136
Sand and gravel.....	450	216	97	783	-----	12	15.32	232
Stone.....	350	260	91	746	-----	35	46.89	1,588
Total <sup>1</sup> .....	875	236	207	1,675	1	53	32.24	4,721

<sup>p</sup> Preliminary.<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Cement.**—There are no cement manufacturing plants in Connecticut. Cement shipment origin data are unavailable, but the preliminary destination data suggest little change from the 1969 consumption of 4,425,000 barrels.

**Clays.**—Common clay production decreased 13 percent in volume but increased 13 percent in value compared with 1969. Clay mines operated by four companies were in Hartford, Middlesex, and New Haven Counties. Most of the clay was consumed in the manufacture of building brick; small quantities were utilized by the ceramic and specialty clay products industry. The State Division of Building Con-

struction reported that there was a decrease in the commercial use of brick and in concrete construction in 1969.

**Feldspar.**—The production of crude feldspar from one mine in Middlesex County was slightly greater than that of 1969. The recovered product was concentrated by flotation. The concentrate was used primarily by manufacturers of glass and ceramic products in New Jersey, Pennsylvania, and Rhode Island. Small quantities were exported.

**Gem Stones.**—Mineralogical societies, dealers, and individuals collected specimens from dumps, quarries, and pegmatite deposits in the State. The value of the collectors' items was about \$8,000, the same as it has been for the past several years.

**Gypsum.**—National Gypsum Co. imported crude gypsum for processing into finished building plaster products and board and sheathing materials at its New Haven plant.

**Lime.**—In 1970, output and value of quicklime and hydrated lime increased 19 percent and 23 percent, respectively. Most of the quicklime was used to treat sewage, and for use in paper manufacture. The hydrated lime was sold primarily to masonry contractors; some was used as agricultural lime. Pfizer, Inc., was the only lime producer, with a plant at Canaan.

**Mica.**—Scrap mica was produced as a byproduct from processing crude feldspar by the flotation process at a plant in Middlesex County. Mica production was the same as that of 1969, and was sold to processors of roofing materials.

**Sand and Gravel.**—The quantity and value of commercial sand and gravel output decreased 15 percent and 9 percent, respectively, in 1970. Government and contractor operations declined even further and retained only 14 percent of the volume and 31 percent of the value of 1969. The total value was just 89 percent of that in 1969, in spite of a rise in the unit selling price from \$1.17 per ton to \$1.36.

Of the 6.8 million tons produced, commercial operators sold or used 98 percent and Government-and-contractor operations used 2 percent. The 6.8 million tons produced were used primarily as aggregate in concrete for structural and paving uses. Other uses were fill, railroad ballast and as molding sand.

Sand and gravel were produced in each of the State's eight counties; the leaders were Hartford and New Haven Counties.

**Table 5.—Connecticut: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	2,001	\$2,459	1,579	\$2,185
Fill.....	313	180	329	205
Paving.....	1,663	2,426	1,653	2,450
Other uses <sup>1</sup> .....	290	313	477	562
Total <sup>2</sup> .....	4,266	5,378	4,038	5,402
<b>Gravel:</b>				
Building.....	1,438	2,403	917	1,552
Fill.....	790	383	389	277
Paving.....	1,003	1,354	832	1,122
Other uses <sup>3</sup> .....	296	422	439	720
Total <sup>2</sup> .....	3,526	4,562	2,577	3,671
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Fill.....	15	10	-----	-----
Paving.....	153	62	27	22
Other uses.....	25	16	32	23
Total <sup>2</sup> .....	193	88	59	45
<b>Gravel:</b>				
Fill.....	44	33	-----	-----
Paving.....	827	299	41	48
Other uses.....	-----	-----	51	37
Total <sup>2</sup> .....	871	332	91	85
<b>Total sand and gravel <sup>2</sup>.....</b>	<b>8,857</b>	<b>10,359</b>	<b>6,765</b>	<b>9,202</b>

<sup>1</sup> Includes molding and other sand.

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

<sup>3</sup> Includes railroad ballast, miscellaneous, and other gravel.

**Stone.**—Production of stone increased 10 percent in both volume and value compared with 1969.

Crushed basalt, used chiefly as construction aggregate and railroad ballast, was the major product in both volume and value. It was produced in Hartford, Litchfield, and New Haven Counties.

Crushed limestone and dolomite were produced in Litchfield County only, by four operators. It was marketed for metallurgical flux, soil neutralizer, lime manufacturing, and filler.

Crushed sandstone produced in Middlesex and New London Counties was used in manufacturing fine aggregate and terrazzo. Quartz was also produced for use in glass, asphalt filler, and abrasives. Dimension sandstone was produced in Windham County and sold primarily for use as rubble and in rough construction work. The dressed stone was marketed as building stone veneer.

## METALS

Pfizer, Inc., at Canaan, Litchfield County, produced metallic barium and calcium and an iron-copper powder registered under the trade name Prefiltron. This firm is the only known U.S. producer of calcium metal. The metal is used to remove impurities during steelmaking, and in the production of aluminum, magnesium, uranium oxide, and thorium. Barium metal is used by the electronics, metals, and chemical industries. Prefiltron is used in the manufacture of electrodes. Although the production of metallic magnesium has stopped, there was some sold during 1970.

The State has six steel mills that produced bars, rods, coils, strip, and wire rope. Approximately 75 foundries produced ferrous and nonferrous castings, and 11 foundries produced ferrous and nonferrous forgings and ingots.

About 25 scrap metal dealers collected and processed ferrous metal for export, and for sale to area foundries.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Clays:</b>			
The Michael Kane Brick Co. ....	654 Newfield St. Middletown, Conn. 06475	Pit. ....	Middlesex.
The Keller Pottery Co. ....	North Wales, Pa. 19454	Pit. ....	Hartford.
The Kelsey Ferguson Brick Co. ....	East Windsor Hill, Conn. 06028	Pit. ....	Do.
Plasticrete Corp., Stiles Brick Div. ....	P.O. Box 248 North Haven, Conn. 06473	Pit. ....	New Haven.
<b>Feldspar:</b>			
The Feldspar Corp. <sup>1</sup> .....	Spruce Pine, N.C. 28777	Pit. ....	Middlesex.
<b>Lime:</b>			
Pfizer, Inc. ....	Daisy Hill Road Canaan, Conn. 06018	Plant. ....	Litchfield.
<b>Gypsum (calcined):</b>			
National Gypsum Company. ....	325 Delaware Ave. Buffalo, N.Y. 14202	..do....	New Haven.
<b>Sand and gravel:</b>			
The Balf Co. <sup>2</sup> .....	190 Huyshope Ave. Hartford, Conn. 06106	Pit. ....	Hartford.
Beard Sand & Gravel Co., Inc. ....	127 Boston Post Road Milford, Conn. 06460	Pit. ....	New Haven.
C. W. Blakeslee & Sons, Inc. ....	58 Waverly St. New Haven, Conn. 06511	Pit. ....	Middlesex.
The D. J. Carten Sand & Gravel Co. ....	Naugatuck Ave. S. P.O. Box 155 Devon, Conn. 06460	Pit. ....	New Haven.
Chapman Sand & Gravel. ....	Box 442 Melrose, Conn. 06049	Pit. ....	Hartford.
Connecticut Sand & Stone Corp. ....	7 West Main St. Plainsville, Conn. 06062	Pit. ....	Hartford and Litchfield.
John J. Doyle Sand & Gravel Co., Inc. .	P.O. Box 732 New London, Conn. 06321	Pit. ....	New London.
Hamden Sand & Gravel Co. ....	P.O. Box 4312 Hamden, Conn. 06514	Pit. ....	New Haven.
John Lomazzo & Sons Corp. ....	Route 57, Weston Rd. Weston, Conn. 06388	Pit. ....	Fairfield.
Meriden-Wallingford Sand & Stone Co., Inc. ....	No. Colony Rd. Wallingford, Conn. 06492	Pit. ....	New Haven.
The New Haven Trap Rock Co., Div. of Ashland Oil, Inc. ....	265 Church St. New Haven, Conn. 06510	Pit. ....	Windham.
Newington Construction Co. ....	187 Richard St. Newington, Conn. 06111	Pit. ....	Hartford.

See footnotes at end of table.

Table 6.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Oneglia & Gervasini Building Materials, Inc. <sup>2</sup>	P.O. Box 907 Torrington, Conn. 06790	Pit.....	Litchfield.
Roncari Industries, Inc.....	1776 South Main St. East Granby, Conn. 06026	Pit.....	Hartford.
Sega Sand & Gravel, Inc.....	271 Danbury Rd. New Milford, Conn. 06776	Pit.....	Litchfield.
Waterbury Sand & Gravel Co.....	551 So. Leonard St. Waterbury, Conn. 06708	Pit.....	New Haven.
Stone:			
Basalt, crushed and broken:			
The Balf Co.....	190 Huyshope Ave. Hartford, Conn. 06106	Quarry..	Hartford.
C. W. Blakeslee & Sons, Inc.....	58 Waverly St. New Haven, Conn. 06510	..do....	New Haven.
A. N. Farnham, Inc.....	90 Pine Rock Ave. New Haven, Conn. 06514	..do....	Do.
The New Haven Trap Rock Co., Div. of Ashland Oil, Inc.	265 Church St. New Haven, Conn. 06510	..do....	Do.
Oneglia & Gervasini Building Materials, Inc.	P.O. Box 907 Torrington, Conn. 06790	..do....	Litchfield.
Roncari Industries, Inc.....	1776 South St. E. Granby, Conn. 06026	..do....	Hartford.
Angelo Tomasso, Inc.....	P.O. Box 76 New Britain, Conn. 06050	..do....	Do.
Tomasso of Farmington, Inc.....	P.O. Box 76 New Britain, Conn. 06050	..do....	Do.
The York Hill Trap Rock Quarry Co.	Westfield Rd. Meriden, Conn. 06450	..do....	New Haven.
Granite, dimension:			
Castellucci & Sons, Inc.....	West River St. Providence, R.I. 02904	..do....	Do.
R. B. Merriott & Sons.....	Oneco, Conn. 06373.....	..do....	Windham.
Tower Hill Granite Co.....	305 Manchester Rd. E. Glastonbury, Conn. 06025	..do....	Hartford.
Granite, crushed and broken:			
The New Haven Trap Rock Co....	265 Church St. New Haven, Conn. 06510	..do....	Windham.
Limestone and dolomite, crushed:			
Allyndale Corp.....	East Canaan, Conn. 06024.....	..do....	Litchfield.
The Conklin Limestone Co., Inc....	Canaan, Conn. 06018.....	..do....	Do.
Pfizer, Inc.....	Daisy Hill Road Canaan, Conn. 06018	..do....	Do.
United States Gypsum Co. (Falls Village).	101 So. Wacker Dr. Chicago, Ill. 60606	..do....	Do.
Quartzite, crushed:			
Ottawa Silica Co., Connecticut Silica Div.	P.O. Box 577 Ottawa, Ill. 61350	..do....	New London.
Sandstone and quartzite, dimension:			
Helene Stone Corp.....	Danielson, Conn. 06239.....	..do....	Windham.
Hughes Stone Co.....	R.D. Box 150 Dayville, Conn. 06241	..do....	Do.
Robert V. Olson.....	P.O. Box 684 Danielson, Conn. 06239	..do....	Do.

<sup>1</sup> Also quartzite and scrap mica.<sup>2</sup> Two operations.



# The Mineral Industry of Delaware

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

By A. F. Grube <sup>1</sup>

The value of mineral production in Delaware showed a 23-percent decrease in 1970, as compared with 1969. Mineral production value decreased from \$2,086,000 in 1969 to \$1,615,000 in 1970. The entire decline was due to decreased output of sand and gravel. In 1969, 2,257,000 short tons of sand and gravel were produced valued at

\$2,074,000, compared with 1970 production of 1,565,000 short tons, valued at \$1,603,000. The 1970 production value of clays and gem stones remained the same as in 1969.

<sup>1</sup> Industry economist, Division Nonmetallic Minerals.

Table 1.—Mineral production in Delaware <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays..... thousand short tons..	11	\$11	11	\$11
Gem stones.....	NA	1	NA	1
Sand and gravel..... thousand short tons..	2,257	2,074	1,565	1,603
Total.....	XX	2,086	XX	1,615
Total 1967 constant dollars.....	XX	2,031	XX	<sup>p</sup> 1,410

<sup>p</sup> Preliminary. 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.—Indicators of Delaware business activity

	1969	1970	Change, percent
Employment and labor force, annual average: <sup>1</sup>			
Civilian work force..... thousands..	241.6	250.8	+3.8
Unemployment..... percent of work force..	3.1	4.0	+29.0
Manufacturing..... thousands..	73.1	71.6	-2.1
Durable goods..... do.....	18.0	18.0	-----
Nondurable goods..... do.....	55.1	53.6	-2.7
Nonmanufacturing..... do.....	134.8	141.2	+4.7
Personal income: <sup>2</sup>			
Total..... millions..	\$2,218	<sup>p</sup> \$2,332	+5.1
Per capita.....	\$4,107	<sup>p</sup> \$4,233	+3.1
Construction activity:			
Cement shipments to Delaware..... thousand 376-pound barrels..	<sup>r</sup> 939	<sup>p</sup> 859	-8.5
Mineral production value <sup>3</sup> ..... thousands..	\$2,086	\$1,615	-22.6

<sup>p</sup> Preliminary. <sup>r</sup> Revised.

<sup>1</sup> Delaware Department of Labor, Office of Planning Research and Evaluation.

<sup>2</sup> Employment and Earnings, V. 17, No. 11, May 1971; U.S. Department of Labor-Bureau of Labor Statistics.

<sup>3</sup> Excludes value of sulfur production.

Table 3.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1969:								
Nonmetal.....	2	313	1	5				
Sand and gravel.....	44	233	10	87		1	11.53	427
Total.....	46	236	11	92		1	10.90	403
1970: <sup>p</sup>								
Nonmetal.....	( <sup>1</sup> )	313	1	5				
Sand and gravel.....	45	202	9	81				
Total <sup>2</sup> .....	50	207	10	86				

<sup>p</sup> Preliminary.<sup>1</sup> Less than 3.<sup>2</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

## NONMETALS

Clays.—As in past years, Delaware Brick Co. was the only producer of clay in the State. Total production of common clay was 11,000 short tons. The clay was used in the manufacture of common red brick.

The agreement between the U.S. Bureau of Mines and the States of Delaware for the investigation of mineral problems of mutual interest was continued. Clays and greensands (glaucanite) were sampled and evaluated in 1970. The Delaware Geological Survey published the result of these

and other tests in a publication entitled, "Report of Investigations No. 14, The Clay Resources of Delaware, 1970."<sup>2</sup>

Gem Stones.—Small quantities of gem stones and mineral specimens were collected.

Sand and Gravel.—Delaware's 1970 production of sand amounted to 1,028,000 short tons, valued at \$1,070,000; gravel production amounted to 537,000 short tons valued at \$533,000. Total production de-

<sup>2</sup> Copies of this report are available only from the State of Delaware Geological Survey Department.

Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Clay:			
Delaware Brick Co.....	River Rd. New Castle, Del. 19720	Pit.....	New Castle.
Gypsum, calcined:			
Georgia-Pacific Corp.....	P.O. Box 311 Portland, Ore. 97207	Plant.....	Do.
Sand and Gravel:			
Atkins Brothers.....	Route 113 Millsboro, Del. 19966	Pit.....	Sussex.
Barber Sand and Gravel.....	R.F.D. 1 Harrington, Del. 19952	Pit.....	Kent.
Clough & Caulk Sand & Gravel...	Route 1, Box 129 Wyoming, Del. 19934	Pit.....	Do.
Delaware Sand & Gravel.....	R.D. 2, Box 286 New Castle, Del. 19720	Pit.....	New Castle.
George Nashold, Inc.....	Box 286 Frederica, Del. 19946	Pit.....	Kent.
Material Transit, Inc.....	Box 210 924 South Herald St. Wilmington, Del. 19800	Pit.....	New Castle.
Parkway Gravel, Inc.....	4048 New Castle Ave. New Castle, Del. 19720	Pit.....	Do.
Petrillo Brothers, Inc.....	Box 426 Wilmington, Del. 19809	Pit.....	Do.
St. Jones River Gravel Co.....	Box 426 Dover, Del. 19901	Pit.....	Do.
Swain Construction Co.....	Lincoln, Del. 19960	Pit.....	Sussex.
Whittington's Sand & Gravel Co..	U.S. Route 40 Bear, Del. 19701	Pit.....	New Castle.
Woodlawn Gravel Co.....	Box 2561 Wilmington, Del. 19805	Pit.....	Do.

creased 31 percent. Leading producers were Woodlawn Gravel Co. and Parkway Gravel, Inc.

**Sulfur.**—Delaware is the country's third largest producer of recovered sulfur. Owing

to the limited number of companies producing sulfur, quantity and value data may not be revealed. The sulfur results from processing crude petroleum into refined products.





# The Mineral Industry of Florida

The chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Florida Bureau of Geology.

By William F. Stowasser <sup>1</sup>

The value of mineral production in Florida totaled \$300 million in 1970, an increase of \$5 million or 2 percent more than 1969. With the exception of a significant increase in crude petroleum production, other mineral production showed only small changes during 1970.

For the 77th consecutive year, Florida led all other States in phosphate rock production. Florida ranked first in the production of fuller's earth and zircon, second in the production of titanium concentrates, third in peat production, and third in kyanite output. It was the only State that produced staurolite.

Florida continued as the principal supplier of phosphate rock to domestic markets, contributing 77 percent of the total. It was second only to Morocco in exporting phosphate rock to world markets. In

1970, exports from Florida increased from 1969 levels and accounted for 95 percent of the total phosphate rock exported from the United States. Exports from Florida moved through the ports of Tampa, Boca Grande, and Jacksonville with shipments to 34 countries. Over 2 million short tons were shipped to Japan, and over 1 million short tons were shipped to Canada, Italy, and West Germany, respectively.

The Seaboard Coastline Railroad closed both its Port Tampa and Seddon Island phosphate elevators during the year. The Rockport terminal was completed and went into operation late in the year.<sup>2</sup>

<sup>1</sup> Physical scientist, Division of Nonmetallic Minerals.

<sup>2</sup> Anslow, R. J., and R. Walker. Unit Trains and Modern Sea Terminals Speed Phosphate Exports. *Min. Eng.*, v. 22, No. 6, June 1970, pp. 75-76.

Table 1.—Mineral production in Florida <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays..... thousand short tons	907	\$13,627	872	\$12,661
Lime..... do	182	2,712	167	2,810
Natural gas..... million cubic feet	50	8	-----	-----
Peat..... thousand short tons	55	359	46	304
Petroleum (crude)..... thousand 42-gallon barrels	1,731	W	2,999	W
Sand and gravel..... thousand short tons	14,409	19,988	12,482	12,254
Stone <sup>2</sup> ..... do	42,332	56,611	43,089	61,302
Value of items that cannot be disclosed:				
Cement, kyanite concentrates, magnesium compounds, natural gas liquids, phosphate rock, staurolite, stone (dimension), titanium concentrates, zirconium concentrates, and values indicated by symbol W.....	XX	208,072	XX	210,711
Total.....	XX	295,377	XX	300,042
Total 1967 constant dollars.....	XX	278,925	XX	p 271,538

<sup>p</sup> Preliminary. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

<sup>2</sup> Excludes dimension limestone; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Florida, by counties <sup>1</sup>

County	1969	1970	Minerals produced in 1970 in order of value
Alachua	\$1,299	\$1,335	Limestone.
Bay	W	W	Sand and gravel.
Brevard	898	W	Sand and gravel, oystershell.
Broward	11,187	11,930	Limestone, sand and gravel.
Calhoun	4	4	Sand and gravel.
Charlotte	W	W	Limestone, sand and gravel.
Citrus	1,673	1,941	Limestone, miscellaneous clay, phosphate rock.
Clay	W	W	Ilmenite, zircon, staurolite, sand and gravel, miscellaneous clay, kyanite.
Collier	3,470	W	Petroleum, limestone.
Dade	33,953	35,184	Cement, limestone, sand and gravel.
Duval	W	W	Oystershell.
Escambia	583	W	Sand and gravel, miscellaneous clay.
Franklin	W	W	Sand and gravel.
Gadsden	W	W	Fuller's earth, sand and gravel, miscellaneous clay.
Gilchrist	W	W	Phosphate rock.
Glades	W	W	Sand and gravel.
Gulf	W	W	Magnesium compounds, lime.
Hamilton	W	W	Phosphate rock.
Hendry	W	W	Petroleum, sand and gravel.
Hernando	W	W	Limestone, lime.
Hillsborough	22,555	20,041	Cement, phosphate rock, sand and gravel, oyster-shell, peat.
Jackson	W	W	Limestone, sand and gravel.
Lake	1,459	1,437	Sand and gravel.
Lee	W	W	Limestone, petroleum, oystershell.
Leon	W	W	Sand and gravel.
Levy	1,046	W	Limestone.
Manatee	W	W	Do.
Marion	1,761	2,562	Limestone, fuller's earth, sand and gravel, phosphate rock.
Monroe	1,223	615	Limestone.
Okaloosa	W	W	Sand and gravel.
Orange	W	W	Sand and gravel, peat.
Palm Beach	1,113	W	Oystershell, limestone, sand and gravel.
Pinellas	W	W	Oystershell, sand and gravel.
Polk	137,696	140,598	Phosphate rock, sand and gravel, peat.
Putnam	1,156	W	Sand and gravel, kaolin, peat.
Santa Rosa	-----	W	Petroleum.
St. Lucie	W	2,444	Limestone, sand and gravel, peat.
Sumter	3,741	W	Limestone, lime, peat.
Suwannee	W	W	Limestone.
Taylor	W	W	Do.
Volusia	W	W	Sand and gravel.
Walton	W	W	Oystershell, sand and gravel.
Undistributed <sup>2</sup>	70,560	81,953	
Total <sup>3</sup>	295,377	300,042	

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

<sup>1</sup> The following counties are not listed because no production was reported: Baker, Bradford, Columbia, DeSoto, Dixie, Flagler, Hardee, Highlands, Holmes, Indian River, Jefferson, Lafayette, Liberty, Madison, Martin, Nassau, Okeechobee, Osceola, Pasco, St. John's, Sarasota, Seminole, Union, Wakulla, and Washington.

<sup>2</sup> Includes value of natural gas (1969), natural gas liquids, and counties indicated by symbol W.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Florida business activity

	1969	1970	Change, percent
Employment and labor force, annual average:			
Total nonagricultural employment..... thousands..	2,069.9	2,155.7	+4.1
Manufacturing..... do.....	328.3	324.2	-1.2
Mining..... do.....	8.1	8.5	+4.9
Contract construction..... do.....	165.5	172.1	+4.0
Other nonagricultural employment <sup>1</sup> ..... do.....	1,568.0	1,650.9	+5.3
Personal income:			
Total..... millions..	\$22,396	\$24,559	+9.7
Per capita..... do.....	\$3,372	\$3,584	+6.3
Construction activity:			
Housing units authorized..... do.....	123,496	110,386	-10.6
Value of nonresidential construction..... millions..	\$650.1	\$618.8	-4.8
Highway construction contract awards..... do.....	\$187.2	\$195.0	+4.2
Farm marketing receipts..... do.....	\$1,343.1	\$1,255.4	-6.5
Mineral production..... do.....	\$295.3	\$300.0	+1.6
Export trade..... do.....	\$971.9	\$1,117.0	+14.9
Import trade..... do.....	\$779.1	\$968.2	+24.3

<sup>1</sup> Includes transportation and public utilities; wholesale and retail trade; finance, insurance, and real estate; services; and government.

<sup>2</sup> Sources: Survey of Current Business, Area Trends in Employment and Unemployment, Roads and Streets, Farm Income Situation, Construction Review, Highlights of U.S. Export and Import Trade, Employment and Earnings, and U.S. Bureau of Mines.

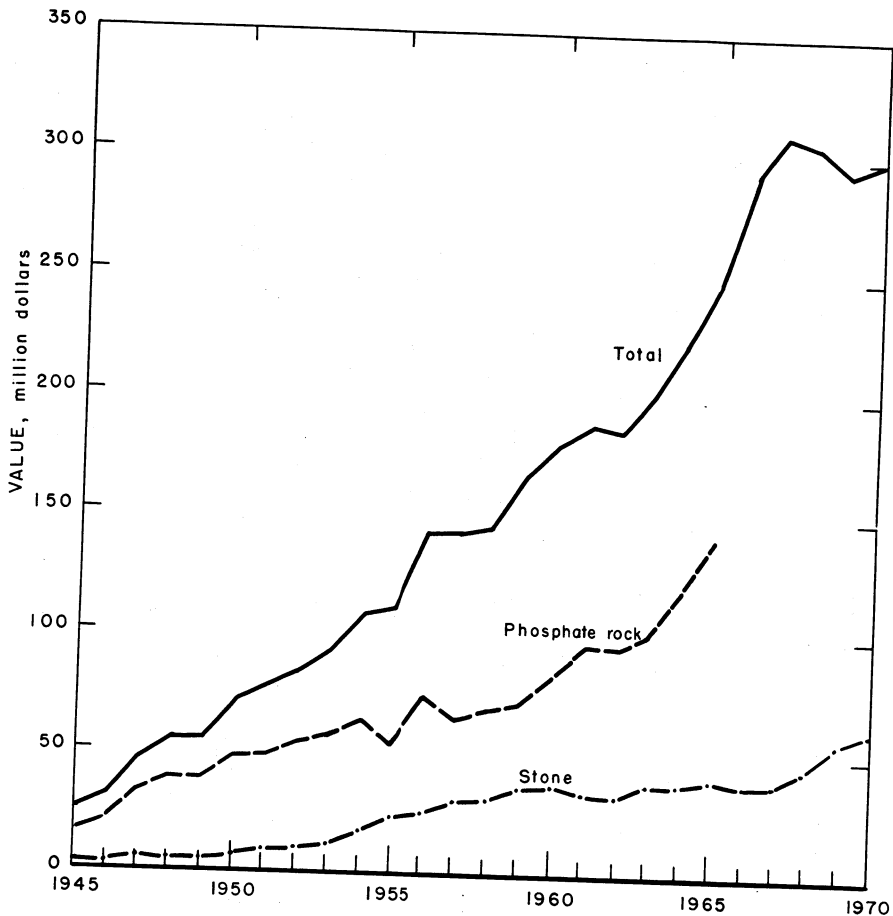


Figure 1.—Value of phosphate rock, stone, and total value of mineral production in Florida.

Plans have been approved by Congress to deepen the Tampa Bay channel to 44 feet to permit maximum loading of ships and barges. To further increase the competitive position of the phosphate industry, the port of Jacksonville is constructing phosphate rock facilities that will place central Florida mines closer to eastern seaboard and European ports.

#### Legislation and Government Programs.

—The Bureau of Mines conducted a study to develop cost estimates on the economic availability of byproduct fluorine in the United States, with emphasis on the availability of the material from Florida. Results of the study were scheduled for publication in late 1971. Three other studies were

conducted at the Bureau of Mines Tuscaloosa Metallurgy Research Laboratory, Tuscaloosa, Ala. The first study investigated methods of beneficiating Florida land-pebble phosphate. The objective was to develop a new process to obtain a marketable product from rejected high-silica phosphate pebble. The purpose of the second study was to determine the surface properties of the constituents of Florida phosphate slimes. The third study examined the admixture of phosphate slimes with flotation tailings to improve slime settling rates.

The Secretary of the Interior placed a 15-month moratorium on the construction of the Cross Florida Barge Canal while a

special Interior Department task force studies the ecological, hydrological, and other environmental problems.

Several bills relating to the minerals industry were introduced in the State legislature in 1970. Two of the bills proposed a severance tax on solid minerals and were shelved. In other State action, at least 100 bills were introduced into the 1970 Florida legislature designed to control pollution. Of this total, 12 of the bills became law.

The Bureau of Geology, Department of Natural Resources, continued studies of mineral resources throughout the State.

During the year the U.S. Bureau of

Mines established a State Liaison office at Tallahassee.

**Employment and Injuries.**—In the mineral industries, 6,340 men worked 16,394,000 man-hours, compared with 6,631 men and 16,563,000 man-hours in 1969, a decrease of 1 percent in man-hours. Employment increased 5 percent at stone quarries and 1 percent at metal mines but decreased 8 percent at other nonmetal mines and 14 percent at peat mines.

There were 210 lost-time injuries in the mineral industries, including four fatalities, compared with 196 injuries and seven fatalities in 1969.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1969:								
Peat.....	45	240	11	85	-----	1	11.82	496
Metal.....	149	354	53	422	-----	61	6.86	1,728
Nonmetal.....	3,713	311	1,153	9,186	2	23	26.35	11,925
Sand and gravel.....	387	264	102	911	1	104	18.12	5,560
Stone.....	2,337	289	676	5,959	4			
Total.....	6,631	301	1,995	16,563	7	189	11.83	3,617
1970: <sup>p</sup>								
Peat.....	38	247	9	73	-----	1	13.66	96
Metal.....	150	358	53	427	-----	40	4.86	901
Nonmetal.....	3,330	316	1,054	8,435	1	39	33.03	440
Sand and gravel.....	470	254	120	1,181	-----	126	20.55	3,382
Stone.....	2,350	302	710	6,278	3			
Total <sup>1</sup> .....	6,340	307	1,947	16,394	4	206	12.81	1,791

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

Nonmetals accounted for 93 percent of the State's total mineral production value in 1970. The principal nonmetals produced in order of their value, were phosphate rock, stone, cement, sand and gravel, and clays.

**Cement.**—Shipments of masonry cement declined 4 percent in quantity, and value decreased less than 1 percent. Shipments of portland cement increased 6 percent, and value increased 5 percent. This reflects the increase in the number of operating kilns in the State.

Types I and II (general-use and moderate-heat), Type III (high-early-strength), and white cements were produced. Most of the shipments were made to consumers within the State, however some shipments

were made to Georgia and other States. Most of the cement was shipped from plants and terminals in bulk with 96 percent transported by truck and 4 percent by rail.

Building material dealers, concrete products manufacturers, and ready-mix concrete manufacturers consumed 87 percent; highway contractors, government agencies, and miscellaneous applications consumed the remainder of the cement produced.

Raw materials used in the manufacture of cement were mined, for the most part, in the State. These included limestone, clay, sand, and staurolite. Small amounts of blast furnace slag, gypsum, and iron ore were obtained from out-of-State sources. Twelve rotary kilns were operated at four plants, which had a total capacity of over

12 million barrels per year. All plants used the wet process. Over 286 million kilowatt-hours of electrical energy were consumed in the manufacture of cement with 94 percent purchased and 6 percent generated.

In January 1970, Maule Industries, Inc., went on stream with its 2.5 million-barrel cement plant at Pensuco near Miami.<sup>3</sup>

An informative article describing Florida Portland Cement Co.'s mining operation was published.<sup>4</sup>

Consumption of cement in Florida was 20,921,000 barrels, ranking third in the Nation, after California and Texas.

**Clays.**—Total clay production decreased 4 percent in quantity, and 7 percent in value from 1969 record levels.

Florida led the Nation for the 13th consecutive year in the production of fuller's earth, although the tonnage produced decreased 6 percent, and the value decreased 8 percent. Three producing companies operated four mines in Gadsden County, and one producer was active in Marion County. The clay was used for fillers, absorbers, insecticides and fungicides, drilling mud, filtering, and other purposes.

Kaolin production remained rather stable, compared with 1969 levels. The quantity increased 2 percent, and the value was unchanged. Kaolin was produced by Edgar Plastic Kaolin Co. in Putnam County and was consumed in the manufacture of whiteware, pottery, and wall tile. The Cyprus Mines Corp. mine in Putnam County remained closed in 1970.

The production of miscellaneous clay consumed in the manufacture of cement, lightweight aggregate, and building brick decreased 3 percent, and its value decreased 1 percent from 1969 levels. Leading producers were General Portland Cement Co. and Florida Solite Co.

**Gypsum.**—Crude imported gypsum was processed into various building products at three plants. Two companies operated plants near Jacksonville, Duval County, and the third operated a plant near Tampa, Hillsborough County. The three plants used nine kettles, one rotary kiln, and one Holoflite unit to calcine the gypsum and four board machines to manufacture gypsum products.

A total of 440,000 tons of calcined gypsum was produced by the three plants, and the estimated value of this product was over \$5 million. The plants have the capa-

bility of producing about 1.5 million tons of calcined products. The crude gypsum was imported from the respective company mines in Nova Scotia, Canada.

**Kyanite.**—Although the quantity of a kyanite-sillimanite mixture recovered from a heavy minerals separation plant represented only a small part of the total national production, the tonnage increased 130 percent, and the value increased 215 percent over 1969 levels. The mixture was marketed to manufacture refractories.

**Lime.**—Quicklime and lime hydrate sold or used totaled 167,000 tons and was valued at \$2.8 million. Compared with 1969 tonnages and values, the quantity decreased about 8 percent, and the value increased 4 percent.

Basic Magnesia, Inc., Port St. Joe, Gulf County, produced quicklime and used it to recover magnesia from sea water. Dixie Lime and Stone Co., Sumterville, and Chemical Lime, Inc., Brooksville, produced quicklime and lime hydrate for paper and pulp industries, food products, construction lime, waste neutralization, water treatment, and other chemical processes. Florida was the major market area; however, a small quantity was shipped into Georgia. Total lime consumed in Florida was 320,000 tons.

**Magnesia.**—The Basic Magnesia, Inc., plant produced both caustic calcined magnesia and refractory magnesia from sea water. The plant's capacity is 60,000 net tons per year, which is consumed in the manufacture of various types of refractories.

Shipments were off about 4 percent in tonnage from 1969 levels, and the value of the shipments declined about 6 percent.

**Perlite.**—Four companies produced 14,390 tons of expanded perlite from ore mined in Colorado and New Mexico. The value of this product was approximately \$855,000. Production increased 49 percent over 1969 levels, and the value increased 26 percent. Operating companies were as follows: W. R. Grace & Co., Dade County; Chemrock Corp., Duval County; Armstrong Cork Co. and Airlite Process Corp., both of Escambia County.

<sup>3</sup> Rock Products. Maule Meets the Challenge in Concrete. V. 73, No. 8, August 1970, pp. 49-57.  
Pensuco Aggregate Plant is Area Leader. V. 73, No. 8, August 1970, pp. 49-57.

Maule Achieves Full Integration with Cement. V. 73, No. 8, August 1970, pp. 49-57.

<sup>4</sup> Levine, Sidney. Florida Portland Cement Digs Limestone From Everglades Marshland. Rock Products, v. 73, No. 5, May 1970, pp. 76-80.

The product was used in concrete aggregate, plaster aggregate, and in formed products, such as pipe and tile.

**Phosphate Rock.**—Marketable production of phosphate rock showed an increase over 1969 levels, reestablishing the upward trend that had been the pattern for many years prior to 1969. Phosphate rock again accounted for the major part of the State's total mineral production value, and, for the 77th consecutive year, Florida led the Nation in the output of this commodity.

Because there is only one producing company in North Carolina, it is necessary to conceal its production data, which are combined with Florida's data. Combined marketable production data from both States was 31.3 million short tons, valued at \$159 million, which represents 81 percent of the total national output. This was a 4-percent increase from the 30-million-ton and a 1-percent decrease from the \$161 million value in 1969. Marketable production sold or used totaled 30.3 million tons valued at \$153.6 million—a 5-percent increase from the 28.8 million tons sold or used and 1-percent decrease in value from 1969. Agricultural uses accounted for 19.5 million tons, or 64 percent; industrial uses consumed 461,000 tons, or 2 percent; and exports accounted for 10.3 million tons, or 34 percent. Agricultural uses were for ordinary superphosphate, triple superphosphate, wet-process phosphoric acid, nitrophosphate, direct application to the soil, stock and poultry feed, and fertilizer filler.

Industrial uses included the manufacture of elemental phosphorus.

Mine production of crude dry ore in Florida and North Carolina was 114.9 million short tons with a  $P_2O_5$  content of 16.2 million short tons.

Land-pebble phosphate rock was produced at 19 mines by 10 companies in three counties.

Soft-rock phosphate was produced by five companies at six mines in three counties. Total sold or used was 23,684 short tons with a  $P_2O_5$  content of 4,690 short tons valued at \$168,257. The soft rock applications were direct application to soil and stock and poultry feed.

American Cyanamid Co. turned over 52 acres of reclaimed land from their Chicora mine to the State and is preparing another 60 acres for transfer at this location.

Phillips Petroleum Co. obtained a per-

mit to mine phosphate rock in Manatee County and to construct a plant in DeSoto County. Plans to start mining are indefinite.

American Cyanamid Co.'s Sydney mine and washer have been closed due to depleted reserves. The expansion phase at its Chicora operations has been completed. A second 45-cubic yard dragline has been added, and the washer and flotation plants expanded to bring the total rated capacity of the operation to 3 million tons per year. Two articles describing the company's new procedure for using phosphate slimes in land reclamation were published.<sup>5</sup>

Mobil Chemical Co. announced plans to increase its phosphate rock production capacity by adding a new washer plant near Nichols. The added capacity will raise its phosphate rock production capacity from 3.2 to 4.4 million tons per year. Construction was scheduled to begin in early 1971.

Occidental Chemical Co. started operating its defluorinated phosphate plant adjacent to the Suwannee River phosphate mine and chemical complex near White Springs. This facility will initially produce 100,000 tons of defluorinated phosphate and consume 135,000 tons of phosphate rock per year.

Several papers were published; one discussed improved beneficiation techniques<sup>6</sup> and the other reported on a special analysis of the fertilizer industry.<sup>7</sup>

The Bureau of Mines completed a study on the phosphate industry in the southeastern United States and its relationship to world mineral fertilizer demand.<sup>8</sup>

**Sand and Gravel.**—Sand and gravel output was 12.5 million tons valued at \$12.2 million. Compared with 1969, quantity decreased 13 percent and value 12 percent. The decline in output was partially due to a reduction in sandfill requirements of Government-and-contractor operations. Sand output for commercial operations in-

<sup>5</sup> Engineering and Mining Journal. Cyanamid Shoots for Instant Reclamation of Mined Land. V. 171, No. 1, January 1970, pp. 90-92.

<sup>6</sup> Commercial Fertilizers. Cyanamid Scores Land Reclamation Breakthrough. V. 120, No. 1, January 1970, p. 3.

<sup>7</sup> Aparo, S. J., Improving Techniques Get More Out of Florida Phosphate. Min. Eng., v. 22, No. 5, May 1970, pp. 76-77.

<sup>8</sup> Florida Journal of Commerce. Florida Phosphate Industry Should Recover About 1973. May 1970, pp. 14-16.

<sup>9</sup> Sweeney, John W., and Robert N. Hasslacher. The Phosphate Industry in the Southeastern United States and Its Relationship to World Mineral Fertilizer Demand. BuMines Inf. Circ. 8459, 1970, 76 pp.

creased slightly, and demand for gravel increased over 1969 levels. Polk and Charlotte Counties were the leading producers of sand for building purposes and of unwashed sandfill. Each county accounted for 20 percent of the State's output. The value of sand from Polk County was 22 percent and from Charlotte County 17 percent of the State's total. Nearly all of the sand was produced by commercial operators. There were 63 sand and gravel operations functioning in 1970, compared with 55 in 1969. Seventy-eight percent of the output was transported by truck and the remaining 22 percent, by rail. The sand and gravel was mainly used for construction purposes, and only a small amount was consumed in other industries.

Meekins Inc., West Hollywood, was negotiating with the Seminole Indians to obtain a contract to mine silica sand and gravel from an estimated 35-million-ton deposit near Lake Okeechobee.

**Staurolite.**—Staurolite was recovered as a byproduct of ilmenite production at the Highland and Trail Ridge plants of E. I. du Pont de Nemours & Co., Inc., in Clay County. Both shipments and value increased significantly over 1969 levels. Florida is the only State that has a recorded production of staurolite.

**Stone.**—Crushed limestone output was 40.2 million tons, valued at \$55.2 million. The tonnage was essentially unchanged; however, the value increased 3 percent over 1969 levels. Output came from 90 quarries in 23 counties, compared with 91 quarries in 23 counties in 1969. The three leading producing counties were Dade, Broward, and Hernando, which supplied 64 percent of the State's total tonnage and 68 percent of the total value. Twelve companies operated 42 quarries, which accounted for 62 percent of the crushed stone output and 65 percent of the value. The limestone sold or used for various

Table 5.—Florida: Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Broward.....	3	744	\$615	3	744	\$627
Calhoun.....	1	4	4	1	4	4
Escambia.....	5	510	W	5	511	421
Jackson.....	1	17	17	1	17	17
Lake.....	5	1,893	1,459	5	1,806	1,437
Orange.....	1	243	243	7	W	W
Palm Beach.....	1	421	281	1	60	30
Pinellas.....	1	W	10	1	W	W
Polk.....	7	2,861	W	9	3,255	3,423
Putnam.....	4	W	W	4	438	574
St. Lucie.....	4	779	673	4	W	W
Undistributed <sup>1</sup> .....	22	6,937	10,688	22	5,648	5,722
Total <sup>2</sup> .....	55	14,409	13,988	63	12,482	12,255

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

<sup>1</sup> Includes Bay, Brevard, Charlotte, Clay, Dade, Franklin, Gadsden, Glades, Hendry, Hillsborough, Leon, Marion, Okaloosa, Volusia, and Walton Counties, and counties indicated by symbol W.

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

Table 6.—Florida: Sand and gravel sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Building sand.....	8,024	\$7,311	8,288	\$7,700
Paving sand.....	555	497	471	266
Paving gravel.....	1	( <sup>1</sup> )	2	15
Other sand and gravel <sup>2</sup> .....	5,829	6,180	3,721	4,273
Total sand and gravel.....	14,409	13,988	12,482	12,254

<sup>1</sup> Less than ½ unit.

<sup>2</sup> Includes glass, molding, blast, engine, filtration, chemical, fill and other sands, and structural, fill, and other gravel.



purposes is shown in the following tabulation, in percent of overall output and value:

	Output	Value
Agricultural stone ----	1	2
Concrete aggregate ----	24	30
Bituminous aggregate --	5	5
Road base stone -----	38	37
Other stone usages ----	32	26

Crushed limestone was transported in the following ways: 79 percent by truck; 18 percent by rail; 0.5 percent by water; and unspecified, about 2 percent.

Oystershell was processed in seven counties. The total output was 2.3 million tons, and its value was about \$4.2 million. These represent increases of 44 percent and 40 percent in tonnage and value respectively, over 1969 levels. Most of the

oystershell was used for road base material, and a small tonnage was consumed as poultry grit.

Dimension limestone was produced by one company in Manatee County for decorative purposes.

Southeastern Materials, Inc., opened a quarry and a crushed stone plant north-west of Hialeah. The operation has a rated capacity of 500 tons per hour. The deposit is estimated to contain 350 million tons of limestone.

An article describing a new hard-rock limestone operation was published.<sup>9</sup>

**Vermiculite.**—Exfoliated vermiculite was produced from six plants in Dade, Duval, Hillsborough, and Palm Beach Counties.

<sup>9</sup> Stearn, Enid W. Rozzo Hits Pay Dirt in Hard Rock. Rock Products, v. 73, No. 4, April 1970, pp. 48–49.

**Table 7.—Florida: Crushed limestone sold or used by products, by counties**  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Alachua.....	6	1,818	\$1,299	4	1,744	\$1,335
Broward.....	16	6,907	10,572	16	6,924	11,303
Collier.....	6	1,374	W	6	1,679	2,502
Dade.....	14	11,720	W	14	11,184	13,356
Hernando.....	6	6,735	10,804	6	7,719	13,023
Levy.....	8	494	1,046	2	249	155
Marion.....	10	801	W	10	924	2,121
Monroe.....	2	1,867	1,223	2	917	615
Palm Beach.....	6	706	832	2	W	W
Sumter.....	3	W	W	3	2,604	2,456
Undistributed <sup>1</sup> .....	19	8,807	27,848	25	6,316	8,310
Total <sup>2</sup> .....	91	40,780	53,626	90	40,210	55,176

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

<sup>1</sup> Includes Brevard (1969), Charlotte, Citrus, Jackson (1969), Lee, St. Lucie, Suwannee, and Taylor Counties, and counties indicated by symbol W.

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

**Table 8.—Florida: Crushed limestone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Concrete aggregate.....	11,346	\$17,682	9,824	\$16,302
Dense graded roadbase stone.....	19,028	22,149	15,232	20,398
Other roadstone <sup>1</sup> .....	2,836	4,148	2,820	4,214
Unspecified aggregate and roadstone.....	W	W	2,866	2,788
Agricultural purposes <sup>2</sup> .....	820	3,066	375	1,353
Fill.....	r 3,045	r 2,227	3,373	2,651
Railroad ballast.....	W	W	120	165
Other uses <sup>3</sup> .....	r 3,655	r 4,354	5,600	7,306
Total <sup>4</sup> .....	40,730	53,626	40,210	55,176

<sup>r</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Other uses."

<sup>1</sup> Other roadstone includes bituminous aggregate, macadam aggregate, and surface-treatment aggregate. The 1969 figures include only bituminous aggregate.

<sup>2</sup> Data include stone used in poultry grit.

<sup>3</sup> Includes asphalt filler, cement, chemical stone, other filler, lime, stone sand (1970), railroad ballast (1969), unspecified aggregate (1969), and other uses.

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

The tonnage and value of the exfoliated vermiculite produced from crude material shipped into the State cannot be published.

### METALS

Metals accounted for only 3 percent of the State's total mineral production value.

**Ferroalloys.**—Three companies produced ferrophosphorus as a byproduct of elemental phosphorus manufacture. The value of ferroalloys is not included in the total State mineral production value.

**Rare-Earth Minerals.**—Rare-earth minerals were not produced in the State during this year; however, Titanium Enterprises is constructing a mine and mill to extract monazite, as well as other minerals, from a heavy mineral sand deposit near Green Cove Springs. Startup is scheduled for mid-1972.

**Titanium Concentrates.**—Both shipments and value of ilmenite concentrates decreased about 7 percent from 1969 levels. This reflects the reduced demand for titanium in the aerospace industry.

Development of the beach sand deposit near Green Cove Springs, Clay County, by Titanium Enterprises is proceeding; production is scheduled for 1972.

The Bureau of Mines completed a research program to investigate the potential of recovering rutile from Florida phosphate beneficiation plants and develop procedures to produce concentrates of rutile, ilmenite, zircon, and monazite from mixed heavy mineral concentrates.

A paper was published that described the heavy mineral ore body of Trail Ridge, Fla.<sup>10</sup>

**Zirconium Concentrates.**—Shipments of zirconium concentrates declined from 1969 levels; there was a corresponding reduction in value. E. I. du Pont de Nemours & Co., Inc., recovered these concentrates from ilmenite production at both the Highland and Trail Ridge plants, Clay County. Zirconium sands are used in ferrous foundries, refractories, and ceramics. The reduction in shipments was attributed to strikes in major foundries and a general reduction in business levels.

### MINERAL FUELS

Mineral fuels production consisted of natural gas, crude petroleum, and coproducts, and peat. Fuels accounted for only 2

percent of the State's total mineral production value.

**Natural Gas.**—From five fields in southern Florida, a relatively small quantity of casinghead gas was produced, which was used to operate heater treaters. The gas-oil ratio was about 100 to 1. Because of the small gas volume, it was not commercially marketed.

The Jay field in the northwestern part of the State was discovered in June 1970. The initial wells are producing oil and gas, and it is predicted that Florida will become a producer of commercial gas from this field.

**Peat.**—Peat production decreased about 16 percent, and its value declined 15 percent from 1969 levels. Eight plants produced 45,743 tons of humus, moss, and reed-sedge peat valued at \$304,000. About half of the production was shredded and the other half unprepared prior to its sale for soil improvement purposes.

**Petroleum.**—Crude petroleum production increased 73 percent over 1969 levels. The main reason for this change was the increase in production from the West Sunoco-Felda field. The daily oil production rate from five wells in this field increased from 980 barrels per day during December 1969 to 1,470 barrels per day from 17 wells during December 1970. A total of 2,998,352 barrels of oil were produced from six fields during 1970 in the entire State. The cumulative oil production during the period 1943 through 1970 was 19.4 million barrels.

On June 11, 1970, the Humble Oil and Refining Co. and the Louisiana Land and Exploration Co., established excellent Jurassic-Smackover oil production at their No. 1 St. Regis Paper Co., well, Jay area, Santa Rosa County, northwestern Florida. On a 6-hour initial production test through perforations at 15,470 to 15,524 feet, this discovery flowed natural at a rate of 1,712 barrels of 50.7° oil plus 2.15 million cubic feet of gas per day through a ¼-inch choke. Tube flow pressure was 3,450 psi, and shut-in surface pressure was 3,775 psi. This is considered to be one of the best Smackover discoveries in the southeast during the past 10 years.

On June 8, 1970, Humble made a discovery in Lee County, southern Florida.

<sup>10</sup> Pirkle, E. C., and W. H. Yoho. The Heavy Mineral Ore Body of Trail Ridge, Florida. *Econ. Geol.*, v. 65, 1970, pp. 17-30.

On the initial pumping production test, through perforations at 11,472 to 11,482 feet in the upper Sunniland Limestone, this well yielded 508 barrels of oil and 20

barrels of water per day; the oil gravity was 27°.

No new regulations, or regulatory orders were issued during 1970.

Table 9.—Florida: Oil and gas well drilling completions, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
Columbia.....	0	0	0	0	0	1	1	3,115
Escambia.....	0	0	0	0	0	1	1	16,020
Hendry.....	11	0	2	0	0	3	16	180,430
Lee.....	1	0	1	1	0	0	3	48,826
Nassau.....	0	0	0	0	0	1	1	5,469
St. Johns.....	0	0	0	0	0	1	1	4,850
Santa Rosa.....	0	0	0	1	0	1	2	33,384
Total.....	12	0	3	2	0	8	25	292,094

Source: American Petroleum Institute.

Table 10.—Florida: Principal producers

Commodity and company	Address	Type of Activity	County
<b>Cement, portland and masonry:</b>			
General Portland Cement Co. ....	Box 1528 Tampa, Fla. 33601	2 plants.....	Dade and Hillsborough.
Lehigh Portland Cement Co. ....	713 Hamilton St. Allentown, Pa. 18105	Plant.....	Dade.
Maule Industries, Inc. ....	100 Biscayne Blvd. Miami, Fla. 33132	...do.....	Do.
<b>Clays:</b>			
<b>Fuller's earth:</b>			
Dresser Industries, Inc. ....	Box 6504 Houston, Tex. 77005	Open pit mine....	Gadsden.
Engelhard Minerals & Chemicals Corp.	Menlo Park Edison, N.J. 08817	2 open pit mines....	Do.
Floridin Co. ....	Berkeley Springs, W. Va. 25411	Open pit mine....	Do.
Mid-Florida Mining.....	Box 63-F Lowell, Fla. 32663	...do.....	Marion.
<b>Kaolin:</b>			
Edgar Plastic Kaolin Co. ....	Edgar, Fla. 32049	...do.....	Putnam.
<b>Miscellaneous:</b>			
Appalachee Correctional Institute.	Box 127 Chattahoochee, Fla. 32324	...do.....	Gadsden.
Bickerstaff Clay Products Co., Inc.	Box 1178 Columbus, Ga. 31902	Open pit mine and plant.	Escambia.
Florida Solite Co. ....	Box 297 Green Cove Springs, Fla. 32043	...do.....	Clay.
General Portland Cement Co. ....	Box 1528 Tampa, Fla. 33601	Open pit mine....	Citrus.
<b>Gypsum, calcined:</b>			
Kaiser Gypsum Co., Inc. ....	300 Lakeside Drive Oakland, Calif. 94612	Plant.....	Duval.
National Gypsum Co. ....	325 Delaware Ave. Buffalo, N. Y. 14202	...do.....	Hillsborough.
U.S. Gypsum Co. ....	101 S. Wacker Drive Chicago, Ill. 60606	...do.....	Duval.
<b>Lime:</b>			
<b>Primary:</b>			
Basic Magnesia, Inc. ....	Box 160 Port St. Joe, Fla. 32456	...do.....	Gulf.
Chemical Lime, Inc. ....	Box 250 Ocala, Fla. 32670	...do.....	Hernando.
Dixie Lime & Stone Co. ....	Box 910 Ocala, Fla. 32670	...do.....	Sumter.
<b>Magnesium compounds:</b>			
Basic Magnesia, Inc. ....	Box 160 Port St. Joe, Fla. 32456	...do.....	Gulf.

Table 10.—Florida: Principal producers—Continued

Commodity and company	Address	Type of Activity	County
<b>Peat:</b>			
M.L.S. Industries .....	Drawer 567 Stuart, Fla. 33494	Mine .....	St. Lucie.
F. E. Stearns Peat .....	Rt. 1 Box 347-I Valrico, Fla. 33594	---do.....	Hillsborough.
Traxler Peat Co. ....	Box 86 Florahome, Fla. 32635	---do.....	Putnam.
Zellwood Peat Co. ....	Box 555 Zellwood, Fla. 32798	---do.....	Orange.
<b>Perlite, expanded:</b>			
Airlite Processing Corp. ....	Rt. 3 Box 417 Vero Beach, Fla. 32960	Plant .....	Indian River.
Armstrong Cork Co. ....	Box 351 Pensacola, Fla. 32502	---do.....	Escambia.
Chemrock Corp. ....	End of Osage St. Nashville, Tenn. 37208	---do.....	Duval.
W. R. Grace & Co. ....	62 Whitmore Ave. Cambridge, Mass. 02140	---do.....	Dade.
<b>Petroleum:</b>			
Humble Oil & Refining Co. ....	Box 2024 Houston, Tex. 77001	Sunniland field.....	Collier.
Sun Oil Company .....	Box 2380 Dallas, Tex. 75221	Sunoco-Felda field..	Collier and Hendry.
<b>Phosphate rock:</b>			
<b>Land-pebble:</b>			
Agrico Chemical Co. ....	5050 Poplar Ave. Memphis, Tenn. 38117	3 open pit mines....	Polk.
American Cyanamid Co. ....	Berdan Ave. Wayne, N.J. 07472	2 open pit mines....	Hillsborough and Polk.
International Minerals & Chemicals Corp. ....	Old Orchard Road Skokie, Ill. 60079	3 open pit mines....	Polk.
Mobil Chemical Co. ....	Box 31 Nichols, Fla. 33863	2 open pit mines....	Do.
Occidental Chemical Co. ....	Box 300 White Springs, Fla. 32096	---do.....	Hamilton.
U.S.S. Agri-Chemicals, Inc. ....	Box 867 Ft. Meade, Fla. 33841	---do.....	Polk.
<b>Soft-rock:</b>			
Howard Phosphate Co. ....	Box 13800 Orlando, Fla. 32809	Open pit mine.....	Citrus.
Kellogg Co. ....	Box 218 Hernando, Fla. 32642	---do.....	Do.
Loncala Phosphate Co. ....	Box 766 High Springs, Fla. 32643	2 open pit mines....	Marion and Gilchrist.
Soil Builders, Inc. ....	Box 368 Dunnellon, Fla. 32630	Open pit mine.....	Citrus.
Sun Phosphate Co. ....	Box 523 Ocala, Fla. 32670	---do.....	Do.
<b>Phosphorus, elemental:</b>			
Agrico Chemical Co. ....	5050 Poplar Ave. Memphis, Tenn. 38117	3 electric furnaces..	Polk.
Mobil Chemical Co. ....	Box 311 Nichols, Fla. 33863	Electric furnace....	Do.
<b>Sand and gravel:</b>			
General Development Corp. ....	1111 South Bayshore Drive Miami, Fla. 33131	3 open pit mines....	Brevard, Charlotte, St. Lucie.
E. R. Jahna Industries, Inc. ....	First & East Tillman Lake Wales, Fla. 33853	Open pit mine.....	Lake and Polk.
Orange Sand Company .....	Box 4667 Jacksonville, Fla. 32204	---do.....	Lake.
Seminole Rock Products, Inc. ....	8100 N.W. 74th St. Miami, Fla. 33166	---do.....	Dade.
Standard Sand & Silica Co. ....	Box 35 Davenport, Fla. 33837	---do.....	Polk.
<b>Staurolite:</b>			
E. I. du Pont de Nemours & Co., Inc. ....	Du Pont Building, D-10084 Wilmington, Del. 19898	Plant .....	Clay.
<b>Stone:</b>			
<b>Limestone, crushed:</b>			
Dixie Lime & Stone Co. ....	Box 910 Ocala, Fla. 32670	5 quarries .....	Jackson, Levy, Marion, Sumter.
Florida Rock Products Corp. ....	Box 4667 Jacksonville, Fla. 32201	2 quarries .....	Hernando and Suwannee.
General Development Corp. ....	1111 South Bayshore Drive Miami, Fla. 33166	3 quarries .....	Charlotte, St. Lucie.
Houdaille-Duval-Wright Co. ....	Box 8068 Seminole Annex Ft. Lauderdale, Fla. 33310	5 quarries .....	Alachua, Broward, Dade.
Maule Industries, Inc. ....	Box 2601 Hialeah, Fla. 33012	2 quarries .....	Broward and Dade.

Table 10.—Florida: Principal producers—Continued

Commodity and company	Address	Type of Activity	County
Stone—Continued			
Limestone, dimension:			
Bradenton Stone Company....	Box 1220 Bradenton, Fla. 33506	Quarry.....	Manatee.
Oystershell:			
Bay Dredging & Construction Co.	Box 1484 Tampa, Fla. 33601	Dredge.....	Hillsborough.
Benton & Company, Inc.....	Box 1347 St. Petersburg, Fla. 33731	....do.....	Pinellas.
Ft. Myers Shell & Dredging Co., Inc.	Box 973 Ft. Myers, Fla. 33902	....do.....	Lee.
Houdaille-Duval-Wright Co....	Box 1588 Jacksonville, Fla. 32201	....do.....	Duval.
Radcliff Materials, Inc.....	Box 1288 Mobile, Ala. 36601	....do.....	Walton.
Titanium concentrates:			
E. I. du Pont de Nemours & Co., Inc.	Du Pont Building D-10084 Wilmington, Del. 19898	2 dredges and plants	Clay.
Vermiculite, exfoliated:			
W. R. Grace & Co.....	62 Whittmore Ave. Cambridge, Mass. 02140	4 plants.....	Dade, Duval, Hillsborough, Palm Beach.
Verlite Company.....	Box 11885 Tampa, Fla. 33610	Plant.....	Hillsborough.
Schmelzer Sales Association, Inc...	3519 Cantrell Road Little Rock, Ark. 72207	....do.....	Do.
Zirconium concentrates:			
E. I. du Pont de Nemours & Co., Inc.	Du Pont Building D-10084 Wilmington, Del. 19898	....do.....	Clay.

# The Mineral Industry of Georgia

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Georgia Department of Mines, Mining and Geology under a cooperative agreement for collecting information on all minerals except fuels.

By J. Robert Wells<sup>1</sup> and J. H. Auvil, Jr.<sup>2</sup>

Georgia ranked 29th among the 50 States in total value of mineral production in 1970. It was far ahead of all others in production of kaolin. Georgia placed second in output of fuller's earth, granite, and marble, third in scrap and flake mica, and fourth in bauxite and titanium concentrate.

Total value of Georgia mineral production in 1970, scoring the 17th consecutive annual increase, was 6 percent above the 1969 record and almost five times higher than that of just 20 years ago. This total has risen with remarkable consistency at an average growth rate of 8 percent per year

throughout that period. The total exceeded \$200 million for the first time on record.

Nonmetallic minerals supplied 98 percent of the 1970 total value; 2 percent was contributed by metallic minerals and mineral fuels. The overall increase in 1970 was mainly due to a sharp rise in the total value of kaolin production, which was up 14 percent from the 1969 figure, although bauxite and kyanite, against smaller bases, showed larger percentage gains.

<sup>1</sup> Physical scientist, Division of Nonmetallic Minerals.

<sup>2</sup> Director, Georgia Department of Mines, Mining and Geology, Atlanta, Ga.

Table 1.—Mineral production in Georgia<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite..... thousand short tons.....	124	\$3,116	W	W
Clays..... do.....	5,670	98,462	5,684	\$110,149
Iron ore (usable)..... thousand long tons, gross weight.....	241	1,338	243	1,467
Sand and gravel..... thousand short tons.....	3,824	4,709	3,667	4,437
Stone..... do.....	27,755	59,451	26,635	59,200
Talc..... short tons.....	47,790	301	45,900	289
Value of items that cannot be disclosed:				
Bauxite, cement, feldspar, kyanite, mica, peat, rare-earth metals concentrates, titanium con- centrates, zirconium concentrates and value indicated by symbol W.....	XX	23,525	XX	27,683
Total.....	XX	190,902	XX	203,225
Total 1967 constant dollars.....	XX	180,269	XX	183,919

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

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

Table 2.—Value of mineral production in Georgia, by counties <sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Baldwin	W	W	Kaolin.
Bartow	\$4, 418	\$4, 238	Barite, limestone, slate, miscellaneous clay.
Bibb	1, 138	W	Miscellaneous clay, sand and gravel.
Charlton	W	W	Ilmenite, zircon, rare-earth metal concentrate.
Chatham	W	W	Sand and gravel.
Chattooga	W	W	Marble.
Cherokee	W	W	Mica.
Clarke	W	975	Granite.
Clayton	W	W	Do.
Cobb	W	W	Do.
Columbia	W	W	Miscellaneous clay.
Cook	86	W	Sand and gravel.
Crawford	W	W	Do.
Decatur	W	W	Fuller's earth.
De Kalb	4, 960	W	Granite.
Dougherty	W	W	Sand and gravel.
Douglas	W	W	Granite, miscellaneous clay.
Early	W	W	Limestone.
Effingham	W	W	Sand and gravel.
Elbert	W	W	Granite.
Evans	W	42	Sand and gravel.
Fannin	W	W	Limestone.
Fayette	W	W	Granite.
Floyd	W	W	Limestone, miscellaneous clay.
Fulton	12, 790	11, 920	Cement, granite, miscellaneous clay, sand and gravel.
Gilmer	W	W	Limestone.
Glynn	W	W	Sand and gravel.
Gordon	W	W	Miscellaneous clay.
Greene	W	W	Sand and gravel.
Gwinnett	W	W	Granite.
Hall	W	W	Granite, limestone.
Hancock	W	W	Granite.
Hart	W	W	Mica.
Henry	W	W	Granite.
Houston	W	W	Cement, limestone, miscellaneous clay.
Jasper	W	W	Feldspar, sandstone.
Jefferson	W	W	Fuller's earth.
Jones	W	W	Granite.
Lamar	W	W	Do.
Lincoln	W	W	Kyanite.
Long	W	W	Sand and gravel.
Lowndes	W	W	Peat.
McDuffie	W	W	Kaolin.
Madison	W	W	Granite.
Mitchell	W	W	Limestone.
Monroe	W	W	Granite.
Montgomery	20	20	Sand and gravel.
Murray	301	W	Talc.
Muscogee	W	W	Granite, sand and gravel.
Oglethorpe	1, 616	1, 350	Granite.
Pickens	W	W	Marble, sandstone, quartz, limestone.
Polk	W	W	Cement, slate, miscellaneous clay, sandstone.
Quitman	W	644	Iron ore.
Rabun	W	W	Granite.
Richmond	4, 830	4, 859	Granite, kaolin, miscellaneous clay, sand and gravel.
Rockdale	731	W	Sand and gravel.
Spalding	W	W	Granite.
Stephens	W	W	Do.
Stewart	W	823	Iron ore.
Sumter	W	W	Kaolin, bauxite.
Talbot	W	W	Sand and gravel.
Taylor	W	W	Do.
Thomas	3, 750	W	Fuller's earth, sand and gravel.
Twigg	W	W	Kaolin, Fuller's earth.
Walker	W	W	Limestone, miscellaneous clay.
Ware	W	W	Sand and gravel.
Warren	W	W	Granite, kaolin.
Washington	36, 043	43, 013	Kaolin.
Whitfield	W	W	Limestone.
Wilkinson	W	W	Kaolin.
Undistributed	120, 218	135, 341	
Total <sup>2</sup>	190, 902	203, 225	

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

<sup>1</sup> The following counties are not listed because no production was reported: Appling, Atkinson, Bacon, Baker, Banks, Barrow, Ben Hill, Berrien, Bleckley, Brantley, Brooks, Bryan, Bulloch, Burke, Butts, Calhoun, Camden, Candler, Carroll, Catoosa, Chattahoochee, Clay, Clinch, Coffee, Colquitt, Coweta, Crisp, Dade, Dawson, Dodge, Dooly, Echols, Emanuel, Forsyth, Franklin, Glascock, Grady, Habersham, Haralson, Harris, Heard, Irwin, Jackson, Jeff Davis, Jenkins, Johnson, Lanier, Laurens, Lee, Liberty, Lumpkin, McIntosh, Macon, Marion, Meriwether, Miller, Morgan, Newton, Oconee, Paulding, Peach, Pierce, Pike, Pulaski, Putnam, Randolph, Schley, Screven, Seminole, Taliaferro, Tattnall, Telfair, Terrell, Tift, Toombs, Towns, Treutlen, Troup, Turner, Union, Upson, Walton, Wayne, Webster, Wheeler, White, Wilcox, Wilkes, and Worth.

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

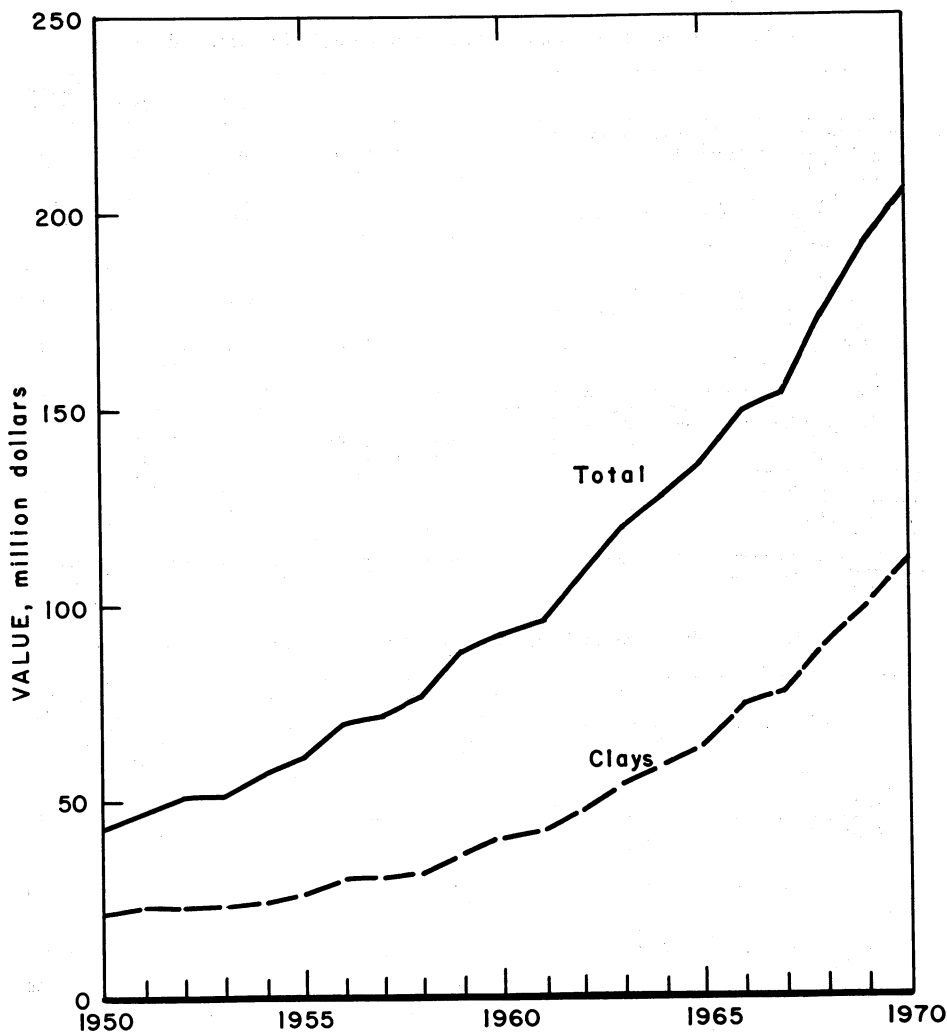


Figure 1.—Value of clays and total value of mineral production in Georgia.

**Employment and Injuries.**—In the mineral industries, 6,425 men worked 15,543,000 man-hours, compared with 6,513 men and 15,572,000 man-hours in 1969. Employment increased 5 percent at other nonmetal and peat mines but decreased 2 percent at sand and gravel mines, 6 percent at metal mines, and 6 percent at stone quarries.

There were 352 lost-time injuries in the mineral industries, including four fatalities, compared with 349 injuries including four fatalities in 1969.

**Legislation and Government Programs.**—The Georgia Department of Mines, Mining and Geology continued its Mineral Exploration Program in search of commercially significant deposits of phosphate rock and other minerals within the State's boundaries. In support of this exploration program, the Department acquired a new diamond drilling rig capable of probing and core sampling hard-rock geological structures to a depth of 4,000 feet. Another of the Department's recent activities was the publication of a large-scale mineral re-



Table 3.—Selected economic indicators of Georgia business activity<sup>1</sup>

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total work force available..... thousands.....	1,905.2	1,928.2	+1.2
Total unemployed..... do.....	55.0	70.7	+23.5
<b>Employment:</b>			
Manufacturing..... do.....	476.3	462.2	-3.0
Transportation and public utilities..... do.....	102.3	106.7	+4.3
Mining..... do.....	6.8	6.9	+1.5
Contract construction..... do.....	81.3	76.5	-5.9
Service..... do.....	181.0	187.3	+3.5
Government..... do.....	285.3	297.8	+4.4
Wholesale and retail trade..... do.....	324.6	330.8	+1.9
Finance, insurance, and real estate..... do.....	73.3	77.5	+5.7
<b>Personal income:</b>			
Total..... millions.....	\$14,253	\$15,102	+6.0
Per capita..... do.....	\$3,132	\$3,277	+4.6
<b>Construction activity:</b>			
Number of private and public residential units authorized.....	39,786	55,116	+38.5
Value of authorized non-residential construction..... millions.....	\$273.7	\$335.6	+22.6
<b>Cement shipments to and within Georgia:</b>			
Portland..... thousand 376-pound barrels.....	10,880	10,124	-6.9
Masonry..... thousand 280-pound barrels.....	1,366	1,278	-6.4
<b>Farm marketing receipts:</b>			
Mineral production..... millions.....	\$1,147.8	\$1,147.8	-----
Export trading..... do.....	\$190.9	\$203.2	+6.4
Import trading..... do.....	\$249.2	\$352.9	+41.6
Import trading..... do.....	\$274.1	\$277.6	+1.3

Sources: Employment and Earnings; Area Trends in Employment and Unemployment; Farm Income Situation; Construction Review; Streets and Roads; Highlights of U.S. Export and Import Trade; Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industry

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Metal.....	125	308	39	330	-----	1	3.03	27
Nonmetal and peat.....	3,303	304	1,004	8,076	1	212	26.38	1,776
Sand and gravel.....	230	266	61	551	-----	11	19.95	437
Stone.....	2,855	261	746	6,614	3	125	19.35	4,400
Total <sup>1</sup> .....	6,513	284	1,850	15,572	4	349	22.67	2,806
<b>1970:<sup>p</sup></b>								
Metal.....	120	306	37	309	-----	2	6.48	55
Nonmetal and peat.....	3,365	314	1,055	8,492	2	191	22.73	2,409
Sand and gravel.....	230	268	61	540	1	10	20.37	11,284
Stone.....	2,715	258	701	6,202	1	145	23.54	1,760
Total <sup>1</sup> .....	6,425	288	1,853	15,543	4	348	22.65	2,412

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

source map in which all known mineral deposits and prospects throughout the State were precisely located. The Department was actively engaged in preparing detailed maps, both geologic and topographic, toward the goal of complete coverage for the State. A published report presented an encompassing view of these and other aspects of Georgia's mining situation in 1970.<sup>3</sup> A directory was also published that listed active mining and quarrying operations in Georgia, as of November 1, 1970, by commodities produced, by coun-

ties, and in alphabetical sequence. Included in the directory was a brief outline of the principal State agencies responsible for the administration of Georgia's mining laws and controls.<sup>4</sup>

In studies closely related to the State's mining industry, a report summarizing the fiscal year 1970 activities of the Georgia

<sup>3</sup> Georgia Department of Mines, Mining and Geology. Minerals for Georgia—Annual Report of Progress 1970. 1971, 33 pp.

<sup>4</sup> Georgia Department of Mines, Mining Directory of Georgia (compiled by Martha A. Green), Circ. 2, 16th ed., 1971, 74 pp.

District, Water Resources Division, U.S. Geological Survey, in cooperation with the Georgia Department of Mines, Mining and Geology and other listed federal, State, and

local agencies was published. This report also provided an extensive listing of selected references dealing with the subject of water resources in Georgia.<sup>5</sup>

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Barite.**—Barite, produced by three companies each of which operated one open pit mine in Bartow County, was used as a heavy component to increase the density of oil-well drilling muds, as a raw material for the manufacture of barium chemicals and glass, and as a filler or pigment in rubber products and paint. Output declined moderately in both quantity and total value. Barium chemicals were produced in Bartow County by Chemical Products Corp., an affiliate of one of the barite producers.

**Cement.**—Both portland cement and masonry cement were produced in Georgia in 1970, and the total value, only fractionally different from that of the previous year, kept cement in third place in the State's mineral production.

Portland cement was manufactured at three plants, one in each of three counties, and was distributed, 67 percent by truck and 33 percent by rail, to ready-mix concrete plants, concrete product manufacturers, highway construction contractors, and building material dealers. About 94 percent of the total tonnage was shipped in bulk and 6 percent in containers.

The principal raw materials used for cement manufacture were limestone and miscellaneous clay, both mined within the State.

**Clays.**—Clays were Georgia's leading source of mineral-industry income. Georgia remained securely in its established position as the nation's foremost clay-producing State, well in advance of the nearest competitor in quantity of clay output and far outdistancing all others in terms of total value.

Clays in three classifications, kaolin, fuller's earth, and miscellaneous clay, were produced by 38 companies from a total of 62 mines in 21 counties. Washington and Twiggs Counties were the leaders, with the largest number of operations, total tonnage of output, and total dollar value.

Kaolin, in first place among Georgia's mineral commodities, as it has been for

many years, contributed 49 percent of the State's total mining proceeds in 1970. It was produced by 18 companies operating 36 mines in eight counties. The year's output of kaolin, three-quarters of the national total, was the largest in the history of the State, 2 percent more in tonnage and 14 percent higher in total value than the previous alltime high record established in 1969. The superior grades of kaolin, especially those used as filler for paper, rubber, and paint, were shipped to destinations throughout the United States and were marketed abroad in greater quantities than ever before. The United Kingdom, normally preeminent as a world supplier of kaolin, experienced a disturbed labor situation and unfavorable weather conditions. These problems contributed to making it possible for the United States to export in 1970 almost a million tons of that commodity, more than in any previous year—and the major share of it from the clay pits of Georgia.

Fuller's earth, used mainly as an absorbent (animal litter, floor sweeping compounds, and for absorbing spilled liquids), as a filler in pesticide formulations, as a component of rotary-drilling muds, and as a filtering and clarifying medium, was produced in 1970 by seven firms from eight mines in four counties. Production increased fractionally in quantity and 10 percent in total value, establishing new records for the State. In July 1970, Georgia-Tennessee Mining & Chemical Co. put into service at Wrens, Jefferson County, a new preparation plant costing \$1 million and employing 30 persons; it has the capacity for producing 75,000 tons per year of a variety of grades of processed fuller's earth. Oil-Dri Corp. of America, with headquarters in Chicago, began constructing a new fuller's earth processing plant in Thomas County, near Georgia's southern border. The new installation, scheduled for completion in mid-1971, will replace existing facilities near Cairo, Grady County. It will

<sup>5</sup> U.S. Geological Survey—Water Resources Division. Water Resources Projects in Georgia 1970. 1971, 39 pp.

provide substantially increased capacity for treating material from company properties in Thomas and Grady Counties to yield a wide range of fuller's earth products. Ground was broken late in 1970 by Cherokee Industries, Inc., for another new fuller's earth processing plant, also in Thomas County.

Miscellaneous clay, 4 percent less in tonnage than in 1969 but reaching a 10-percent higher total value, was produced in 11 counties in 1970 from 18 mines operated by 14 companies, principally to provide

material for the manufacture of brick and tile and for use as an ingredient in portland cement mixtures.

**Feldspar.**—At its Monticello mill, the Feldspar Corp. processed feldspathic rock from an open pit operation in Jasper County and produced flotation concentrate feldspar, which was used in the manufacture of glass and ceramics and as a filler in latex products. The 1970 production figures showed a moderate decline in tonnage and a sharp decrease in total value.

**Gypsum.**—Three companies, two with

Table 5.—Kaolin sold or used by producers, by counties

County	1969		1970	
	Number of mines	Thousand short tons	Number of mines	Thousand short tons
Twigg	5	1,307	5	1,309
Washington	14	1,632	19	1,558
Wilkinson	5	392	5	W
Other counties <sup>1</sup>	5	344	7	881
Total <sup>2</sup>	29	3,676	36	3,749

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

<sup>1</sup> Includes Baldwin, McDuffie (1970), Richmond, Sumter, and Warren Counties, and data indicated by symbol W.

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

Table 6.—Kaolin sold or used by producers, by uses  
(Thousand short tons)

Use	1969	1970
Pottery: Whiteware		
Refractories: Firebrick and block	103	100
Fillers:	289	354
Paper filling and coating		
Rubber	2,357	2,491
Paint	103	104
Chemicals, other	116	101
Other uses <sup>1</sup>	30	W
Total	678	599
Total	3,676	3,749

W Withheld to avoid disclosing individual company confidential data.

<sup>1</sup> Includes stoneware; floor and wall tile; mortar, foundries and steelworks (bulk); kiln furniture; high-alumina brick; other refractories; insecticides and fungicides; fertilizer filler (1969); plastics filler; other fillers; portland and other cements; catalysts (oil refining); other uses; and data indicated by symbol W.

Table 7.—Miscellaneous clay and shale sold or used by producers, by counties

County	1969		1970	
	Number of mines	Thousand short tons	Number of mines	Thousand short tons
Bartow	1	2	1	2
Douglas			1	78
Fulton	4	475	3	W
Gordon	1	12	1	( <sup>1</sup> )
Richmond	3	500	3	W
Other counties <sup>2</sup>	8	674	9	1,520
Total <sup>3</sup>	17	1,663	18	1,601

W Withheld to avoid disclosing individual company confidential data.

<sup>1</sup> Less than ½ unit.

<sup>2</sup> Includes Bibb, Columbia, Floyd, Houston, Polk, and Walker Counties, and data indicated by symbol W.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

one plant each in Chatham County and the other with one plant in Glynn County, calcined gypsum from out-of-State mines for use in plaster and wallboard. The total quantity of material processed was slightly less than in 1969.

**Kyanite.**—Aluminum Silicates, Inc., a subsidiary of Combustion Engineering, Inc., reported tonnage and total value figures for 1970 kyanite production from the Graves Mountain open-pit mine in Lincoln County that were markedly higher than in 1969. This represented the State's largest output of that mineral in history. Increased production in Georgia followed the closing in South Carolina of the kyanite production facilities of Commercialores, Inc., also a Combustion Engineering subsidiary. Georgia kyanite, as usual, was chiefly consumed in the production of mullite-type high-performance refractories. A study was undertaken by the Georgia Department of Mines, Mining and Geology to develop an economically feasible process for the production of sillimanite, a kyanite-group mineral that also is used in refractories. In addition to mullite-containing refractory materials prepared by high-temperature treatment of kyanite-group minerals, synthetic mullite was produced by two companies, one operating at Augusta in Richmond County and the other at Americus in Sumter County, where a major plant expansion was still underway at yearend. Georgia's 1970 output of synthetic mullite was substantially higher than in 1969, when only one company was producing this material.

**Mica.**—Two companies produced mica in 1970, one from one mine in Cherokee County and the other from one mine in

Hart County. The product, classified as scrap and flake mica, was used in flake form as a coat for roofing or as ground filler for joint cement, rubber, and paint.

**Perlite.**—Crude perlite mined elsewhere was shipped into Georgia and expanded at a plant in Bibb County to serve as lightweight aggregate in plaster and concrete mixtures or for agricultural purposes.

**Sand and Gravel.**—Sand and gravel held fourth place in dollar value among Georgia's mineral products in 1970 but was 4 percent less in tonnage and 6 percent less in reported value than in 1969. Sand and gravel were produced by 22 companies from 25 open-pit and dredging operations in 19 counties. The output was consumed mostly in the construction industry as building and paving material. Smaller quantities of sand were used in the making of glass, as sandblasting abrasive, and in molding and foundry applications.

**Stone.**—Stone, second in value in mineral production, contributed 29 percent of Georgia's total income from mining in 1970. The tonnage of stone produced was 4 percent less than in 1969, and the total value decreased slightly. Stone was produced in 35 counties from 78 quarries operated by 45 private companies and three governmental agencies. Fourteen quarries yielded more than 900,000 tons each, nine quarries between 500,000 and 900,000 tons, 15 quarries between 100,000 and 500,000 tons, and 40 quarries less than 100,000 tons each. Production of stone totaling more than 1 million tons was recorded in each of 11 counties, among which the leaders were DeKalb, Fulton, Jones, and Gwinnett Counties. Stone valued at more than \$1 million was produced in each of 23 coun-

Table 8.—Georgia: Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Cook.....	1	115	\$86	1	W	W
Evans.....	1	W	W	1	28	\$42
Montgomery.....	1	20	20	1	20	20
Rockdale.....	1	452	731	1	W	W
Undistributed <sup>1</sup> .....	21	3,237	3,872	21	3,621	4,377
Total <sup>2</sup> .....	25	3,824	4,709	25	3,667	4,437

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

<sup>1</sup> Includes Bibb, Chatham, Crawford, Dougherty, Effingham, Fulton, Glynn, Greene, Long, Muscogee, Richmond, Talbot, Taylor, Thomas, and Ware Counties.

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

**Table 9.—Georgia: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building.....	3,016	\$2,997	2,737	\$2,637
Fill.....	22	18	22	23
Paving.....	384	305	387	313
Other uses <sup>1</sup> .....	318	1,193	445	1,278
Total <sup>2</sup> .....	3,739	4,514	3,591	4,251
Gravel:				
Other uses <sup>3</sup> .....	86	194	76	185
Total <sup>2</sup> .....	86	194	76	185
Total sand and gravel <sup>2</sup> .....	3,824	4,709	3,667	4,437

<sup>1</sup> Includes blast, engine, filtration, foundry (1969), glass, molding, and other sands.

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

<sup>3</sup> Includes building, fill, and paving gravel.

ties; Pickens, DeKalb, Fulton, and Jones Counties headed the list. Approximately 74 percent of the 1970 output of crushed stone was shipped by truck, 24 percent by rail, and 2 percent by water.

Crushed granite was produced by 11 companies from 24 quarries in 18 counties. Quantity and value increased 4 percent and 11 percent, respectively, establishing new records for the State. This material was used principally as concrete and bitumen aggregate and for railroad ballast. Dimension granite was supplied by 23 firms that operated 26 quarries in five counties. Of the total tonnage of dimension granite produced, more than half was used for monuments. Lesser quantities were sold in the form of rubber, rough blocks, and curb stones.

Crushed limestone was produced by nine companies and three governmental agencies (county highway departments) from 15 quarries in 11 counties. The total quantity was 2 percent greater than in 1969 but 4 percent below that of the record year 1968. Total value increased sharply, reaching a level 30 percent higher than that of 1969 and 25 percent above the previous record. This product was used chiefly for road building, as concrete aggregate, and in the manufacture of cement. A smaller quantity was marketed as agricultural limestone.

Crushed marble was produced by two companies from six quarries in two counties. Both tonnage and total value were down sharply from 1969. Approximately 90 percent of this material was used in the

form of industrial filler, whiting, concrete and roofing aggregate, and terrazzo stone. Dimension marble, sold mainly as cut stone, stone veneer, and sawed stone, was produced by one company from one quarry in Pickens County. The quantity produced was considerably less than in 1969, but the total value was practically the same.

Crushed sandstone was produced by one company from one quarry in Jasper County and was used for concrete aggregate and in the manufacture of cement. Dimension sandstone, mostly in the form of rough blocks and irregular-shaped stone, was produced by two companies, each of which operated one quarry in Pickens County. Dimension quartzite, all used as stone veneer, was produced by one company from one quarry, also in Pickens County. Output sandstone and quartzite in 1970 was moderately greater in tonnage than in 1969 and substantially higher in total value.

Crushed slate suitable for use as roofing granules or in the form of slate flour for industrial fillers was produced by one company from a quarry in Bartow County. Another firm produced a considerably larger tonnage of crushed slate of expansible quality from one quarry in Polk County for the manufacture of lightweight aggregate. The State's 1970 output of crushed slate, compared with that of 1969, represented a moderate decrease in both quantity and total value.

**Table 10.—Georgia: Crushed granite sold or used by producers, by uses**  
(Thousand short tons and thousand dollars)

Use	1969			1970		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Concrete aggregate.....	4,465	\$6,788	\$1.51	6,680	\$10,566	\$1.58
Dense graded road base stone.....	9,769	14,255	1.46	1,942	3,124	1.61
Macadam aggregate <sup>1</sup> .....	1,098	1,542	1.40	4,296	6,773	1.58
Surface treatment aggregate.....	1,156	1,784	1.54	948	1,589	1.68
Unspecified aggregate & roadstone.....	W	W	W	2,521	3,991	1.58
Asphalt fill.....	250	W	W	-----	-----	-----
Railroad ballast.....	1,423	1,934	1.36	2,145	3,002	1.40
Other uses <sup>2</sup> .....	2,088	3,224	1.54	2,430	3,662	1.48
<b>Total<sup>3</sup>.....</b>	<b>20,249</b>	<b>29,476</b>	<b>1.46</b>	<b>21,013</b>	<b>32,706</b>	<b>1.56</b>

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

<sup>1</sup> Data includes bituminous aggregate.

<sup>2</sup> Data includes stone used in agricultural purposes, riprap, uses not listed or unspecified; also, filter stone, stone sand, and roofing aggregates (1969).

<sup>3</sup> Data may not add to totals shown because of independent rounding.

**Table 11.—Dimension granite sold or used by producers, by counties**

County	1969				1970			
	Number of quarries	Thousand cubic feet	Short tons (equivalent)	Value (thousands)	Number of quarries	Thousand cubic feet	Short tons (equivalent)	Value (thousands)
De Kalb.....	4	458	80,878	\$1,441	4	354	31,573	\$863
Elbert.....	12	328	44,227	1,969	10	338	30,524	1,747
Oglethorpe.....	10	475	41,854	1,616	9	531	45,305	1,350
Undistributed <sup>1</sup> .....	3	353	33,069	1,073	3	369	30,559	1,307
<b>Total<sup>2</sup>.....</b>	<b>29</b>	<b>1,614</b>	<b>200,028</b>	<b>6,100</b>	<b>26</b>	<b>1,592</b>	<b>137,961</b>	<b>5,267</b>

<sup>1</sup> Includes Hancock and Madison counties.

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

**Table 12.—Georgia: Dimension granite sold or used by producers, by uses**  
(Thousand cubic feet and thousand dollars)

Use	1969			1970		
	Quantity	Value		Quantity	Value	
		Total	Average per cubic foot		Total	Average per cubic foot
Rough monumental.....	1,082	\$3,926	\$3.63	1,013	\$3,980	\$3.93
Dressed monumental.....	72	W	W	-----	-----	-----
Other uses <sup>1</sup> .....	460	2,174	4.73	579	1,237	2.22
<b>Total.....</b>	<b>1,614</b>	<b>6,100</b>	<b>3.78</b>	<b>1,592</b>	<b>5,267</b>	<b>3.31</b>

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

<sup>1</sup> Includes rough construction, architectural stone, curbing, flagging and rubble.

**Table 13.—Georgia: Crushed limestone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Concrete aggregate.....	742	\$1,282	689	\$1,231
Dense graded road base stone.....	1,435	2,030	1,291	1,766
Agricultural limestone.....	170	336	445	W
Cement.....	1,400	1,914	1,301	1,982
Other uses <sup>1</sup> .....	586	1,036	681	3,607
<b>Total<sup>2</sup>.....</b>	<b>4,334</b>	<b>6,599</b>	<b>4,407</b>	<b>8,586</b>

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

<sup>1</sup> Includes bituminous aggregate, surface treatment aggregate and unspecified aggregate; also, macadam aggregate (1969).

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

**Strontium.**—Mineral raw materials imported from Mexico were processed by Chemical Products Corp. in Cartersville, Bartow County, for the preparation of industrial strontium chemicals.

**Talc.**—Southern Talc Co., formerly Georgia Talc Co., operated underground talc mines near Chatsworth, Murray County. Most of the mined material was ground by the producer for use in roofing, insecticides, rubber, paper, and asphalt preparations for the protective coating of oil and gas pipelines.

#### METALS

**Bauxite.**—The 1970 output of bauxite, all produced by one company from one mine in Sumter County, was substantially greater in both quantity and total value than in 1969; the reported unit value of the product was notably higher.

**Iron Ore.**—Two firms produced iron ore from open pit mines in Stewart County. Output tonnage was practically the same as in 1969, but the total value was about 10 percent higher. Iron-oxide minerals for use as coloring matter for paints, concrete, and bricks and as reagents in chemical processes were produced by one company from an open pit operation in Bartow County.

**Rare-Earth Minerals.**—Monazite concentrate was recovered as a coproduct by

Humphreys Mining Co. in the dredging and milling of complex sands from alluvial deposits in Charlton County. Both volume and value of output were moderately greater than in 1969.

**Titanium.**—Ilmenite concentrate was the principal product obtained by Humphreys Mining Co. in processing the heavy-mineral material dredged from water-deposited accumulations of titaniferous sands near Folkston, Charlton County. Quantity was slightly higher than in 1969, but total value declined.

**Zirconium.**—Zircon concentrate was recovered as a coproduct by Humphreys Mining Co. from the dredging and milling of mineral-bearing sands from Pleistocene river terraces near Folkston. The zirconium-mineral fraction separated in 1970 was greater in quantity and total value than in 1969 and was used mainly as a component in foundry-sand mixtures and in the production of refractories.

#### FUELS

**Peat.**—Peat, 17 percent less in tonnage and 20 percent less in total value than in 1969, was produced by one company in Lowndes County. The product, classified as humus peat, was shredded and shipped in bulk for use as packing material for flowers, plants, and shrubs.

Table 14.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Barite, primary:</b>			
Milchem, Inc.-----	3920 Essex Lane Houston, Tex. 77027	Open pit mine-----	Bartow.
New Riverside Ochre Co.-----	Box 387 Cartersville, Ga. 30120	---do-----	Do.
Paga Mining Co.-----	Cartersville, Ga. 30120	Open pit mine and grinding mill.	Do.
<b>Bauxite: American Cyanamid Co.-----</b>	Berdan Ave. Wayne, N.J. 07472	Open pit mine and drying plant.	Sumter.
<b>Cement, portland:</b>			
Marquette Cement Manufactur- ing Co.-----	20 N. Wacker Dr. Chicago, Ill. 60606	Plant-----	Polk.
Penn-Dixie Cement Corp.-----	Box 152 Nazareth, Pa. 18064	---do-----	Houston.
Southern Cement Co., Div. Martin Marietta Corp.-----	18th Floor, Daniel Bldg. Birmingham, Ala. 35233	---do-----	Fulton.
<b>Clay:</b>			
<b>Fuller's earth:</b>			
Cairo Production Co., Inc.---	Box 358 Cairo, Ga. 31728	Open pit mine-----	Thomas.
Englehard Minerals & Chemicals Corp.-----	Menlo Park Edison, N.J. 08817	---do-----	Decatur.
Milwhite Co., Inc.-----	Attapulgus, Ga. 31715	---do-----	Do.
Georgia-Tennessee Mining & Chemical Co.-----	Box 307 Wrens, Ga. 30833	---do-----	Jefferson.
Thor Mining Co.-----	Berkeley Springs, W. Va. 25411	---do-----	Thomas.
Waverly Mineral Products Co.-----	Meigs, Ga. 31765	---do-----	Do.
<b>Kaolin:</b>			
American Industrial Clay Co. of Sandersville.-----	Sandersville, Ga. 31082	2 open pit mines---	McDuffie and Washington.
Englehard Minerals & Chemicals Corp.-----	Menlo Park Edison, N.J. 08817	---do-----	Washington and Wilkinson.
Freeport Kaolin Co.-----	405 Lexington Ave. New York, N.Y. 10017	Open pit mine-----	Twiggs.
Georgia Kaolin Co.-----	433 North Broad St. Elizabeth, N.J. 07208	---do-----	Do.
J. M. Huber Corp.-----	630 3rd Ave. New York, N.Y. 10017	2 open pit mines---	Twiggs and Warren.
<b>Miscellaneous:</b>			
Burns Brick Co.-----	Box 4787 Macon, Ga. 31208	Open pit mine-----	Bibb.
Chattahoochee Brick Co.-----	3195 Brick Plant Rd. Atlanta, Ga. 30321	4 open pit mines---	Floyd (1), Fulton (2), and Polk (1).
Cherokee Brick & Tile Co.---	Box 4567 Macon, Ga. 31208	Open pit mine-----	Bibb.
Merry Brothers Brick & Tile Co.-----	415 Masonic Bldg. Augusta, Ga. 30902	---do-----	Richmond.
Southern Cement Co., Div. Martin Marietta Corp.-----	18th Floor, Daniel Bldg. Birmingham, Ala. 35233	---do-----	Fulton.
<b>Feldspar: The Feldspar Corp.-----</b>	Spruce Pine, N.C. 28777	Open pit mine and flotation plant.	Jasper.
<b>Gypsum, calcined:</b>			
The Flintkote Co.-----	480 Central Ave. East Rutherford, N.J. 07073	Plant-----	Chatham.
Georgia-Pacific Corp.-----	Commonwealth Bldg. Portland, Ore. 97207	---do-----	Glynn.
National Gypsum Co.-----	325 Delaware Ave. Buffalo, N.Y. 14202	---do-----	Chatham.
<b>Iron ore:</b>			
Davis Bros.-----	Brantley, Ala. 36009	Open pit mine-----	Stewart.
Lumpkin Mining Co.-----	Box 234 Greenville, Ala. 36037	---do-----	Do.
Luverne Mining Co.-----	P.O. Box 409 Luverne, Ala. 36104	---do-----	Do.
<b>Iron oxide pigment materials:</b>			
New Riverside Ochre Co.-----	Box 387 Cartersville, Ga. 31020	---do-----	Bartow.
<b>Kyanite: Aluminum Silicates, Inc.---</b>	Box 649 Washington, Ga. 30673	Open pit mine and mill.	Lincoln.
<b>Mica, scrap:</b>			
Franklin Mineral Products Co.---	Box 0 Wilmington, Mass. 01887	Open pit mine and grinding mill.	Hart.
Thompson-Weinman & Co.-----	Cartersville, Ga. 30120	Underground mine and grinding mill.	Cherokee and Bartow.



Table 14.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Peat:</b>			
Lake Park Peat Moss Co.....	Lake Park, Ga. 31636...	Open pit mine.....	Lowndes.
<b>Perlite, expanded:</b>			
Armstrong Cork Co.....	Macon, Ga. 30312.....	Plant.....	Bibb.
<b>Rare-earth metals: Humphreys Mining Co.</b>	Box 8 Folkston, Ga. 31537	Dredge and plant...	Charlton.
<b>Sand and gravel:</b>			
Atlanta Sand & Supply Co.....	604 Forsyth Bldg. Atlanta, Ga. 30303	Open pit mine.....	Crawford.
Dawes Silica Mining Co., Inc....	Drawer 920 Thomasville, Ga. 31792	4 open pit mines...	Dougherty, Effingham, Long, and Thomas.
Drake Eye Mining Co.....	Box 236 Lithonia, Ga. 30058	Open pit mine and dredge.	Rockdale.
Howard Sand Co.....	Howard, Ga. 31039.....	Open pit mine.....	Taylor.
Taylor County Sand Co.....	Junction City, Ga. 31812	---do.....	Talbot.
<b>Stone:</b>			
<b>Granite, crushed:</b>			
Dixie Lime & Stone Co.....	Box 910 Ocala, Fla. 32670	5 quarries.....	Clayton, Fayette, Monroe, and Spalding.
Hitchcock Corp.....	Box 35 Murphy, N.C. 28906	3 quarries.....	Clayton, Fulton, and Jones.
Stone Mountain Grit Co., Inc.	Box 458 Lithonia, Ga. 30058	2 quarries.....	De Kalb and Fulton.
Vulcan Materials Co.....	Box 12078 N. Side Sta. Atlanta, Ga. 30305	6 quarries.....	Cobb, Douglas, Fulton, Gwinnett, Henry and Muscogee.
Weston & Brooker Co.....	Box 335 Gray, Ga. 31032 Box 180 Thomas, Ga. 30824	Quarry..... ---do.....	Jones. Warren.
<b>Granite, dimension:</b>			
Bennie & Harvey.....	Box 958 Elberton, Ga. 30635	---do.....	Oglethorpe.
Coggins Granite Industries, Inc.	Box 250 Elberton, Ga. 30635	2 quarries.....	Elbert and Madison.
Comolli Granite Co.....	Box 898, Elberton, Ga. 30635	Quarry.....	Elbert.
Davidson Granite Co., Inc....	Lithonia, Ga. 30058	---do.....	De Kalb.
Georgia Marble Co.....	Elberton, Ga. 30635	---do.....	Madison.
Stone Mountain Granite Co.	Stone Mountain, Ga. 30083	---do.....	De Kalb.
<b>Limestone, crushed:</b>			
Dalton Rock Products Co....	Box 1608 Dalton, Ga. 30720	---do.....	Whitfield.
Georgia Rock Products Co....	Arlington, Ga. 31713	---do.....	Early.
Penn-Dixie Cement Corp....	Box 152 Nazareth, Pa. 18064	---do.....	Houston.
The Stone Man, Inc.....	3814 Tennessee Ave. Chattanooga, Tenn. 37409	---do.....	Walker.
<b>Marble, crushed:</b>			
Georgia Marble Co.....	Tate, Ga. 30177.....	4 quarries.....	Pickens.
Marble Products Co.....	67 Peachtree Park Dr. Atlanta, Ga. 30309	2 quarries.....	Chattooga and Pickens.
<b>Marble, dimension:</b>			
Georgia Marble Co.....	Tate, Ga. 30177.....	Quarry and finish- ing plant.	Pickens.
<b>Sandstone, crushed:</b>			
Marquette Cement Manu- facturing Co.	20 N. Wacker Dr. Chicago, Ill. 60606	Quarry.....	Polk.
<b>Sandstone, dimension:</b>			
Carl S. Johnson.....	Route 1 Talking Rock, Ga. 30175	---do.....	Pickens.
North Georgia Stone Co.....	Whitestone, Ga. 30186..	2 quarries.....	Do.
<b>Slate, crushed:</b>			
General Aniline & Film Corp.	Fairmont, Ga. 30139....	Underground quarry.	Bartow.
Georgia Lightweight Aggre- gate Co.	Box 19781, Station N Atlanta, Ga. 30325	Quarry and expand- ing plant.	Polk.
<b>Talc: Southern Talc Co.....</b>	Box 273 Chatsworth, Ga. 30705	5 underground mines.	Murray.
<b>Titanium concentrates:</b>			
Humphreys Mining Co.....	Box 8 Folkston, Ga. 31537	Dredge and plant...	Charlton.
<b>Zirconium concentrates:</b>			
Humphreys Mining Co.....	Box 8 Folkston, Ga. 31537	---do.....	Do.

# The Mineral Industry of Hawaii

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Hawaii Department of Land and Natural Resources for the collection of mineral data.

By Avery H. Reed<sup>1</sup>

Mineral production value declined slightly from that of the 1969 record year. Output of many mineral commodities was about the same as in 1969. A new annual record was set for cement production.

**Employment and Injuries.**—In the mineral industries, 685 men worked 1,410,000 man-hours, compared with 717 men and 1,427,000 man-hours in 1969. Employment

increased 62 percent at sand and gravel mines but decreased 2 percent at stone quarries and 3 percent at other nonmetal mines.

There were 66 lost-time injuries in the mineral industries, compared with 48 injuries in 1969.

<sup>1</sup> Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Mineral production in Hawaii<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement.....thousand 376-pound barrels..	2,075	\$10,544	2,162	\$10,334
Clay.....thousand short tons..	2	9	2	11
Lime.....do.....	9	287	9	338
Pumice, pumicite, and volcanic cinder.do.....	403	783	350	933
Sand and gravel.....do.....	552	1,816	514	1,679
Stone.....do.....	6,534	16,059	26,331	15,538
Value of items that cannot be disclosed: Gem stones, salt and dimension stone (1970)	XX	41	XX	132
Total.....	XX	29,539	XX	28,965
Total 1967 constant dollars.....	XX	27,894	XX	26,213

XX Not applicable.

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

<sup>2</sup> Excludes dimension stones; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Hawaii, by counties

(Thousands)

County	1969	1970	Minerals produced in 1970, in order of value
Hawaii.....	\$2,039	\$2,215	Stone, pumice, volcanic cinder.
Honolulu.....	24,337	23,919	Stone, cement, lime, clays, salt.
Kauai.....	839	766	Stone, sand and gravel, volcanic cinder.
Maui.....	2,324	2,065	Sand and gravel, volcanic cinder, lime, stone, gemstones.
Total.....	29,539	28,965	

Table 3.—Indicators of Hawaii business activity

	1969	1970 <sup>p</sup>	Change, percent	
Total nonagricultural employment.....	thousands	276.3	292.0	+5.7
Manufacturing.....	do	25.4	25.3	- .4
Contract construction.....	do	23.0	25.2	+9.6
All other industries <sup>1</sup> .....	do	227.9	241.2	+5.8
Personal income:				
Total.....	millions	\$3,060	\$3,429	+12.1
Per capita.....	do	\$4,163	\$4,530	+8.8
Construction activity:				
Number of private and public residential units authorized.....		13,794	10,678	-22.6
Value of nonresidential construction.....	millions	\$106.9	\$112.0	+4.8
Farm marketing receipts.....	do	\$198.6	\$206.6	+4.0
Mineral production value.....	do	\$29.5	\$28.9	-2.0

<sup>p</sup> Preliminary.

<sup>1</sup> Includes transportation and public utilities; wholesale and retail trade; finance, insurance, and real estate; services; and government.

Sources: Survey of Current Business, Construction Review, Employment and Earnings and Monthly Report on the Labor Force, Farm Income Situation, and Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1969:								
Nonmetal.....	97	119	12	91	-----	4	43.94	538
Sand and gravel.....	33	97	3	26	-----	-----	-----	-----
Stone.....	587	266	156	1,310	-----	44	33.58	869
Total.....	717	239	171	1,427	-----	48	33.64	833
1970: <sup>p</sup>								
Nonmetal.....	85	127	11	88	-----	5	56.87	1,194
Sand and gravel.....	50	102	5	42	-----	4	96.29	1,830
Stone.....	545	285	156	1,231	-----	57	44.50	1,543
Total <sup>1</sup> .....	685	252	172	1,410	-----	66	46.80	1,530

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Cement.**—Hawaiian Cement Corp. operated a cement plant at Barbers Point, and Kaiser Cement & Gypsum Corp. operated a cement plant near Nanakuli, both on Oahu. Shipments were a record 2,162,000 barrels valued at \$10,334,000 compared with 2,075,000 barrels valued at \$10,544,000 in 1969, an increase of 4 percent in quantity but a decrease of 2 percent in value. Unit value dropped from \$5.08 per barrel to \$4.78. Both portland and masonry cements were produced.

Portland cement was consumed by ready-mixed concrete companies (54 percent), by highway contractors and governmental agencies (27 percent), and for other uses (19 percent).

Raw materials used in making portland

cement included 477,000 tons of coral, 79,000 tons of basalt, 44,000 tons of silica sand, and 19,000 tons of gypsum. Silica sand, gypsum, and some clinker were imported. The two plants purchased 52.5 million kilowatt-hours of electric energy.

Kaiser installed a new 36-inch crusher and was proceeding with plans for an additional 1.5-million-barrel kiln expansion. Hawaiian Cement Corp. proceeded with its \$6 million expansion, designed to increase capacity to 2.5 million barrels.

**Clays.**—Pacific Clay Corp. mined 2,500 tons of miscellaneous clay at Waimanalo, Oahu. The clay was used in the company's Barbers Point plant on Oahu for building brick.

**Gem Stones.**—Small quantities of red and black coral were collected.

**Lime.**—Gaspro, Ltd., operated a lime

plant at Waianae, Oahu, and Hawaiian Commercial & Sugar Co., Ltd., operated a lime plant at lower Paia, on Maui. Production was about the same as in 1969. Quicklime was sold for use in electric steel furnaces. Hydrated lime was sold or used for sugar refining, construction, sewage treatment, and water purification.

**Pumice and Volcanic Cinder.**—Output of pumice and volcanic cinder for light-weight aggregate, roadmetal, landscaping, filtration, and other uses declined 13 percent, but value increased 19 percent. The 14 open pit mines were on Hawaii, Kauai, Molokai, and Maui. Leading producers were Volcanite, Ltd., on Hawaii, and HC&D, Ltd., on Molokai.

**Salt.**—Tanaka Hawaiian Salt produced a small quantity of salt by evaporation of seawater near Honolulu.

**Sand and Gravel.**—Output of sand and gravel by 17 producers decreased 7 percent. Most of the production was from Maui County by 10 producers, of which HC&D, Ltd., Maui Concrete & Aggregates, Inc., and Concrete Industries, Inc., were the largest. The sand and gravel was used for building, paving, fill, and other uses.

**Stone.**—Eleven operators crushed 4,752,000 tons of traprock valued at 11,803,000. Leading counties were Honolulu and Hawaii. Leading producers were Lone Star Cement Corp., HC&D, Ltd., and

Pacific Concrete and Rock Co., Ltd. The stone was used for construction, fill, and other uses.

Ten operators crushed 1,200,000 tons of limestone valued at \$3,104,000 for construction, cement, lime, agriculture, and other uses. Leading county was Honolulu. Leading producers were Pacific Concrete & Rock Co., Ltd., Kaiser Cement & Gypsum Corp., and Hawaiian Cement Corp.

Sixteen operators crushed 380,000 tons of miscellaneous stone valued at \$631,000. Leading county was Hawaii. Leading producers were Puna Sugar Co., Ltd., Laupahoehoe Sugar Co., and Yamada Sons, Inc. The stone was used for construction purposes. A small quantity of dimension stone was quarried for rubble and for rough architectural uses. The miscellaneous stone produced included aa, lava, and moss rock.

**Vermiculite.**—Crude vermiculite from Montana was exfoliated on Oahu by Vermiculite of Hawaii, Inc.

#### MINERAL FUELS

Hawaiian Independent Refinery, Inc., which in 1969 announced plans for building a foreign trade subzone at Barbers Point, Oahu, applied to the Board of Land and Natural Resources for use of submerged lands to construct pipelines and tanker mooring facilities.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	Island
<b>Cement:</b>			
Hawaiian Cement Corp.-----	1600 Kapiolani Blvd., Suite 1200 Honolulu, Hawaii 96814	Dry process portland cement plant.	Oahu.
Kaiser Cement & Gypsum Corp.-	Permanente Rd. Permanente, Calif. 95014	Wet process portland cement plant.	Do.
<b>Clays: Pacific Clay Corp.</b> -----	547 Halekauwila St. Honolulu, Hawaii 96813	Open pit mine.-----	Do.
<b>Lime:</b>			
GasPrO, Ltd.-----	P.O. Box 2454 Honolulu, Hawaii 96804	Rotary kiln and con- tinuous hydrator.	Do.
Hawaiian Commercial & Sugar Co.	Puunene, Hawaii 96784	.....do.....	Maui.
<b>Pumice and volcanic cinder:</b>			
Concrete Industries, Inc.-----	P.O. Box 86 Puunene, Hawaii 96784	Open pit mine.-----	Do.
Fong Construction Co., Ltd.-----	237 Dairy Rd. Kahului, Hawaii 96732	.....do.....	Do.
James W. Glover, Ltd.-----	P.O. Box 275 Hilo, Hawaii 96720	.....do.....	Hawaii.
Grove Farm Co., Ltd.-----	Puhi Rural Station Lihue, Hawaii 96766	.....do.....	Kauai.
Haleakala Ranch Company-----	Makawao, Hawaii 96768	.....do.....	Maui.
Hawaiian Agricultural Co., Ltd.-	Pahala, Hawaii 96777	.....do.....	Hawaii.
HC&D, Ltd.-----	P.O. Box 190 Honolulu, Hawaii 96810	.....do.....	Molokai.
Hutchinson Sugar Co., Ltd.-----	Naalehu, Hawaii 96772	.....do.....	Hawaii.
James Kuwana-----	P.O. Box 406 Pahoa, Hawaii 96778	.....do.....	Do.

Table 5.—Principal producers—Continued

Commodity and company	Address	Type of activity	Island
<b>Pumices and volcanic cinder—Continued</b>			
Maui Land & Pineapple Co., Inc.	R.R. 1, Box 445-C Lahaina, Hawaii 96761	Open pit mine-----	Maui.
McBryde Sugar Co., Ltd.	Eleele, Hawaii 96705	---do-----	Kauai.
Olokele Sugar Company, Ltd.	Kaunakani, Hawaii 96747	---do-----	Do.
Pacific Concrete & Rock Co., Ltd.	2344 Pahounui Dr. Honolulu, Hawaii 96819	---do-----	Molokai.
Pepeekeo Sugar Co.	Pepeekeo, Hawaii 96783	---do-----	Hawaii.
Puna Sugar Co., Ltd.	Keaau, Hawaii 96749	---do-----	Do.
Volcanite, Ltd.	828 Fort St. Honolulu, Hawaii 96813	---do-----	Do.
<b>Salt:</b>			
Tanaka Hawaiian Salt	968 D Akepo Lane Honolulu, Hawaii 96817	Solar evaporation----	Oahu.
<b>Sand and gravel:</b>			
Concrete Industries, Inc.	P.O. Box 86 Puunene, Hawaii 96784	Open pit mine-----	Maui.
Dole Corp.	Lanai City, Hawaii 96763	---do-----	Lanai.
Hale Kauai, Ltd.	Nawiliwili, Hawaii 96766	---do-----	Kauai.
Hawaiian Commercial & Sugar Co., Ltd.	Puunene, Hawaii 96784	---do-----	Maui.
HC&D, Ltd.	P.O. Box 190 Honolulu, Hawaii 96810	---do-----	Molokai.
Kekaha Sugar Co., Ltd.	Kekaha, Hawaii 96752	---do-----	Kauai.
Lihue Planation Co., Ltd.	P.O. Box 751 Lihue, Hawaii 96766	---do-----	Do.
Maui Concrete & Aggregates, Inc.	8 Central Ave. Wailuku, Hawaii 96793	---do-----	Maui.
McBryde Sugar Co., Ltd.	Eleele, Hawaii 96705	---do-----	Kauai.
Molokai Rock & Equipment	Manawainui, Hawaii	---do-----	Molokai.
Pacific Concrete & Rock Co., Ltd.	2344 Pahounui Dr. Honolulu, Hawaii 96819	---do-----	Molokai, Oahu.
Pioneer Mill Co., Ltd.	Lahaina, Hawaii 96761	---do-----	Maui.
Louis K. Rego Trucking	Lihue, Hawaii 96766	---do-----	Kauai.
Wailuku Sugar Co.	Wailuku, Hawaii 96793	---do-----	Maui.
<b>Stone:</b>			
Concrete Industries, Inc.	P.O. Box 86 Puunene, Hawaii 96784	Open quarry-----	Do.
Ewa Sugar Co., Inc.	Ewa Beach, Hawaii 96706	---do-----	Oahu.
James W. Glover, Ltd.	P.O. Box 275 Hilo, Hawaii 96720	---do-----	Hawaii.
Grove Farm Co., Inc.	Puhi Rural Station Puhii, Hawaii 96766	---do-----	Kauai.
Hawaiian Agricultural Co., Ltd.	Pahala, Hawaii 96777	---do-----	Hawaii.
Hawaiian Bitumuls & Paving Co., Ltd.	P.O. Box 2240 Honolulu, Hawaii 96804	---do-----	Oahu.
Hawaiian Cement Corp.	1600 Kapiolani Blvd., Suite 1200 Honolulu, Hawaii 96814	---do-----	Do.
HC&D, Ltd.	P.O. Box 190 Honolulu, Hawaii 96810	---do-----	Do.
Honokaa Sugar Co.	Haina, Hawaii 96709	---do-----	Hawaii.
Joe's Moss Rock Co.	1446 Meyers St. Honolulu, Hawaii 96819	---do-----	Oahu.
Kahuku Plantation Co.	Kahuku, Haw ii 96731	---do-----	Do.
Kaiser Cement & Gypsum Corp.	Permanente Rd. Permanente, Calif. 95014	---do-----	Do.
Kohala Sugar Co.	Hawi, Hawaii 97619	---do-----	Hawaii.
James Kuwana	P.O. Box 406 Pahoa, Hawaii 96778	---do-----	Do.
Kuwaye Brothers, Inc.	P.O. Box 707 Hilo, Hawaii 96720	---do-----	Do.
Laie Concrete & Aggregate, Inc.	Laie, Hawaii 96762	---do-----	Oahu.
Laupahoehoe Sugar Co.	Papaaloa, Hawaii 96780	---do-----	Hawaii.
Lihue Plantation Co., Ltd.	P.O. Box 751 Lihue, Hawaii 96766	---do-----	Kauai.
Moss Rock Hawaii	6154-A Kalaniana'ole Hwy. Honolulu, Hawaii 96821	---do-----	Oahu.
Paauihu Sugar Co., Ltd.	Paauihu, Hawaii 96775	---do-----	Hawaii.
Pacific Cement & Aggregates Co.	400 Alabama St. San Francisco, Calif. 94110	---do-----	Oahu.
Pacific Concrete & Rock Co., Ltd.	2344 Pahounui Dr. Honolulu, Hawaii 96819	---do-----	Molokai, Oahu.
Puna Sugar Co., Ltd.	Keaau, Hawaii 96749	---do-----	Hawaii.
R & R Moss Rock	87-1430-A Akowai Rd. Waianae, Hawaii 96792	---do-----	Oahu.
Ultramar Chemical Co.	P.O. Box 395 Hilo, Hawaii 96720	---do-----	Do.
Yamada Sons, Inc.	P.O. Box 577 Hilo, Hawaii 96720	---do-----	Do.
<b>Vermiculite (exfoliated):</b>			
Vermiculite of Hawaii, Inc.	842-A Mapunapuna St. Honolulu, Hawaii 96819	Exfoliating plant----	Do.

# The Mineral Industry of Idaho

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

By Francis C. Mitko <sup>1</sup>

The value of Idaho's mineral production increased 1 percent from its 1969 record high; the 1970 production was \$119.7 million according to reports received by the U.S. Bureau of Mines. As in the past, silver was the leading product in value, accounting for 28 percent of Idaho's total mineral production. The quantity of silver produced increased slightly, but there was a drop in the average annual price. The value of copper production rose 32 percent owing to increased production and a higher average annual price in 1970. Other significant gains were posted in antimony and vanadium.

Sand and gravel and stone rose 51 percent and 13 percent, respectively, in tonnage, and while sand and gravel value increased 32 percent, that for stone decreased slightly. There was a decline in employment in construction, particularly heavy construction. Some of the larger State proj-

ects were hindered by rain and mud. Cement shipments and clay sold or used by producers fell, but pumice output rose 95 percent.

The Idaho State Legislature abolished the requirement for excavation work at newly located mining claims on Federal land. The previous requirement had been for a shaft 4 feet by 4 feet and 10 feet deep, or an excavation of 160 cubic feet of ground to show good faith. This was abolished to reduce unnecessary disturbance of the land.

The Bunker Hill Co. in Kellogg held a Press Day in conjunction with the installation of nearly \$6.5 million in pollution control equipment. The company planned to begin production in January 1971 at its newly constructed acid plant, at which time operations were to have met the Idaho pollution regulations.

<sup>1</sup> Economist, Division of Nonferrous Metals.

Table 1.—Mineral production in Idaho <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ore and concentrate—short tons, antimony content.....	922	W	993	W
Clays <sup>2</sup> ..... thousand short tons.....	23	\$51	13	\$28
Copper (recoverable content of ores, etc.)..... short tons.....	3,332	3,168	3,612	4,168
Gem stones.....	NA	90	NA	90
Gold (recoverable content of ores, etc.)..... troy ounces.....	3,403	141	3,128	114
Lead (recoverable content of ores, etc.)..... short tons.....	65,597	19,541	61,211	19,121
Mercury..... 76-pound flasks.....	1,012	511	1,038	423
Peat..... thousand short tons.....	1	W	W	W
Pumice..... do.....	21	62	41	83
Sand and gravel..... do.....	8,555	7,583	12,953	10,022
Silver (recoverable content of ores, etc.)..... thousand troy ounces.....	18,930	33,897	19,115	33,849
Stone..... thousand short tons.....	3,750	6,426	<sup>3</sup> 4,240	<sup>3</sup> 6,368
Tungsten ore and concentrate (60 percent WO <sub>3</sub> basis)..... short tons.....	27	63	W	W
..... do.....	55,900	16,323	41,052	12,578
Zinc (recoverable content of ores, etc.)..... do.....				
Value of items that cannot be disclosed:				
Cement, fire clay, garnet, iron ore, kaolin, lime, perlite, phosphate rock, vanadium, and values indicated by symbol W.....	XX	30,453	XX	32,904
Total.....	XX	118,309	XX	119,748
Total 1967 constant dollars.....	XX	111,719	XX	<sup>p</sup> 108,372

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

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

<sup>2</sup> Excludes fire clay and kaolin; included with "Value of items that cannot be disclosed."

<sup>3</sup> Excludes certain dimension stone; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Idaho, by counties  
(Thousands)

County	1969	1970	Minerals produced in 1970, in order of value
Ada	W	W	Sand and gravel, clays.
Adams	\$22	W	Sand and gravel, silver, zinc.
Bannock	2,867	W	Cement, sand and gravel, stone, peat.
Bear Lake	83	W	Sand and gravel.
Benewah	W	W	Garnet, stone.
Bingham	W	W	Phosphate rock, sand and gravel, pumice.
Blaine	1,279	\$380	Lead, silver, zinc, copper.
Boise	W	W	Sand and gravel, gold, lead, zinc, silver, copper.
Bonner	166	W	Stone, silver, lead, copper.
Bonneville	619	755	Lime, sand and gravel, pumice.
Boundary	W	28	Sand and gravel, silver, gold, zinc.
Butte	W	W	Sand and gravel, silver, lead, zinc.
Camas	W	1	Sand and gravel.
Canyon	727	710	Lime, sand and gravel, pumice.
Caribou	W	17,798	Phosphate rock, vanadium, stone, sand and gravel.
Cassia	W	W	Sand and gravel, clays.
Clark	58	11	Sand and gravel.
Clearwater	W	W	Stone, sand and gravel.
Custer	1,331	W	Silver, lead, zinc, copper, tungsten, gold, sand and gravel.
Elmore	W	W	Sand and gravel, clays, gold, silver, copper.
Franklin	83	W	Sand and gravel.
Fremont	W	64	Stone.
Gem	276	4	Sand and gravel.
Gooding	10	W	Stone, sand and gravel.
Idaho	473	W	Clays.
Jefferson	W	W	Sand and gravel, stone.
Jerome	18	W	Clays, stone, sand and gravel.
Kootenai	355	W	Copper, sand and gravel, lead, silver, gold, zinc.
Latah	821	1,164	Clays, stone, sand and gravel.
Lemhi	88	86	Copper, sand and gravel, lead, silver, gold, zinc.
Lewis	W	W	Sand and gravel.
Lincoln	W	W	Do.
Madison	19	W	Lime, sand and gravel, clays.
Minidoka	238	W	Sand and gravel, stone.
Nez Perce	440	W	Sand and gravel, perlite, pumice.
Oneida	182	116	Silver, gold.
Owyhee	14	1	Sand and gravel.
Payette	23	W	Do.
Power	W	W	Silver, lead, zinc, copper, antimony, gold, sand and gravel.
Shoshone	71,701	70,185	Sand and gravel.
Teton	255	281	Sand and gravel, lime, clays.
Twin Falls	968	887	Mercury, iron ore.
Valley	99	W	
Washington	547	W	
Undistributed <sup>1</sup>	34,607	27,277	
Total	118,309	119,748	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."  
<sup>1</sup> Includes value of mineral production that cannot be assigned to specific counties and values indicated by symbol W.

Table 3.—Indicators of Idaho business activity

	1969	1970	Change, percent	
Employment and labor force, annual average:				
Total labor force				
Unemployment	thousands	295.4	303.8	+2.8
Employment	do	11.8	15.4	+30.5
Construction	do	10.4	10.9	+4.8
Lumber and wood products	do	13.1	12.7	-3.1
Food products	do	14.7	15.7	+6.8
All manufacturing	do	39.5	41.1	+4.1
All industries	do	283.6	288.4	+1.7
Personal income:				
Total	millions	\$2,120	\$2,289	+8.0
Per capita	do	\$2,999	\$3,206	+6.9
Construction activity:				
Housing units authorized				
Value of nonresidential construction	millions	1,862	2,992	+60.7
State Highway Commission: Value of contracts awarded	do	\$35.2	\$29.8	-15.3
Cement shipments to and within Idaho	thousand 376-pound barrels	333.3	\$44.2	+32.7
Farm marketing receipts	millions	2,539.0	2,704.0	+6.5
Mineral production value	do	\$620.3	\$637.9	+2.8
		\$118.3	\$119.7	+1.2

Sources: Survey of Current Business, Construction Review, The Farm Income Situation, Area Trends in Employment and Unemployment, Employment and Earnings, Idaho Labor Market, Labor Force and Employment in Idaho, Distribution by Industry of Wages Paid for Covered Employment in Idaho, Idaho State Highway Commission, and Bureau of Mines.

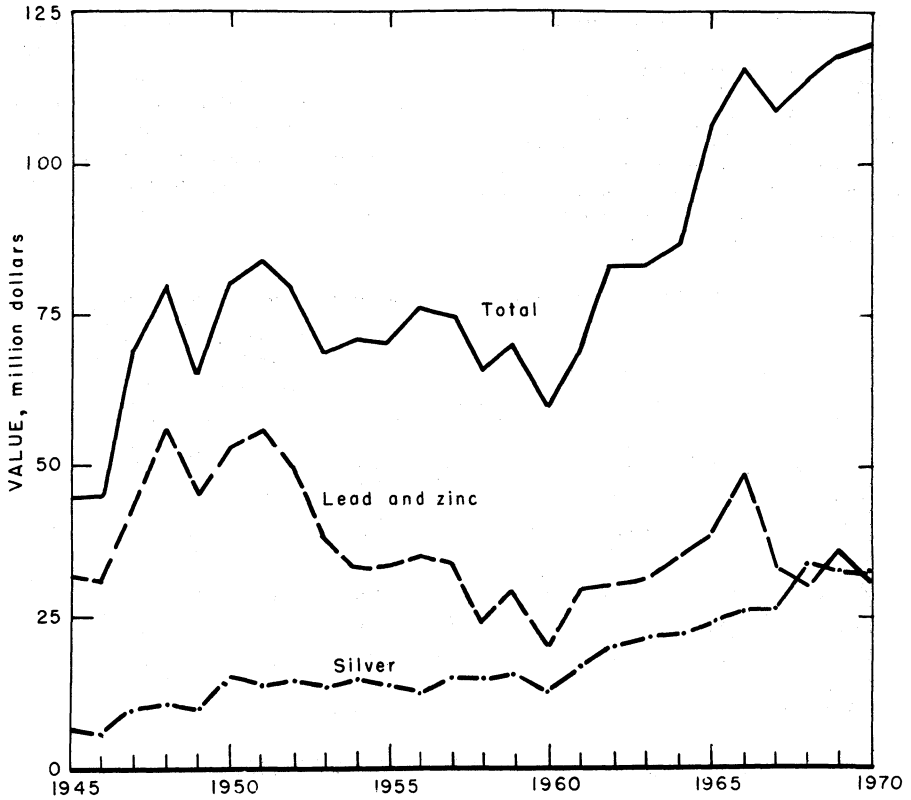


Figure 1.—Value of silver, lead and zinc, and total value of mineral production in Idaho.

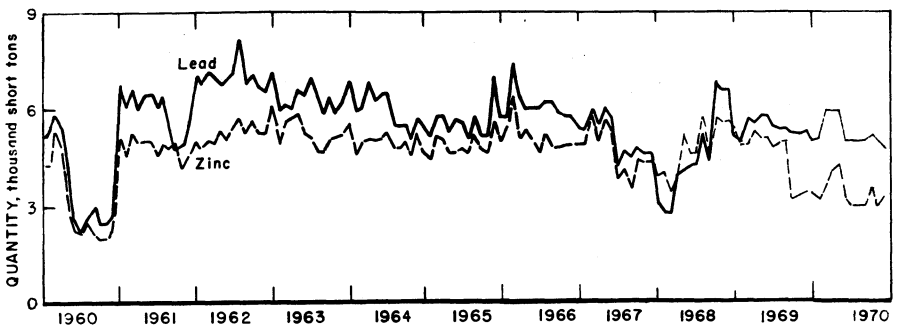


Figure 2.—Mine production of lead and zinc in Idaho, by months, in terms of recoverable metals.



**Employment, Trade, and Markets.**—Most of the key economic indicators of Idaho business activity worsened in 1970, reflecting the nationwide business downturn in that year. The average monthly unemployment rate in Idaho rose from 4.0 percent in 1969 to 5.1 percent in 1970. The weekly average of initial unemployment compensation claims rose, and the daily average of nonagricultural job placements declined.

However, the average workweek in manufacturing remained the same as in 1969, and the average hourly earnings in manufacturing rose, as did average monthly building permits, nonagricultural wage and salary employment, and cash receipts from farm marketing. Mining employment (average men working daily) declined by 4 percent.

**Table 4.—Worktime and injury experience in the mineral industries**

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Metal.....	2,314	247	572	4,576	5	347	76.92	12,561
Nonmetal and peat.....	486	223	108	903	1	15	17.72	6,856
Sand and gravel.....	813	163	133	1,066	--	19	17.82	356
Stone.....	312	203	63	513	--	6	11.69	479
Total <sup>1</sup> .....	3,925	223	877	7,059	6	387	55.68	9,110
<b>1970: <sup>p</sup></b>								
Metal.....	2,260	257	580	4,638	1	362	78.26	3,876
Nonmetal and peat.....	425	217	92	752	1	10	14.62	8,097
Sand and gravel.....	750	193	145	1,152	--	24	20.83	482
Stone.....	340	186	63	509	--	7	13.74	469
Total <sup>1</sup> .....	3,770	233	880	7,052	2	403	57.43	3,525

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW OF MINERAL COMMODITIES

### METALS

**Antimony.**—Output of antimony increased 8 percent, to 993 short tons. The production was derived entirely as a by-product of silver ores mined primarily at the Sunshine mine, near Kellogg, Shoshone County. All the antimony produced in the State was leached from silver concentrates and recovered at the Sunshine Mining Co.'s electrolytic plant as cathode metal. The value of the antimony produced increased three-fold because of increased production and a higher price for the product after government stockpile sales were halted.

By yearend, Sunshine Mining Co. had completed construction of its \$1.5 million antimony plant at Big Creek, near Wallace, Shoshone County. The new operation was expected to increase production to about 4.5 million pounds of antimony per year, compared with the 2-million-pound capacity of the existing plant. Sunshine announced a marketing agreement with Cerro Sales Corp. of New York whereby

Cerro Sales became the exclusive agent for all cathode antimony metal produced from the Sunshine unit mine area.

Antimony ore was reportedly being mined on a development basis from the Idaho-Antimony and Sourdough properties on Pine Creek, near Kellogg, and from the Papoose mine in Idaho county. Antimony concentrates were apparently shipped to Cleveland, Ohio. Exploration drilling for antimony was conducted at the Yellow Pine mine property at Stibnite, Valley County, in central Idaho. Ranchers Exploration and Development Corp. leased the property, which is said to be one of the largest deposits in the world. Plans to bring the property into production in 1970 did not materialize.

**Copper.**—Production of copper increased 8 percent, to 3,612 tons. Total value increased 32 percent, to \$4,168,000, as the estimated average price rose from 47.5 cents per pound in 1969, to 57.7 cents per pound in 1970. Concentration of copper dross slag produced at the Bunker Hill



**Table 7.—Idaho: Mine production of gold, silver, copper, lead, and zinc in 1970, by classes of ore or other source materials, in terms of recoverable metals**

Source	Number of mines	Material sold or treated (thousand short tons)	Gold (troy ounces)	Silver (thousand troy ounces)	Copper (thousand pounds)	Lead (thousand pounds)	Zinc (thousand pounds)
<b>Ore:</b>							
Dry gold.....	5	( <sup>1</sup> )	134	( <sup>1</sup> )	( <sup>1</sup> )	--	--
Gold-silver.....	3	( <sup>1</sup> )	72	1	( <sup>1</sup> )	2	( <sup>1</sup> )
Silver.....	9	544	902	13,688	5,916	3,109	1,497
Total <sup>2</sup> .....	17	544	1,108	13,689	5,916	3,111	1,498
Copper.....	4	2	27	2	176	( <sup>1</sup> )	--
Copper-lead and zinc <sup>3</sup> .....	3	16	3	17	1	792	2,936
Lead.....	13	86	26	326	45	6,450	1,018
Lead-zinc.....	15	912	1,959	5,055	1,085	111,436	76,280
Total <sup>2</sup> .....	34	965	2,015	5,400	1,307	118,677	80,234
<b>Other lode material: Lead-zinc cleanup, lead-zinc tailings, and zinc tailings <sup>3</sup>.....</b>							
	2	30	--	26	( <sup>1</sup> )	634	372
Total lode <sup>2</sup> .....	50	1,539	3,123	19,115	7,223	122,422	82,104
<b>Placer.....</b>							
	1	--	5	--	--	--	--
Total all sources <sup>2</sup> .....	51	1,539	3,128	19,115	7,223	122,422	82,104

<sup>1</sup> Less than ½ unit.

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

<sup>3</sup> Combined to avoid disclosing individual company confidential data.

**Table 8.—Idaho: Mine production of gold, silver, copper, lead, and zinc in 1970 by types of material processed and methods of recovery, in terms of recoverable metals**

Method of recovery and type of material processed	Gold (troy ounces)	Silver (thousand troy ounces)	Copper (thousand pounds)	Lead (thousand pounds)	Zinc (thousand pounds)
<b>Lode:</b>					
Amalgamation: Ore.....	129	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )
Smelting of concentrates from—					
Ore.....	2,852	19,041	7,029	121,376	81,492
Tailings.....	--	25	--	612	288
Total <sup>2</sup> .....	2,981	19,066	7,029	121,987	81,779
Direct smelting of—					
Ore.....	142	48	194	413	240
Tailings and cleanup.....	--	1	( <sup>1</sup> )	22	84
Total <sup>2</sup> .....	142	49	194	435	325
<b>Placer.....</b>					
	5	--	--	--	--
Grand total <sup>2</sup> .....	3,128	19,115	7,223	122,422	82,104

<sup>1</sup> Less than ½ unit.

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

**Gold.**—Production of gold fell 275 ounces, to 3,128 ounces, and the value declined 19 percent, to \$114,000.

Production was obtained from 28 lode mines throughout the State and one small placer operation in Owyhee County, but 88 percent of the output continued to be byproduct production from lead, zinc, and silver ores of the Coeur d'Alene region, in Shoshone County. The leading source was the Lucky Friday mine in Shoshone

County, which produced 1,305 ounces, or 42 percent of the State's total.

**Iron Ore.**—Production of iron ore, as measured by shipments, declined 25 percent from the 1969 total. The Iron Mountain magnetite deposit near Weiser, Washington County, operated by C & W Sand & Gravel Co., formerly Rock Island Gypsum Co., and magnetite from the Porter Bros. Corp. stockpile near Lowman, Boise County, accounted for all of the iron ore shipped.

The decline was due to iron "mill scale" replacing iron ore in the cementmaking process. Both companies terminated their operations and liquidated their stockpiles in 1970.

**Lead.**—Lead production of 61,211 tons was 7 percent lower than in 1969. However, the \$14.48-per-ton increase in the average annual price of lead resulted in only a 2-percent reduction in the value of lead production to a \$19,121,000 total. A \$2.5 million sintering plant at the Bunker Hill lead smelter near Kellogg was placed in operation in September. The new plant replaced 10 ore-roasting machines installed in 1917. Work continued at the \$3.8 million sulfuric acid plant adjacent to the smelter which, when completed in January 1971, will be used in conjunction with the Lurgi sintering machine to reduce SO<sub>2</sub> emissions by an estimated 90 percent. A \$210,000 effluent treatment facility was installed at the lead smelter to treat the smelter's waste water prior to its entering the Coeur d'Alene River. The first of four slag pots was reconditioned in July to institute a rebuilding program at the smelter which was scheduled to be continued through early 1971.

Silver Crystal Mines, Inc., developed ore from the No. 1 and No. 3 levels of the Bear Top mine and also completed repair work and explored veins on the No. 3 level of the adjoining Silver Crystal mine near Murray, Shoshone County.

**Mercury.**—The Idaho-Almaden mine near Weiser, Washington County, accounted for all the mercury production in the State. Production of 1,038 flasks, each containing 76 pounds of mercury, was slightly above the 1969 production. Total value of the mercury produced was \$423,000. A 17-percent decline in value resulted from a drop in the average annual market price to \$408 per flask, compared with \$505 per flask in 1969.

**Molybdenum.**—According to its annual report, American Smelting and Refining Co. (Asarco) deferred development work on its molybdenum project in the Little Boulder Creek area of the Challis National Forest pending completion of a Forest Service ecological study and supported the moratorium on mineral activity in the district.

**Silver.**—Production of silver increased from 18,930,000 ounces in 1969 to 19,115,000 ounces in 1970; the estimated

value decreased slightly to \$33,849,000. Sunshine Mining Co. was the leading silver producer in the State, and reported production of over 8,425,000 ounces from the Sunshine mine in the Coeur d'Alene mining region. Additional mines in the Coeur d'Alene area yielding substantial quantities of silver included Galena, Lucky Friday, Bunker Hill, and Crescent.

Asarco continued to seek deeper levels of production at the Galena property near Wallace. The No. 3 main hoisting shaft was extended below the 4,900-foot level. At the Callahan Project, east of the Galena mine, a 5,000-foot access adit was completed, and work continued on schedule in the second phase of the project, which consisted of installing a large underground hoist and related facilities for shaft sinking.

Sunshine Mining Co. awarded a \$2,834,000 contract to Vitro Corp. of America for a new silver refinery at Kellogg. Engineering work for the refinery was done by the Colorado School of Mines. At the Sunshine mine, ore was developed from the 5,000- and 5,200-foot levels in the Sunshine Unit area. Work continued on the No. 12 shaft with the primary purpose to explore and develop ore bodies associated with the Syndicate Fault.

Coeur D'Alene Mines Corp. began deepening the main shaft of the Silver Summit mine in the Osburn area. Day Mines, Inc., installed facilities for a new offset vertical winze below the 1,450-foot level of the Dayrock mine. Work was begun on developing the Hornet vein on the 1,600- and 1,700-foot levels. The Silver Star-Queens mine in Blaine County was closed by Federal Resources Corp. in April.

Exploration for silver continued at both the deep silver mines in the Coeur d'Alene region and drilling projects in various counties throughout the State. Sunshine Mining Co. explored in the Sunshine Unit area, the Silver Syndicate mine, and the Big Creek Apex area. At the Coeur Project, Asarco explored and developed ore on the 2,800-, 3,100-, and 3,400-foot levels and opened the 3,700-foot level to examine the veins at greater depth.

Exploration drilling and soil sampling for silver were conducted on properties of Silver Champion in the Mullan area, Shoshone County. An exploration program was conducted on Presta Creek leases near Priest River, Bonner County. Exploration for silver was also reported in the Mirror

Lake-Talache area southwest of Sandpoint in Bonner County and at the Mineral Ridge area of Kootenai County.

In other developments, the No. 2 shaft at the Crescent mine was deepened below the 3,900-foot level. Hecla Mining Co. completed installation of a 2,500-horsepower hoist at the Star-Morning mine's No. 4 shaft.

Development work continued on the lower levels of the Lucky Friday mine. Excavation of the 4,050-foot station was completed, and development of the 4,050-foot level was begun to drive into the DIA project ground, which includes the Gold Hunter (Day Mines, Inc.), Independence, and Abot properties lying northwest of Hecla Mining's Lucky Friday mine.

**Tungsten.**—The Tungsten Jim mine of the Salmon River Scheelite Corp. was the only reported tungsten producer in the State during the year. Total output was lower than that of 1969. Scheelite mineralization was reported at Mineral Ridge in Kootenai County. Midwest Oil Co. of Denver conducted exploration work at the Ima mine in Lemhi County.

**Vanadium.**—The production of vanadium in the State decreased 3 percent from that of 1969. Vanadium was recovered from byproduct ferrophosphorus at the Kerr-McGee Corp. plant at Soda Springs and Union Carbide Corp. plants at Hot Springs, Ark., and Rifle, Colo.

**Zinc.**—Total State production of zinc was 41,052 tons, down 27 percent from that of 1969. Reduced shipments from mines in the Coeur d'Alene region to The Bunker Hill Co. smelter and to other processors outside the State resulted in the lower production. An estimated annual price of 15.319 cents per pound resulted in a total value of \$12,578,000, down 23 percent from that of 1969. In April, The Bunker Hill Co. announced a 15-percent reduction in zinc production at Kellogg to bring its stock back into balance with market requirements.

The Star-Morning Unit area, Bunker Hill, and Lucky Friday mines in the Coeur d'Alene area continued to supply the major portion of the total zinc production in the State, accounting for 83 percent of the total.

#### NONMETALS

**Cement.**—Shipments of portland cement were moderately lower than those for 1969;

masonry cement shipments also declined. As in previous years, production was from operations of the Idaho Portland Cement Co. at Inkom, Bannock County.

**Clays.**—The quantity of miscellaneous clays sold or used by producers declined about 44 percent compared with the 1969 total. Miscellaneous clay, used in manufacturing structural clay products, was mined in Ada, Cassia, Elmore, Jefferson, and Minidoka Counties. Fire clay for refractories manufacture was mined near Helmer, Latah County, by A.P. Green Refractories Co. J.R. Simplot Co. produced kaolin from an operation in Latah County for use as filler clay by the paper industry.

**Fluorspar.**—Seaforth Mining Co., Cleveland, Ohio, announced plans for reactivating mining at the Meyers Cove fluorspar deposits in Lemhi County. Construction was begun on a heavy-media separation plant to treat and upgrade the fluorspar ore to a metallurgical-grade product. The last production from the Meyers Cove property was in 1953, when Fluorspar Mines, Inc., a subsidiary of J.R. Simplot Co., shipped concentrates to the General Services Administration for Government stockpiling. In April 1953, fire destroyed the beneficiating plant, and mining was suspended. Subsequently, the leases were surrendered by the Simplot firm.

**Garnet.**—Shipments of abrasive garnet were reduced sharply from those of the previous year. Output was from operations of the Idaho Garnet Abrasive Co. and Emerald Creek Garnet Miling Co., both near Fernwood, Benewah County. The processed material was used mainly as an airblast abrasive.

**Gem Stones.**—Digging sites in the State continued to be a source of gem stone materials that were suitable for cutting and polishing, and for finishing into mineral specimen displays. Collection, largely by individuals, continued to be centered at the star garnet digging area near Fernwood, Benewah County, and at the precious opal digging site northeast of Spencer, Clark County. Value of materials collected was estimated to have remained essentially the same as in 1969.

**Lime.**—Production of lime increased 16 percent compared with the 1969 total. Output, from lime kilns at beet-sugar refineries in Bonneville, Canyon, Minidoka, and Twin Falls Counties, was used in the processing of beet-sugar.

**Perlite.**—Production of crude perlite from the open pit operation of Oneida Perlite Corp. north of Malad, Oneida County, advanced 17 percent compared with the 1969 total. The crude material was screened, sized, and shipped to the firm's plant at Malad for expanding and storage. Crude perlite was used mainly as loose-fill insulation, concrete and plaster aggregate, and for soil conditioning.

**Phosphate Rock.**—Production of marketable phosphate rock by Idaho producers declined 6 percent compared with the total for 1969. J. R. Simplot Co. continued producing from the Conda and Gay mines, in Caribou and Bingham Counties, respectively. Monsanto Co. production was from the Henry mine in Caribou County. Stauffer Chemical Co. continued mining at the Wooley Valley Deposits, Caribou County. The Stauffer production was shipped to the firm's elemental phosphorus plant at Silver Bow, Mont.

Elemental phosphorus was produced by FMC. Corp., Mineral Products Division,

Pocatello, Power County, and Monsanto Co., Soda Springs, Caribou County. Output was shipped to phosphorus conversion plants of the respective firms in the Western and Midwestern States for manufacturing into industrial phosphate products.

J. R. Simplot Co. manufactured phosphate fertilizer products at the Pocatello works. Phosphate rock from company mines in Bingham and Caribou Counties supplied the raw material requirements. The Bunker Hill Co. marketed phosphate fertilizer products at Kellogg, Shoshone County. Purchased calcined phosphate rock and sulfuric acid manufactured from waste gases at the firm's Kellogg smelter complex were the principal raw materials used in manufacturing the fertilizer products.

**Pumice.**—Production of pumice, principally from operations in Bonneville and Oneida Counties, registered a sharp increase compared with output of the previous year. Volcanic scoria was mined in

**Table 9.—Idaho: Sand and gravel sold or used by producers, by classes of operations and uses**  
(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building .....	299	\$421	188	\$327
Fill .....	24	16	28	22
Paving .....	74	114	22	44
Other uses <sup>1</sup> .....	54	289	1,019	628
Total <sup>2</sup> .....	450	839	1,258	1,020
Gravel:				
Building .....	345	511	275	491
Fill .....	167	114	2,494	1,414
Paving .....	1,078	1,158	748	829
Other uses <sup>3</sup> .....	79	74	122	157
Total <sup>2</sup> .....	1,669	1,858	3,637	2,890
<b>Government-and-contractor operations:</b>				
Sand:				
Fill .....	3	2	20	1
Paving .....	76	94	4,651	3,893
Other uses .....	1	( <sup>4</sup> )	10	2
Total <sup>2</sup> .....	80	96	4,681	3,896
Gravel:				
Building .....	1	5	66	80
Fill .....	5,801	4,496	706	86
Paving .....	544	279	2,020	1,750
Other uses .....	9	9	585	299
Total <sup>2</sup> .....	6,355	4,789	3,377	2,215
Total sand and gravel <sup>2</sup> .....	8,555	7,583	12,953	10,022

<sup>1</sup> Includes railroad ballast (1969), and sand for other uses.

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

<sup>3</sup> Includes railroad ballast (1969), miscellaneous and other gravel.

<sup>4</sup> Less than ½ unit.

Canyon County. Production by commercial firms was used largely as an aggregate and admixture for lightweight concrete; smaller quantities of scoria went for ballast and decorative landscaping uses.

**Sand and Gravel.**—Sand and gravel production increased 51 percent, to 12,954,000 short tons, despite the decline in construction employment and the heavy rains which hindered large State projects. The value of production increased 32 percent, to \$10,022,000. Clearwater County was the principal producing area, and production exceeded 300,000 tons in each of the following counties: Ada, Bonneville, Canyon, Teton and Twin Falls. Sand and gravel production was reported from operations in 33 of the 44 counties in the State; however, significant tonnages were also pro-

duced that could not be assigned to a specific county of origin.

**Stone.**—Production of stone rose 13 percent in quantity, but declined less than 1 percent in value. The 21 quarries operating in 1970 produced 4.2 million short tons of stone valued at \$6.4 million. Clearwater County, with 5 quarries, produced 2,931,458 short tons. Other major producing counties were Bannock, Caribou, Idaho, and Latah.

#### MINERAL FUELS

**Peat.**—Production of reed-sedge peat from an operation near Downey, Bannock County, was continued by Idaho Peat Co., Inc. Output went mainly for horticultural and general soil improvement uses.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
<b>METALS</b>			
Antimony: Sunshine Mining Co. ....	Kellogg, Idaho 83837	Mine and plant	Shoshone.
Copper:			
Sunshine Mining Co. ....	Kellogg, Idaho 83837	Mine and mill	Do.
American Smelting & Refining Co. ....	Wallace, Idaho 83873	do	Do.
Gold:			
The Bunker Hill Co. ....	Kellogg, Idaho 83837	do	Do.
Sunshine Mining Co. ....	Kellogg, Idaho 83837	do	Do.
American Smelting & Refining Co. ....	Wallace, Idaho 83873	do	Do.
Hecla Mining Co. ....	Wallace, Idaho 83873	do	Do.
Iron Ore: C & W Sand & Gravel Co. ....	Route 1, Weiser, Idaho 83672	Mine	Washington.
Lead:			
American Smelting & Refining Co. ....	Wallace, Idaho 83873	Mine and mill	Shoshone.
The Bunker Hill Co. ....	Kellogg, Idaho 83837	Mine, mill, smelter.	Do.
Canyon Silver Mines, Inc. ....	Wallace, Idaho 83873	Mine	Do.
Clayton Silver Mines ....	Wallace, Idaho 83873	Mine and mill	Custer.
Day Mines, Inc. ....	Wallace, Idaho 83873	do	Shoshone.
Federal Resources Corp. ....	Mine—Hailey, Idaho 83333	Mine	Blaine.
Hecla Mining Co. ....	Mill—Bellevue, Idaho 83313	Mill	Do.
Mercury: El Paso Natural Gas Co. ....	Wallace, Idaho 83873	Mine and mill	Shoshone.
	P.O. Box 1492	Mine and plant	Washington.
	El Paso, Tex. 79999		
	(Weiser, Idaho 83673)		
Silver:			
American Smelting & Refining Co. ....	Wallace, Idaho 83873	Mine and mill	Shoshone.
The Bunker Hill Co. ....	Kellogg, Idaho 83837	do	Do.
Clayton Silver Mines ....	Wallace, Idaho 83873	do	Custer.
Day Mines, Inc. ....	Wallace, Idaho 83873	do	Shoshone.
Hecla Mining Co. ....	Wallace, Idaho 83873	do	Do.
Sunshine Mining Co. ....	Kellogg, Idaho 83837	do	Do.
Tungsten: Salmon River Scheelite Corp. ....	Clayton, Idaho 83227	Mine and plant	Custer.
Vanadium: Kerr-McGee Corp. ....	Soda Springs, Idaho 83276	Plant	Caribou.
Zinc:			
The Bunker Hill Co. ....	Kellogg, Idaho 83837	Mine, mill, smelter.	Do.
Canyon Silver Mines, Inc. ....	Wallace, Idaho 83873	Mine	Shoshone.
Clayton Silver Mines ....	Wallace, Idaho 83873	Mine and mill	Custer.
Day Mines, Inc. ....	Wallace, Idaho 83873	do	Caribou.
Federal Resources Corp. ....	Mine—Hailey, Idaho 83333	do	Blaine.
Hecla Mining Co. ....	Mill—Bellevue, Idaho 83313	do	Do.
<b>NONMETALS</b>			
Cement: Idaho Portland Cement Co. ....	Inkom, Idaho 83245	Plant	Bannock.
Clays:			
Burley Brick & Sand Co. ....	P.O. Box 497 Burley, Idaho 83318	Pit and plant	Cassia.
A. P. Green Refractories Co. ....	Troy, Idaho 83871	do	Latah.
Idaho Falls Brick & Tile Co., Inc. ....	Route 3, Box 53 Idaho Falls, Idaho 83401	do	Jefferson.

See footnote at end of table.

Table 10.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
NONMETALS—Continued			
Clays—Continued			
Pullman Brick Co., Inc.-----	7901 Warm Springs Ave. Boise, Idaho 83706	Pit and plant.---	Ada, Elmore.
J. R. Simplot-----	P.O. Box 647 Bovill, Idaho 83806	---do-----	Latah.
Snake River Pottery-----	Bliss, Idaho 83314-----	---do-----	Twin Falls.
Garnet:			
Emerald Creek Garnet Milling Co.---	Box 192 Kellogg, Idaho 83837	Mine and plant---	Benewah.
Idaho Garnet Abrasive Co.-----	P.O. Box 1080 Kellogg, Idaho 83837	---do-----	Do.
Peat: Idaho Peat, Inc.-----	Downey, Idaho 83234-----	Bog	Bannock.
Perlite (crude and exported): Oneida Perlite Corp.-----	P.O. Box 162 Malad City, Idaho 83252	Pit and plant.---	Oneida.
Phosphate Rock:			
Monsanto Co.-----	Soda Springs, Idaho 83276-----	Mine and plant---	Caribou.
J. R. Simplot Co.-----	Box 912, Pocatello, Idaho 83201	Mine-----	Bingham.
Stauffer Chemical Co.-----	Conda, Idaho 83230-----	Mine and plant---	Caribou.
	Box 160, Montpelier, Idaho 83245	Mine-----	Do.
Pumice:			
Hess Pumice Products-----	P.O. Box 209 Malad City, Idaho 83252	Mine and plant---	Oneida.
Producer's Pumice-----	2743 East Lincoln Idaho Falls, Idaho 83401	Mine-----	Bonneville.
Western Block, Inc.-----	224 First St. South Nampa, Idaho 83651	---do-----	Canyon.
Sand and Gravel:			
Curtis Construction Co.-----	1401 North Fancher Rd. Spokane, Wash. 99206	Stationary plant.	Clearwater.
DeAtley Corp.-----	Box 648 Lewiston, Idaho 83501	Pit and plant.---	Nez Perce.
Quinn Robbins Co., Inc.-----	703 South 16th Boise, Idaho 83707	---do-----	Ada.
Bryon C. Rambo Crushing Co.-----	Nampa, Idaho 83651-----	---do-----	Canyon.
Strang Sand & Gravel-----	Route 2, Nampa, Idaho 83651.	Stationary plant.	Do.
Twin Falls Construction Co.-----	Box 325 Twin Falls, Idaho 83301	Pit and plant.---	Twin Falls.
Stone:			
DeAtley Corp.-----	Box 648 Lewiston, Idaho 83501	Quarry and plant.	Clearwater, Nez Perce.
N. A. Degerstrom-----	E15 32nd St. Spokane, Wash. 99203	---do-----	Benewah.
Dworshak Dam Construction-----	Box 1422 Orofino, Idaho 83544	---do-----	Clearwater.
L. C. Fountain & Sons-----	636 2d St. Clarkstown, Wash. 99403	---do-----	Latah.
Idaho Portland Cement Co.-----	Inkom, Idaho 83245-----	Pit and plant.---	Bannock.
Materne Bros.-----	Box 0, Rosewood Station Spokane, Wash. 99208	---do-----	Various.
Monsanto Chemical Co.-----	800 North Lindberg Ave. St. Louis, Mo. 63166	---do-----	Caribou.
Sather & Sons-----	Box 326, Parkwater Station Spokane, Wash. 99211	---do-----	Clearwater.

<sup>1</sup> Recovered from byproduct ferrophosphorus.





# The Mineral Industry of Illinois

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

By Grace N. Broderick <sup>1</sup>

In 1970, the value of mineral production in Illinois was nearly \$689 million, an increase of 4.4 percent over that of 1969. Increases in value were recorded for coal, fluorspar, lead, natural gas, sand and gravel, stone, zinc, and natural gasoline. Decreases occurred in values of cement, clays, petroleum, peat, lime, liquefied petroleum gases, and tripoli. Mineral fuels accounted for the major part of the total mineral value.

Illinois continued to rank first among the States producing fluorspar, providing about 55 percent of the Nation's total for 1970. The State ranked second in stone production, fourth in sand and gravel, and fourth in coal output. Illinois also ranked high in the processing of mineral raw materials.

<sup>1</sup> Physical scientist, Division of Ferrous Metals.

Table I.—Mineral production in Illinois <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland..... thousand 376-pound barrels	8,720	\$29,996	7,946	\$25,252
Masonry..... thousand 280-pound barrels	603	2,137	508	1,874
Clays <sup>2</sup> ..... thousand short tons	1,863	4,321	1,676	3,862
Coal (bituminous)..... do	64,722	279,712	65,119	320,705
Fluorspar..... short tons	88,480	4,676	148,208	8,637
Lead (recoverable content of ores, etc.)..... do	791	236	1,532	479
Natural gas..... million cubic feet	3,800	536	4,850	761
Peat..... thousand short tons	67	958	63	711
Petroleum (crude)..... thousand 42-gallon barrels	50,724	161,302	43,747	141,994
Sand and gravel..... thousand short tons	44,138	56,688	43,926	60,155
Stone..... do	54,857	81,318	55,776	86,502
Zinc (recoverable content of ores, etc.)..... short tons	13,765	4,019	16,797	5,146
Value of items that cannot be disclosed: Fuller's earth, gem stones, lime, natural gas liquids, and tripoli.....	XX	33,916	XX	32,619
Total.....	XX	659,815	XX	688,697
Total 1967 constant dollars.....	XX	623,063	XX	623,271

<sup>p</sup> Preliminary. 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, included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Illinois, by counties<sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Adams	\$2,639	W	Stone, lime, sand and gravel, petroleum.
Alexander	278	\$240	Tripoli, sand and gravel, stone.
Bond	583	W	Sand and gravel, petroleum, clays.
Boone	458	W	Stone, sand and gravel.
Brown	23	W	Stone, sand and gravel, clays, petroleum.
Bureau	682	825	Sand and gravel.
Calhoun	W	W	Stone.
Carroll	365	W	Stone, sand and gravel.
Cass	26	—	—
Champaign	789	748	Sand and gravel, petroleum.
Christian	W	W	Coal, petroleum, stone.
Clark <sup>2</sup>	2,988	3,084	Petroleum, stone, sand and gravel.
Clay	W	W	Petroleum, stone.
Clinton	3,126	2,691	Petroleum, stone, sand and gravel.
Coles	W	W	Do.
Cook	42,348	39,575	Stone, lime, sand and gravel, clays, peat.
Crawford	W	W	Petroleum, sand and gravel.
Cumberland <sup>2</sup>	W	205	Sand and gravel.
De Kalb	721	W	Stone, sand and gravel.
De Witt	989	1,001	Petroleum, sand and gravel.
Douglas	W	W	Coal, petroleum.
Du Page	W	W	Stone, sand and gravel.
Edgar	316	308	Petroleum.
Edwards	2,549	W	Petroleum, sand and gravel.
Effingham	2,057	W	Do.
Fayette	18,586	16,239	Petroleum, stone, sand and gravel, clays.
Ford	277	334	Sand and gravel.
Franklin	W	44,549	Coal, petroleum.
Fulton	29,886	28,206	Coal, sand and gravel.
Gallatin	W	W	Coal, petroleum, sand and gravel.
Greene	653	W	Stone.
Grundy	4,929	W	Sand and gravel, clays.
Hamilton	6,908	5,320	Petroleum.
Hancock	<sup>2</sup> 785	687	Stone.
Hardin	8,894	14,952	Fluorspar, stone, zinc, lead.
Henderson	564	458	Stone.
Henry	W	W	Stone, sand and gravel.
Iroquois	19	W	Sand and gravel.
Jackson	804	1,255	Stone, coal, sand and gravel.
Jasper	4,237	3,434	Petroleum.
Jefferson	W	W	Coal, petroleum.
Jersey	169	199	Stone.
Jo Daviess	3,039	2,377	Zinc, stone, lead, sand and gravel.
Johnson	W	W	Stone, sand and gravel.
Kane	7,213	7,557	Sand and gravel, stone.
Kankakee	3,393	9,832	Coal, stone, clays, sand and gravel.
Kendall	W	W	Stone, sand and gravel.
Knox	W	W	Coal, stone, clays.
Lake	1,000	W	Sand and gravel, peat.
La Salle	29,959	W	Sand and gravel, cement, clays, stone.
Lawrence	18,445	17,273	Petroleum, sand and gravel.
Lee	W	W	Cement, stone, sand and gravel.
Livingston	3,280	W	Stone, clays, sand and gravel.
Logan	676	W	Stone, sand and gravel.
McDonough	<sup>2</sup> W	W	Stone, petroleum, clays.
McHenry	6,656	6,691	Sand and gravel, stone.
McLean	804	1,256	Sand and gravel.
Macon	415	593	Sand and gravel, petroleum.
Macoupin	253	W	Coal, stone, petroleum.
Madison	2,749	W	Stone, sand and gravel, petroleum.
Marion	W	W	Petroleum, stone.
Marshall	W	W	Sand and gravel.
Mason	W	W	Do.
Massac	W	W	Cement, stone, sand and gravel.
Menard	W	W	Stone.
Mercer	300	415	Coal, stone, sand and gravel.
Monroe	W	W	Stone.
Montgomery	W	W	Coal, stone, petroleum.
Morgan	14,760	2	Sand and gravel.
Moultrie	W	W	Sand and gravel, petroleum.
Ogle	2,503	W	Sand and gravel, stone.
Peoria	13,513	15,977	Coal, sand and gravel, stone.
Perry	38,349	30,517	Coal, petroleum.
Pike	1,387	W	Stone, sand and gravel.
Pope	4	69	Coal, sand and gravel.
Pulaski	W	W	Clays, stone, sand and gravel.
Putnam	W	W	Sand and gravel.
Randolph	12,296	W	Coal, stone, petroleum, sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Illinois, by counties<sup>1</sup>—Continued  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Richland.....	\$6,850	\$5,570	Petroleum.
Rock Island.....	2,574	W	Stone, sand and gravel.
St. Clair.....	29,371	W	Coal, stone, petroleum, sand and gravel, clays.
Saline.....	W	21,600	Coal, petroleum.
Sangamon.....	1,658	W	Sand and gravel, petroleum, clays.
Schuyler.....	W	W	Sand and gravel, stone.
Scott.....	309	245	Stone, clays, sand and gravel.
Shelby.....	464	473	Sand and gravel, petroleum, stone.
Stark.....	W	W	Coal, sand and gravel.
Stephenson.....	803	770	Stone, sand and gravel.
Tazewell.....	1,396	W	Sand and gravel, clays.
Union.....	W	W	Stone, sand and gravel.
Vermilion.....	6,179	W	Stone, coal, sand and gravel, clays.
Wabash.....	W	W	Petroleum, sand and gravel.
Warren.....	W	W	Stone.
Washington.....	W	W	Petroleum, stone.
Wayne.....	18,003	15,778	Petroleum.
White.....	23,266	W	Petroleum, sand and gravel.
Whiteside.....	1,363	1,260	Peat, sand and gravel, stone.
Will.....	11,843	10,143	Stone, sand and gravel.
Williamson.....	21,573	23,101	Coal, petroleum.
Winnebago.....	2,677	2,031	Sand and gravel, stone.
Woodford.....	548	W	Sand and gravel.
Undistributed <sup>2</sup> .....	232,301	350,355	
Total <sup>4</sup> .....	659,815	688,697	

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

<sup>1</sup> Data for natural gas and natural gas liquids are not available on a county basis; however, value for these commodities are included with "Undistributed." Piatt County is not included because no production was reported.

<sup>2</sup> Value of petroleum production in Cumberland County included with Clark County, and in 1969, McDonough County with Hancock County because actual source of production cannot be identified.

<sup>3</sup> Includes value for natural gas, natural gas liquids, and gem stones that cannot be assigned to specific counties, and values indicated by symbol W.

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

Table 3.—Indicators of Illinois business activity

	1969	1970	Change, percent
Labor force and employment, annual average:			
Total labor force.....	thousands.. 5,033.7	5,063.0	+ .6
Unemployment.....	do.. 147.5	149.8	+1.6
Employment:			
Manufacturing.....	do.. 1,400.2	1,344.1	-4.0
Construction.....	do.. 193.3	184.4	-4.6
Mining.....	do.. 23.3	23.0	-1.3
Transportation and public utilities.....	do.. 287.9	285.1	-1.0
Wholesale and retail trade.....	do.. 939.3	942.7	+ .4
Finance, insurance, and real estate.....	do.. 227.6	233.9	+2.8
Services.....	do.. 671.1	684.4	+2.0
Government.....	do.. 615.6	639.8	+3.9
Personal income:			
Total.....	millions.. \$47,340	\$50,325	+6.3
Per capita.....	do.. \$4,288	\$4,516	+5.3
Construction activity:			
Building permits:			
Valuation of authorized nonresidential private construction.....	millions.. \$823.2	\$614.6	-25.3
Number of private and public residential permits issued.....	68,278	54,905	-19.5
State highway division:			
Contracts awarded.....	millions.. \$332.0	\$435.0	+31.0
Portland cement shipments to and within Illinois.....	thousand 376-pound barrels.. 19,580	17,595	-10.1
Farm marketing receipts.....	millions.. \$2,703	\$2,742	+1.4
Mineral production.....	do.. \$659.8	\$688.7	+4.4

Sources: Survey of Current Business; Area Trends in Employment and Unemployment; Employment and Earnings; Construction Review; Farm Income Situation; Streets and Roads; and U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Coal.....	8,566	266	2,283	17,832	12	699	39.87	5,793
Peat.....	41	62	3	23	--	--	--	--
Metal.....	52	276	14	115	--	7	60.85	1,852
Nonmetal.....	1,068	240	257	2,084	--	49	23.51	962
Sand and gravel.....	1,668	226	378	3,240	--	50	15.43	1,018
Stone.....	3,541	272	963	7,983	2	170	21.55	2,501
Total <sup>1</sup> .....	14,936	261	3,897	31,277	14	975	31.62	4,117
<b>1970<sup>p</sup></b>								
Coal.....	9,100	266	2,428	18,982	15	730	39.20	6,470
Peat.....	49	62	3	29	--	1	34.60	104
Metal.....	55	257	15	117	1	8	76.88	69,271
Nonmetal.....	1,000	266	266	2,159	--	74	34.27	3,992
Sand and gravel.....	1,640	232	381	3,295	--	54	16.39	714
Stone.....	3,475	270	938	7,794	3	172	22.45	3,145
Total <sup>1</sup> .....	15,350	263	4,030	32,376	19	1,039	32.68	5,140

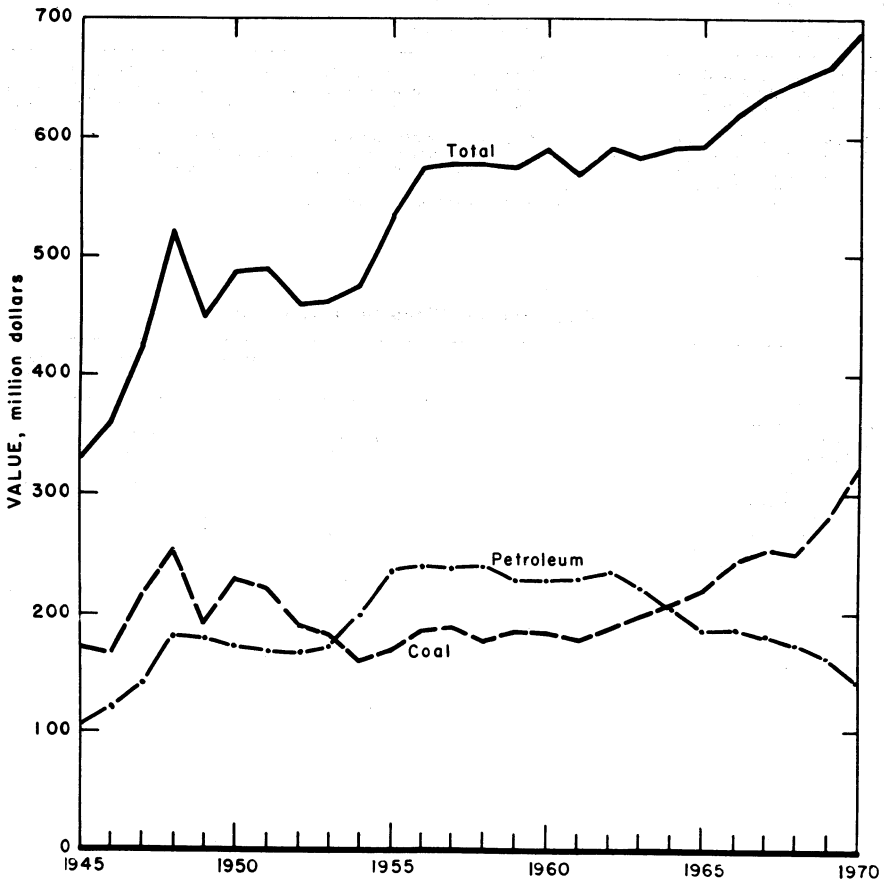
<sup>p</sup> Preliminary.<sup>1</sup> Data may not add to totals shown because of independent rounding.

Figure 1.—Value of coal, petroleum, and total value of mineral production in Illinois.

## REVIEW BY MINERAL COMMODITIES

## MINERAL FUELS

**Coal (Bituminous).**—Illinois continued to rank as the fourth largest coal-producing State, with production of 65.1 million tons valued at \$320.7 million, representing a slight increase in tonnage and an increase of more than 14 percent in value over the 1969 figures. The value of bituminous coal production accounted for 47 percent of the State's total mineral production value. Strikes during the first quarter of 1970 contributed to holding down bituminous coal production.

Production in 1970, excluding mines producing less than 1,000 short tons per year, was reported by 59 mines operating in 21 counties. Major producing counties, in order of decreasing tonnage, were Franklin, Perry, St. Clair, Jefferson, Fulton, Christian, Williamson, Randolph, Saline, Gallatin, Peoria, Montgomery, Knox, and Douglas. The sixth largest producing bituminous coal mine in the United States was Peabody No. 10 in Christian County. A little more than half of the coal produced in the State was from strip mines.

Four strip coal mines owned and operated by Peabody Coal Co., a wholly owned

subsidiary of Kennecott Copper Corp., were sold to the American Smelting and Refining Co. (Asarco). The four mines—Allendale, Edwards, Elm, and Mecco—are located in northern Illinois and have a capacity of about 6 million tons per year. Midland Coal Co., a newly formed division of Asarco, will operate the properties.

New coal mines opened in 1970 included the following: Peabody Coal Co.'s Midwest Highwall No. 3 and River King Highwall underground mines in St. Clair County, and Elm No. 2 strip mine in Fulton County; Big Ridge Coal Co.'s strip mine in Saline County; Sahara Coal Co., Inc.'s No. 20 underground mine in Saline County; Monterey No. 1, an underground mine in Macoupin County, operated by Monterey Coal Co., a subsidiary of Carter Oil Co.; E & L Coal Co.'s strip mine in Williamson County; and Mt. Zion Mining Co.'s strip mine in Pope County.

Mines abandoned during the year were the Harmattan strip mine of Ayrshire Coal Co. in Vermilion County, an underground mine of Belle Valley Coal Co. Inc. in St. Clair County, and Peabody Coal Co.'s Midwest Highwall No. 2 underground mine in St. Clair County.

**Table 5.—Illinois: Coal (bituminous) production, by type of mine and counties**  
(Excludes mines producing less than 1,000 short tons per year)

County	Number of mines <sup>1</sup>			Production <sup>1</sup> (thousand short tons)			Value (thousands)
	Under-ground	Strip	Total	Under-ground	Strip	Total <sup>2</sup>	
Christian	1	--	1	4,900	--	4,900	W
Douglas	1	--	1	1,140	--	1,140	W
Franklin	4	--	4	8,324	--	8,324	\$41,446
Fulton	--	4	4	--	5,635	5,635	27,510
Gallatin	2	1	3	2,149	749	2,898	14,932
Jackson	--	2	2	--	134	134	W
Jefferson	3	--	3	6,395	--	6,395	W
Kankakee	--	1	1	--	976	976	W
Knox	1	--	1	262	--	262	W
Macoupin	1	1	2	36	6	42	W
Mercer	1	--	1	2,651	--	2,651	W
Montgomery	--	3	3	--	2,875	2,875	W
Peoria	--	3	3	--	8,086	8,086	W
Perry	--	2	2	--	12	12	W
Pope	1	2	3	827	2,767	3,594	W
Randolph	3	3	6	1,384	5,992	7,376	32,145
St. Clair	3	4	7	1,519	1,938	3,457	19,795
Saline	--	1	1	--	622	622	W
Stark	2	1	3	65	185	250	W
Vermilion	4	2	6	2,441	1,520	3,961	22,588
Williamson	--	--	--	--	--	--	162,288
Undistributed <sup>3</sup>	--	--	--	--	--	--	--
<b>Total <sup>2</sup></b>	<b>28</b>	<b>81</b>	<b>59</b>	<b>32,093</b>	<b>33,026</b>	<b>65,119</b>	<b>320,705</b>

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

<sup>1</sup> No auger operations reported.

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

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

Table 6.—Shipments of bituminous coal for consumption in Illinois  
by district of origin and consumer use  
(Thousand short tons)

	District of origin <sup>1</sup>									Total
	1	3 and 6	4	7 and 8	9	10	11	15	19	
1966:										
Electric utilities.....	--	--	--	--	2,198	25,058	552	--	--	27,808
Coke and gas plants.....	--	--	--	2,113	--	1,513	--	--	--	3,626
Retail dealers.....	--	8	13	1,364	930	1,889	59	--	--	4,263
All others.....	--	55	--	740	256	9,113	521	--	--	10,685
Total.....	--	63	13	4,217	3,384	37,573	1,132	--	--	46,382
1967:										
Electric utilities.....	--	--	--	17	2,121	26,825	534	--	--	29,497
Coke and gas plants.....	--	110	--	1,871	--	1,468	--	--	--	3,449
Retail dealers.....	--	5	12	1,342	847	1,831	37	--	--	4,074
All others.....	--	52	--	553	182	8,386	517	--	--	9,690
Total.....	--	167	12	3,783	3,150	38,510	1,088	--	--	46,710
1968:										
Electric utilities.....	--	12	127	12	1,885	25,539	646	--	--	28,221
Coke and gas plants.....	--	196	--	1,673	--	1,200	--	--	--	3,069
Retail dealers.....	--	--	11	1,231	665	1,362	43	--	--	3,312
All others.....	--	41	--	484	258	7,618	462	--	--	8,863
Total.....	--	249	138	3,400	2,808	35,719	1,151	--	--	43,465
1969:										
Electric utilities.....	--	4	--	--	3,063	26,622	656	--	48	30,393
Coke and gas plants.....	--	99	--	2,076	--	1,538	--	--	--	3,713
Retail dealers.....	--	--	14	1,237	537	1,141	48	--	--	3,077
All others.....	22	45	--	356	254	7,102	282	--	--	8,061
Total.....	22	148	14	3,719	3,904	36,403	986	--	48	45,244
1970:										
Electric utilities.....	--	--	--	1	2,175	25,688	514	--	1,075	29,453
Coke and gas plants.....	--	1	--	2,069	--	1,618	--	--	--	3,688
Retail dealers.....	--	--	5	1,329	237	1,015	2	3	--	2,591
All others.....	13	29	--	447	188	5,657	245	--	--	6,579
Total.....	13	30	5	3,846	2,600	33,978	761	3	1,075	42,311

<sup>1</sup> States or portion of States represented by each district are as follows: District 1—Maryland, eastern Pennsylvania, and eastern West Virginia; 3 and 6—northern West Virginia; 4—Ohio; 7 and 8—eastern Kentucky, Virginia, southern West Virginia, and north-central Tennessee; 9—western Kentucky; 10—Illinois; 11—Indiana; 15—Kansas, Missouri, and Oklahoma; 19—Idaho and Wyoming.

An experimental plant in Chicago began using a new coal-to-gas conversion process known as Hygas. The process was developed by the Institute of Gas Technology, a Chicago affiliate of the Illinois Institute of Technology.

**Coke.**—Coke was produced at five plants in the State in 1970. Total production of 2,356,000 short tons represented a slight increase over the 2,341,000 short tons produced in 1969. The majority of the coke was consumed by the producing companies. About 97.6 percent of the total production was used in blast furnaces. Nearly 3.7 million tons of coal was carbonized at Illinois coke plants, of which about 43 percent came from Illinois, 54 percent from Kentucky and West Virginia, and the remainder from Pennsylvania and Virginia.

About 206,000 tons of coke breeze was recovered at the producing plants, an increase of 3.5 percent over that of 1969. Other by-products of coke-oven operations in the State included coke-oven gas, ammonia, tar, crude light oil, and light-oil derivatives.

**Peat.**—In 1970, Illinois produced 62,990 short tons of peat, a decrease of more than 6 percent from the 67,330 short tons produced in 1969. Production was reported by six companies from Cook, Lake, and Whiteside Counties.

Sales totaling 63,341 short tons at an average value of \$11.23 per ton were almost 6 percent less and averaged \$2.99 per ton less than in 1969. Humus was sold in bulk form; moss and reed-sedge were sold in bulk and packaged forms. Of all sales, 84.6 percent were in packaged form. The majority of the

peat was used for general soil improvement; a small amount was used for potting soils.

Illinois continued to rank second in output of peat in the United States, accounting for more than 12 percent of the nation's total.

**Petroleum, Natural Gas, and Natural Gas Liquids.**—For the eighth consecutive year crude petroleum production declined. Output decreased 13.8 percent in quantity and 12 percent in value. According to the American Petroleum Institute, reserves of crude oil were 228,680,000 barrels on December 31, 1970, a decrease of 43,435,000 barrels from that of the previous year.

The American Petroleum Institute reported the completion of 697 wells in 1970;

311 were producing oil wells, five were gas wells, 201 were dry holes in proven fields, and 180 were unsuccessful wildcats. The total footage drilled in new wells was 1,592,697, of which 1,177,490 was in development completions and 415,207 was in exploratory completions.

Proved reserves of natural gas on December 31, 1970, were 415,414 million cubic feet, according to the American Gas Association, an increase of 77,602 million cubic feet over 1969 estimates.

Proved recoverable reserves of natural gas liquids totaled 1,135,000 barrels on December 31, 1970, according to the American Gas Association, a decline of 337,000 barrels from that of 1969.

**Table 7.—Illinois: Crude petroleum production, by counties**  
(Thousand 42-gallon barrels and thousand dollars)

County	1969		1970	
	Quantity <sup>1</sup>	Value <sup>2</sup>	Quantity <sup>1</sup>	Value <sup>2</sup>
Adams.....	4	\$13	3	\$10
Bond.....	66	209	68	221
Brown.....	2	5	1	3
Champaign.....	( <sup>3</sup> )	( <sup>3</sup> )	1	3
Christian.....	364	1,158	452	1,467
Clark <sup>4</sup> .....	525	1,670	499	1,620
Clay.....	2,808	8,981	2,168	7,087
Clinton.....	908	2,888	743	2,412
Coles.....	455	1,447	342	1,110
Crawford.....	2,271	7,223	2,010	6,524
Cumberland.....	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )	( <sup>4</sup> )
De Witt.....	214	679	192	623
Douglas.....	45	142	50	162
Edgar.....	99	316	95	308
Edwards.....	785	2,496	732	2,376
Effingham.....	645	2,051	452	1,467
Fayette.....	5,645	17,951	4,780	15,515
Franklin.....	1,244	3,956	956	3,103
Gallatin.....	1,036	3,296	833	2,704
Hamilton.....	2,172	6,908	1,639	5,320
Hancock.....	437	1,116	--	--
Jasper.....	1,332	4,237	1,058	3,434
Jefferson.....	1,293	4,113	1,133	3,677
Lawrence.....	5,714	18,170	5,230	16,975
McDonough.....	( <sup>4</sup> )	( <sup>4</sup> )	39	127
Macon.....	10	33	9	29
Macoupin.....	8	26	3	10
Madison.....	150	476	121	393
Marion.....	3,777	12,012	3,584	11,633
Montgomery.....	2	5	1	3
Moultrie.....	4	12	4	13
Perry.....	21	66	19	62
Randolph.....	133	421	118	383
Richland.....	2,154	6,850	1,716	5,570
St. Clair.....	110	351	115	373
Saline.....	694	2,207	556	1,805
Sangamon.....	220	699	201	652
Shelby.....	58	185	43	140
Wabash.....	2,064	6,562	1,770	5,745
Washington.....	756	2,405	760	2,467
Wayne.....	5,661	18,003	4,861	15,778
White.....	7,102	22,585	6,232	20,228
Williamson.....	135	429	158	513
Total <sup>5</sup> .....	50,724	161,302	43,747	141,994

<sup>1</sup> Source: Illinois Geological Survey.

<sup>2</sup> County values calculated by using State average value per barrel; \$3.18 for 1969 and \$3.25 for 1970.

<sup>3</sup> Less than ½ unit.

<sup>4</sup> Production of Cumberland County included with Clark County, and McDonough County with Hancock County because actual source of production cannot be identified.

<sup>5</sup> Data may not add to totals shown because of independent rounding.



Two of the new oil fields, Roby East in Christian County and Clear Lake East in Sangamon County, produce from Silurian strata. The new gas field, Corinth South in Williamson County, and two other new oil fields, Stringtown South in Richland County and Stewardson West in Shelby County, produce from Mississippian strata. Each of the new fields, except Roby East, had only one well producing at the end of 1970. Roby East had 18 producing wells, with initial production figures on individual wells ranging from six to 1,008 barrels of oil per day and averaging 218 barrels. In addition to the wells completed, several additional wells have been staked or are being drilled in this field.

## NONMETALS

**Cement.**—Portland and masonry cements were produced by four companies with plants in La Salle, Lee, and Massac Counties. Portland cement shipments decreased 9 percent in quantity and 16 percent in value. Shipments of masonry cement declined nearly 16 percent in quantity and over 12 percent in value.

Alpha Portland Cement Co. closed its La Salle cement plant at the end of 1970. The Marquette Cement Manufacturing Co. resumed operations at its Oglesby mill and announced plans to modernize the plant.

**Clays.**—Total production of fire clay and miscellaneous clay and shale decreased

Table 8.—Illinois: Oil and gas well drilling completions, by counties

County	Proved field wells			Exploratory wells			Total number of wells	Footage
	Oil	Gas	Dry	Oil	Gas	Dry		
Adams	--	--	1	--	--	--	1	687
Bond	--	--	1	--	--	3	4	4,714
Brown	--	--	1	--	--	--	1	572
Champaign	--	--	--	--	--	--	--	310
Christian	20	--	17	--	--	13	54	108,073
Clark	2	--	3	4	--	--	2	6,971
Clay	28	--	18	1	--	--	4	141,768
Clinton	2	--	4	--	--	17	23	32,906
Coles	5	1	--	--	--	1	7	14,897
Crawford	20	1	4	--	--	2	27	40,064
Cumberland	1	--	--	--	--	1	2	4,999
De Witt	--	--	4	--	--	2	2	2,861
Douglas	3	--	7	--	--	3	10	15,998
Edgar	--	1	2	--	--	1	6	3,435
Edwards	7	--	8	1	--	5	21	63,946
Effingham	7	--	8	--	--	3	18	42,476
Fayette	1	--	3	--	--	3	7	11,634
Franklin	9	--	5	1	--	4	19	52,467
Gallatin	--	--	1	--	--	--	1	1,590
Greene	--	--	--	--	--	1	1	1,087
Hamilton	3	--	4	--	--	2	9	21,115
Hancock	--	--	--	--	--	3	3	1,638
Jasper	8	--	7	--	--	7	22	57,072
Jefferson	6	--	4	1	--	2	13	37,851
Jersey	--	--	--	--	--	1	1	1,447
Lawrence	45	--	21	--	--	10	76	147,251
Logan	--	--	--	--	--	2	2	3,182
McDonough	--	--	--	--	--	2	2	888
McLean	--	--	--	--	--	1	1	864
Macoupin	--	--	--	--	--	2	2	1,955
Madison	1	--	5	--	--	--	6	3,657
Marion	14	--	4	1	--	4	23	64,193
Monroe	--	--	--	--	--	1	1	56
Montgomery	--	--	1	--	--	1	2	3,030
Perry	--	--	--	--	--	7	7	12,762
Pike	--	--	--	--	--	1	1	398
Randolph	--	--	1	--	--	3	4	6,035
Richland	18	--	22	1	--	6	47	148,953
St. Clair	4	--	1	--	--	6	11	24,132
Saline	6	--	3	--	--	--	9	25,206
Sangamon	3	--	8	3	--	--	21	61,187
Schuyler	--	--	1	--	--	--	1	758
Shelby	--	--	--	1	--	6	7	13,986
Union	--	--	--	--	--	2	2	1,882
Wabash	7	--	7	--	--	--	14	29,301
Washington	7	--	3	--	--	9	19	35,697
Wayne	50	--	21	1	--	3	75	235,329
White	14	--	7	1	--	1	23	61,956
Williamson	4	--	1	--	1	10	16	44,461
Total	295	3	201	16	2	180	697	1,592,697

Source: American Petroleum Institute.

Table 9.—Illinois: Portland cement salient statistics  
(Thousand 376-pound barrels and thousand dollars)

	1969	1970
Number of active plants.....	4	4
Production.....	8,872	7,400
Shipments from mills:		
Quantity.....	8,720	7,946
Value.....	\$29,996	\$25,252
Stocks at mills, Dec. 31.....	1,765	1,080

about 10 percent in quantity and value; production of fuller's earth, however, increased in both quantity and value over that of the previous year.

Production of clay and shale was reported from 16 counties. Fire clay was produced by seven companies in Grundy, La Salle, McDonough, and Scott Counties.

**Fluorspar.**—Illinois continued to rank first among the fluorspar-producing states, supplying 55 percent of the fluorspar output. Total Illinois shipments increased 67.5 percent in quantity and 84.7 percent in value. Acid-grade fluorspar accounted for 58.5 percent of the sales; ceramic grade, 40.8 percent; and metallurgical grade, 0.7 percent. Sales of all grades increased—ceramic grade, 51.6 percent; acid grade, 81.5 percent; and metallurgical grade, 21.9 percent.

Crude ore came from Hardin and Pope Counties in Illinois and from Kentucky. A small amount of Illinois crude ore was processed in Kentucky. Producers included Cullum Mining Co., Minerva Oil Co., Ozark-Mahoning Co., O. R. Austin & Sons, Harker Miley, and J. D. Quarant. Rosiclare Lead and Fluorspar Mining Co. removed crude ore from stockpiles.

**Lime.**—Output of lime decreased 4 percent, and value decreased 5 percent from that of 1969. Producing companies (in order of output) were Marblehead Lime Company (Adams and Cook Counties) and Standard Lime & Refractories Company (Cook County). Lime was used for construction, refractories, and chemicals.

**Perlite.**—Crude perlite mined outside the State was expanded by five companies with plants in Cook, De Kalb, Lake, and Will Counties. Production of the expanded product decreased 9.7 percent in quantity but increased 1.8 percent in value. Principal uses were for roof insulation and for concrete aggregate, which accounted for over 69 percent and 16 percent, respectively. Other uses included plaster aggregate, filter aid, low-temperature insulation, masonry and cavity fill insulation, and horticultural

aggregates. Illinois continued to lead the country in production of expanded perlite and also in the quantity used and sold by producers.

**Sand and Gravel.**—Illinois ranked fourth in the Nation in quantity and second in value of sand and gravel produced. Production in 1970 decreased less than 1 percent, but value increased over 6 percent.

**Stone.**—Illinois, with production of nearly 56 million tons, ranked second in the Nation's output of stone. Production increased over 1 percent in quantity and over 6 percent in total value.

**Tripoli (Amorphous Silica).**—Crude material was recovered from underground mines in Alexander County by Illinois Minerals Co. near Elco, and by Tammsco Div. (Lowe's, Inc.) near Tamms. The production of crude material decreased 17 percent in quantity and 14 percent in value. Output of prepared material decreased more than 9 percent in quantity and value. Prepared material was used for abrasives, filler, and other purposes. Of the few States that produce tripoli in the United States, Illinois ranked first.

**Vermiculite.**—Crude vermiculite mined outside the State was processed at plants operated by three companies in Cook, De Kalb, and Macoupin Counties. The output of exfoliated vermiculite, used for insulation, concrete and plaster aggregate, masonry fill, and agricultural purposes, declined almost 9 percent in quantity, but increased slightly in value.

## METALS

**Lead and Zinc.**—Lead and zinc production, in terms of recoverable metals, increased about 94 and 22 percent, respectively, from 1969 quantities. Total value of lead increased 103 percent and of zinc, 28 percent. Increased fluorspar production was an important factor in the increased output of lead and zinc.

Averaged weighted yearly prices used to calculate values of lead and zinc in table

Table 10.—Illinois: Sand and gravel sold or used by producers, by classes of operations and uses  
(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Blast.....	150	\$795	168	\$898
Building.....	6,363	6,611	6,281	6,993
Foundry uses.....	58	W	57	W
Glass <sup>1</sup> .....	2,201	5,278	2,224	5,661
Molding.....	1,159	4,305	1,109	4,303
Paving.....	8,821	8,910	8,969	9,345
Other uses <sup>2</sup> .....	3,256	7,189	3,319	7,951
Total <sup>3</sup> .....	22,010	33,089	22,130	35,152
Gravel:				
Building.....	8,384	8,409	7,580	8,370
Fill.....	1,503	1,273	1,403	1,050
Paving.....	11,321	13,307	12,307	15,127
Miscellaneous.....	--	--	22	103
Other uses <sup>4</sup> .....	--	65	67	81
Total <sup>3</sup> .....	21,267	23,054	21,378	24,732
<b>Government-and-contractor operations:</b>				
Sand:				
Fill.....	230	188	--	--
Paving.....	113	68	2	2
Total <sup>3</sup> .....	342	206	2	2
Gravel:				
Building.....	4	2	7	5
Paving.....	514	337	408	264
Total <sup>3</sup> .....	518	339	415	269
Total sand and gravel <sup>3</sup> .....	44,138	56,688	43,926	60,155

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

<sup>1</sup> Includes ground and underground glass.

<sup>2</sup> Includes abrasives, chemical, enamel, engine, fill, filler, filtration, grinding and polishing, oil (hydrafrac), pottery, porcelain, tile, and other sands.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

<sup>4</sup> Includes railroad ballast.

1 were 15.619 cents and 15.319 cents per pound, respectively, compared with 14.90 cents per pound for lead and 14.60 cents per pound for zinc in 1969.

In northern Illinois (Jo Daviess County), Eagle-Picher Industries, Inc., operated the Bautsch, Blackjack, and Rehm-Bauer mines and began production in August from a new incline shaft into the Gray ore body. Two companies in southern Illinois (Hardin and Pope Counties), Minerva Oil Co. and Ozark-Mahoning Co., recovered lead and zinc as byproducts of fluorspar operations.

**Pig Iron and Steel.**—About 7.4 million tons of pig iron, valued at \$470.3 million, was shipped from Illinois blast furnaces or was consumed by the producing companies. This output represented an increase of about 1.7 percent over 1969 production. Pig iron was produced by five companies operating blast furnaces in Granite City

and South Chicago. Thirteen blast furnaces were operated in 1970.

According to the American Iron and Steel Institute, steel production in Illinois was 11.8 million tons, a decrease of 1 percent from the 1969 quantity.

**Other Metals.**—American Zinc Co. recovered byproduct cadmium at its Monsanto plant, in St. Clair County, and the New Jersey Zinc Co. recovered cadmium as a byproduct of domestic zinc ore at its Depue plant, in Bureau County. United Refining & Smelting Co. produced bismuth and cadmium and some low-melting alloys at its Franklin Park plant, Cook County. Lindsay Rare Earths (formerly American Potash & Chemical Corp.), a subsidiary of Kerr-McGee Chemical Corp., processed concentrates bearing thorium, rare-earth elements, europium, and yttrium at its West Chicago plant, Du Page County.

Table 11.—Illinois: Sand and gravel sold or used by producers, by counties  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Adams	1	50	\$71	1	W	W
Alexander	3	108	W	3	W	W
Bond	4	271	279	5	296	\$309
Boone	6	110	95	8	162	133
Brown	1	3	W	1	W	W
Bureau	12	806	682	15	935	825
Cass	1	44	26	--	--	--
Champaign	10	761	789	6	664	745
Clark	3	400	W	4	267	305
Clinton	3	74	W	2	W	W
Coles	3	182	174	3	326	434
Cook	6	1,169	1,350	7	1,170	1,498
Cumberland	2	136	154	1	176	205
De Kalb	5	341	W	4	346	356
De Witt	5	229	310	4	276	378
Edwards	1	60	53	1	W	W
Effingham	1	8	6	1	W	W
Ford	5	206	277	6	262	334
Fulton	5	663	821	8	601	696
Gallatin	2	252	265	2	W	W
Iroquois	5	20	19	4	W	W
Jo Daviess	1	146	101	1	33	23
Johnson	--	--	--	1	W	23
Kane	16	5,404	5,853	14	5,917	5,830
Kankakee	3	18	17	2	W	W
Lake	8	1,267	990	6	1,300	1,070
La Salle	18	4,601	14,972	16	4,604	15,833
Lawrence	5	302	275	6	325	298
Lee	7	209	220	4	W	W
Logan	5	266	W	5	W	W
McHenry	18	6,858	6,642	20	6,377	6,690
McLean	13	758	804	16	984	1,256
Macon	7	463	382	7	556	564
Madison	5	564	W	4	622	726
Marshall	4	405	W	4	W	W
Mason	1	23	W	2	W	W
Massac	5	W	1	5	121	101
Menard	1	1	W	--	--	--
Morgan	1	W	W	1	4	2
Moultrie	1	19	W	1	W	W
Ogle	4	856	1,925	4	W	W
Peoria	8	1,701	W	4	W	W
Pope	2	7	4	2	10	6
Pulaski	3	41	36	3	W	W
Rock Island	6	1,089	W	5	894	687
Sangamon	4	768	W	4	787	1,060
Shelby	2	167	W	2	W	W
Stephenson	2	153	109	2	91	108
Tazewell	13	1,082	W	12	1,189	1,831
Union	2	24	19	2	24	19
Vermilion	9	245	210	7	322	245
Wabash	2	141	W	2	W	W
White	5	820	681	4	W	W
Whiteside	2	97	163	2	W	W
Will	14	2,914	W	9	3,380	4,205
Winnebago	9	1,558	1,438	9	1,201	1,180
Woodford	4	367	548	4	W	W
Undistributed <sup>1</sup>	39	4,964	15,925	32	9,707	12,203
Total <sup>2</sup>	333	44,138	56,688	310	43,926	60,155

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

<sup>1</sup> Includes Carroll, Crawford, Du Page, Fayette, Grundy, Henry, Jackson, Kendall, Livingston, Mercer (1970), Pike, Putnam, Randolph, Schuyler, Scott, St. Clair, and Stark Counties.

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

**Table 12.—Illinois: Limestone and dolomite sold or used by producers, by uses**  
(Thousand short tons and thousand dollars unless otherwise specified)

Use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Rough construction.....	12	\$103	12	\$89
Dressed architectural:				
Sawed stone <sup>1</sup> ..... thousand cubic feet..	2	25	2	25
House stone veneer <sup>2</sup> ..... do.....	5	13	3	12
Total (approximate thousand short tons).....	12	141	13	126
<b>Crushed and broken:</b>				
Bituminous aggregate.....	8,781	13,117	6,894	11,138
Concrete aggregate.....	9,487	14,578	9,250	14,755
Dense graded road base stone.....	12,920	18,320	15,910	23,409
Macadam aggregate.....	4,982	7,712	4,799	7,741
Surface treatment aggregate.....	6,057	8,947	4,491	6,744
Unspecified aggregate and roadstone.....	1,387	1,995	2,329	3,616
Agricultural limestone.....	4,245	6,561	4,000	6,271
Asphalt filler.....	217	1,024	397	1,264
Cement.....	2,730	2,279	2,213	1,977
Flux.....	42	45	48	52
Railroad ballast.....	980	1,420	929	1,317
Riprap and jetty stone.....	197	289	647	954
Other <sup>3</sup> .....	777	1,070	712	949
Total <sup>4</sup> .....	54,844	81,174	55,683	86,230
Grand total <sup>4</sup> .....	54,856	81,315	55,695	86,356

<sup>1</sup> Data includes cut stone.

<sup>2</sup> Data includes dressed flagging.

<sup>3</sup> Includes limestone for chemical uses; dead-burned dolomite (1969); lime; mine dusting; poultry grit; stone sand; terrazzo, whitening and other fillers; disinfectant; other and unspecified uses.

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

**Table 13.—Illinois: Mine production (recoverable) of lead and zinc**

	1968	1969	1970
<b>Mines producing:</b>			
Lode.....	7	5	6
<b>Material sold or treated:</b>			
Ore:			
Fluorspar..... thousand short tons..	440	221	348
Zinc..... do.....	205	261	266
<b>Production (recoverable):</b>			
Quantity:			
Lead..... short tons..	1,467	791	1,532
Zinc..... do.....	18,182	13,765	16,797
<b>Value:</b>			
Lead..... thousands..	\$388	\$236	\$479
Zinc..... do.....	4,909	4,019	5,146
Total..... do.....	5,297	4,255	5,625

Table 14.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Alpha Portland Cement Co.....	15 South Third St. Easton, Pa. 18043	Portland, dry process.....	La Salle.
Marquette Cement Mfg. Co.....	20 North Wacker Dr. Chicago, Ill. 60606	Portland and masonry, dry process.	Do.
Medusa Portland Cement Co.....	Box 5668 Cleveland, Ohio 44101	.....do.....	Lee.
Missouri Portland Cement Co.....	7751 Carondelet Ave. St. Louis, Mo. 63105	.....do.....	Massac.
<b>Clays and shale:</b>			
American Brick Co.....	6558 West Fullerton Ave. Chicago, Ill. 60635	Pit and plant.....	Cook.
Hydraulic-Press Brick Co. (Illinois Streator Div.)	705 Olive St. St. Louis, Mo. 63101	Pit.....	La Salle.
		Pit.....	Livingston.
Illinois Brick Co.....	228 North La Salle St. Chicago, Ill. 60601	Pit and plant.....	St. Clair.
		.....do.....	Cook.
A. P. Green Refractories Co. (Div. of U.S. Gypsum Co.)	Box 64, Morris, Ill. 60450	.....do.....	Grundy.
Marblehead Lime Co. (General Dynamics Corp.)	300 West Washington St. Chicago, Ill. 60606	.....do.....	La Salle.
Marquette Cement Mfg. Co.....	20 North Wacker Dr. Chicago, Ill. 60606	Pit.....	Do.
Richards Brick Co.....	234 Springer Ave. Edwardsville, Ill. 62025	Pit.....	Bond.
Southern Clay Co., Inc. (Lowe's Inc.)	North Edward St. Cassopolis, Mich. 49031	Pit and plant.....	Pulaski.
Western Brick Co. (Div. of Illi- nois Brick Co.)	Box 591 Danville, Ill. 61832	.....do.....	Vermilion.
<b>Coal (bituminous):</b>			
Ayrshire Coal Co., Div. of Ameri- can Metal Climax, Inc.:	430 Big Four Bldg. 105 South Meridian St. Indianapolis, Ind. 46225	Strip mine, cleaning plant.	Fulton.
Sun Spot.....	.....do.....		Vermilion.
Harmattan.....	.....do.....	.....do.....	Williamson.
Delta.....	.....do.....	.....do.....	Do.
Bell & Zoller Coal Co.....	Box 100 Johnston City, Ill. 62951	Underground, mine cleaning plant.	Do.
Forsyth-Energy, Inc.....	20 South Central Clayton, Mo. 63105	Strip mine, cleaning plant.	Do.
Freeman Coal Mining Corp.:	307 North Michigan Ave. Chicago, Ill. 60601	Underground mine, cleaning plant.	Franklin.
Orient No. 5.....	.....do.....	.....do.....	Jefferson.
Orient No. 3.....	.....do.....	.....do.....	Do.
Orient No. 6.....	.....do.....	.....do.....	Montgomery.
Crown.....	.....do.....	.....do.....	Williamson.
Orient No. 4.....	.....do.....	.....do.....	Jefferson.
Inland Steel Co.....	30 West Monroe St. Chicago, Ill. 60608	.....do.....	Douglas.
Moffat Coal Co.....	Box 74 Murdock, Ill. 62941	.....do.....	Do.
Old Ben Coal Corp.:	10 South Riverside Plaza Chicago, Ill. 60606	.....do.....	Franklin.
Old Ben No. 21.....	.....do.....	Underground mine.....	Do.
Old Ben No. 24.....	.....do.....	Underground mine, cleaning plant.	Do.
Old Ben No. 26.....	.....do.....	.....do.....	Do.
Peabody Coal Co.:	301 North Memorial Dr. St. Louis, Mo. 63102	.....do.....	Christian.
No. 10.....	.....do.....	.....do.....	Stark.
Allendale.....	.....do.....	Strip and underground mines, cleaning plant.	Gallatin.
Eagle.....	.....do.....	Strip mine, cleaning plant.	Kankakee.
Northern Illinois.....	.....do.....	.....do.....	Knox.
Mecco.....	.....do.....	.....do.....	Peoria.
Edwards.....	.....do.....	.....do.....	Do.
Elm.....	.....do.....	Strip and underground mines, cleaning plant.	St. Clair.
Midwest.....	.....do.....	Strip mine, cleaning plant.	Do.
River King.....	.....do.....	.....do.....	Saline.
Will Scarlet.....	.....do.....	.....do.....	Do.
Sahara Coal Co., Inc.:	59 East Van Buren St. Chicago, Ill. 60605	Underground mine.....	Do.
No. 5.....	.....do.....	Strip mine, cleaning plant.	Do.
No. 6.....	.....do.....	Underground mine.....	Do.
No. 16.....	.....do.....	.....do.....	Do.
No. 20.....	.....do.....	.....do.....	Do.

Table 14.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Coal (bituminous)—Continued</b>			
Southwestern Illinois Coal Corp.:	1514 Merchants Bank Bldg. Indianapolis, Ind. 46204		
Captain.....		Strip mine, cleaning plant.	Perry.
Streamline.....		Strip mine.....	Randolph.
Cleaning plant.....			Do.
Traux-Traer Coal Co., Div. Consolidation Coal Co., Inc.:	Box 218 Pinckneyville, Ill. 62674		
Hillsboro.....		Underground mine.....	Montgomery.
Norris.....		Strip mine, cleaning plant.	Fulton.
do.....		do.....	Perry.
do.....		do.....	Randolph.
The United Electric Coal Cos.:	307 North Michigan Ave. Chicago, Ill. 60601		
Cuba No. 9.....		do.....	Fulton.
Buckheart No. 17.....		do.....	Do.
Banner No. 27.....		Strip mine, cleaning plant.	Peoria.
do.....		do.....	Perry.
Zeigler Coal & Coke Co.: Spartan	208 South La Salle St. Chicago, Ill. 60604	Underground mine, cleaning plant.	Randolph.
<b>Coke:</b>			
General Motors Corp.....	7-210 General Motors Bldg. Detroit, Mich. 48202	Coke ovens.....	Lake.
Granite City Steel Co.....	Box 367 Granite City, Ill. 62041	do.....	Madison.
Interlake Steel Corp.....	135th St. and Perry Ave. Chicago, Ill. 60627	do.....	Cook.
International Harvester Co.....	401 North Michigan Ave. Chicago, Ill. 60611	do.....	Do.
Republic Steel Corp.....	1629 Republic Bldg. Cleveland, Ohio 44101	do.....	Do.
<b>Fluorspar:</b>			
Minerva Company, Mining Div. Minerva Oil Co.:	Eldorado, Ill. 62930		
Crystal Group.....		Underground mines.....	Hardin, Pope.
Minerva No. 1.....		Mill.....	Hardin.
Ozark-Mahoning Co.....	Box 57 Rosiclare, Ill. 62982	Underground mine, mill.....	Do.
		Underground mines.....	Hardin, Pope.
		Mill.....	Hardin.
<b>Iron and steel:</b>			
Granite City Steel Co.....	Box 365 Granite City, Ill. 62040	Iron and steel furnaces.....	Madison.
Interlake Steel Corp.....	310 South Michigan Ave. Chicago, Ill. 60604	Iron furnaces.....	Cook.
Republic Steel Corp.....	1629 Republic Bldg. Cleveland, Ohio 44101	Iron furnace and steel furnace.....	Do.
United States Steel Corp.....	3426 East 89th St. Chicago, Ill. 60617	Iron and steel furnaces.....	Do.
Wisconsin Steel Division International Harvester Co.	410 North Michigan Ave. Chicago, Ill. 60611	do.....	Do.
<b>Lead and zinc:</b>			
Eagle-Picher Industries, Inc.:	Box 1040 Galena, Ill. 61036		
Bautsch, Blackjack and Rehm-Bauer. Graham mill.....		Underground mines, ore processed at Graham mill.....	Jo Daviess.
Minerva Company, Mining Div. Minerva Oil Co.:	Eldorado, Ill. 62930		
Minerva No. 1.....		Underground mine, mill.....	Do.
Ozark-Mahoning Co.....	Box 57 Rosiclare, Ill. 62982	Underground mines.....	Hardin, Pope.
		Mill.....	Hardin.
<b>Lime:</b>			
Marblehead Lime Co.:	300 West Washington St. Chicago, Ill. 60606		
Marblehead Limekiln.....		Quicklime and hydrated lime, 3 shaft kilns.	Adams.
Quincy Limekiln.....		Quicklime, 1 calcimatic kiln.	Do.
South Chicago Limekiln.....		Quicklime and hydrated lime, 4 rotary kilns.	Cook.
Thornton Limekiln.....		do.....	Do.
Standard Lime & Refractories Co. (Div. Martin Marietta Corp.)	2000 First National Bank Bldg. Baltimore, Md. 21203	Quicklime, 3 rotary kilns.	Do.
Natural gas processing:			
U.S. Industrial Chemicals Co., Div. of National Distillers & Chem. Corp.	99 Park Ave. New York, N.Y. 10016		Douglas.

Table 14.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Peat:</b>			
Anderson Peat Co. (Old Fort Industries, Inc.)	Morrison, Ill. 61270.....	Bog, processing plant....	Whiteside.
Markman Peat Co.....	Route 3 Morrison, Ill. 61270	...do.....	Do.
<b>Expanded perlite:</b>			
Filter Materials Corp.....	124 North Buesching Rd. Lake Zurich, Ill. 60047	Processing plant.....	Lake.
Johns-Manville Perlite Corp., Building Products Div.	22 East 40th St. New York, N.Y. 10016	...do.....	Will.
Mica Pellets, Inc.....	1008 Oak St. De Kalb, Ill. 60115	...do.....	De Kalb.
National Gypsum Co.....	325 Delaware Ave. Buffalo, N.Y. 14202	...do.....	Lake.
Silbrico Corp.....	6300 River Rd. La Grange, Ill. 60525	...do.....	Cook.
<b>Petroleum refineries:</b>			
American Oil Co.....	910 South Michigan Ave. Chicago, Ill. 60680	.....	Madison.
Clark Oil & Refining Co.....	8530 West National Ave. Milwaukee, Wis. 53227	.....	Cook, Madison.
Marathon Oil Co.....	539 South Main Findlay, Ohio 45840	.....	Crawford.
Mobil Oil Corp.....	150 East 42nd New York, N.Y. 10017	.....	St. Clair.
Shell Oil Co.....	50 West 50th New York, N.Y. 10020	.....	Madison.
Texaco Inc.....	135 East 42nd New York, N.Y. 10017	.....	Lawrence, Will.
Union Oil Co. of California.....	Union Oil Center Los Angeles, Calif. 90054	.....	Cook.
<b>Sand and gravel:</b>			
Accorsi Sand & Gravel, Inc.....	Box 365 Bartlett, Ill. 60103	Pit; portable plant.....	Do.
Bellrose Silica Co.....	307 Central Life Bldg. Ottawa, Ill. 61350	...do.....	La Salle.
Beverly Gravel Co. (Plote, Inc.).....	2400 South Roselle Rd. Palatine, Ill. 60067	Pit; portable and stationary plants.	Kane.
Chain O Lakes Sand & Gravel Co., Evanston Fuel & Material Co.	Fox Lake, Ill. 60020.....	Pit; stationary plant.....	McHenry.
Chicago Gravel Co.....	343 South Dearborn St. Chicago, Ill. 60604	Pits; stationary plants...	Cook, Will.
Concrete Materials Division, Martin Marietta Corp.	4096 1st Ave. NE Cedar Rapids, Iowa 52406	Pits; portable and stationary plants.	Ogle, Peoria, Tazewell, Woodford.
Elmhurst-Chicago Stone Co.....	400 West 1st St. Elmhurst, Ill. 61026	Pits; stationary plants...	Du Page, Will.
Feltes Sand & Gravel Co., Inc....	Route 25 North Aurora, Ill. 60542	Pits; portable plants.....	Kane.
Illinois-Wisconsin Sand & Gravel Co.	Eastern Ave. South Beloit, Ill. 61080	Pit; dredge; stationary plant.	Winnebago.
McHenry Sand & Gravel Co., Inc.	920 North Front St. McHenry, Ill. 60050	Pits; portable plants.....	McHenry.
Manley Sand Division Martin Marietta Corp.	Rockton, Ill. 61072.....	Pit; stationary plant.....	Ogle.
Material Service Division General Dynamics Corp.	300 West Washington St. Chicago, Ill. 60606	Pits; stationary plants...	Cook, Grundy, Kane, McHenry, Will.
Meyer Aggregate.....	Box 56, Route 2 Algonquin, Ill. 60102	Pits; portable and stationary plants.	McHenry.
Meyer Aggregate West Division.....	.....	do.....	Kane, Kendall.
Moline Consumers Co.....	313 16th St. Moline, Ill. 61265	...do.....	Bureau, La Salle, Rock Island.
Ottawa Silica Co.....	Box 577, Ottawa, Ill. 61350	Pit; stationary plant.....	La Salle.
Road Materials Corp., E. M. Melahn Construction Co., Inc.	Box 205 East Dundee, Ill. 60118	Pits; stationary plants...	Kane, McHenry.
Rowe Construction Co., R. A. Cullinan & Son.	1523 West Market St. Bloomington, Ill. 61701	Pits; portable and stationary plants.	Livingston, McLean.
Edward Schneider.....	Route 3, Box 72 Elgin, Ill. 60120	...do.....	Kane.
Thelen Sand & Gravel.....	Route 3, Box 330 Antioch, Ill. 60002	Pit; portable and stationary plants.	Lake.



Table 14.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Sand and gravel—Continued</b>			
Urban Sand & Gravel Co.....	Route 1 Champaign, Ill. 61820	Pits; dredges; portable plants.	Champaign, Cumberland, McLean.
Vulcan Materials Co., Midwest Division.	29 North Wacker Dr. Chicago, Ill. 60606	Pits; stationary plants...	Kane, Lake, McHenry.
Wedron Silica Co., Del Monte Properties Co.	135 South La Salle St. Chicago, Ill. 60603	Pit; stationary plant.....	La Salle.
White County Sand & Gravel....	Maunie, Ill. 62861.....	.....do.....	White.
<b>Smelters and refineries:</b>			
American Zinc Co.....	20 South Fourth St. St. Louis, Mo. 63101	Zinc secondary plant.....	Montgomery.
Apex Smelting Co.....	2537 Taylor St. Chicago, Ill. 60612	Zinc primary plants.....	St. Clair.
Goldsmith Div. of National Lead Co.	900 West 18th St. Chicago, Ill. 60608	Zinc secondary plant.....	Cook.
Imperial Type Metal Co.....	3400 Aramingo Ave. Philadelphia, Pa. 19134	Lead secondary plant....	Do.
National Lead Co.....	111 Broadway New York, N.Y. 10006	.....do.....	Do.
The New Jersey Zinc Co.....	160 Front St. New York, N.Y. 10038	.....do.....	Madison.
Sandoval Zinc Co.....	3649 South Albany Ave. Chicago, Ill. 60632	Zinc primary plant.....	Bureau.
		Zinc secondary plant.....	Marion.
<b>Stone:</b>			
<b>Limestone and dolomite:</b>			
Charleston Stone Co.....	Box 280 Charleston, Ill. 61920	Quarries; stationary plant.	Coles.
Columbia Quarry Co.....	1007 Washington Ave. St. Louis, Mo. 63101	Quarries; stationary plants.	Johnson, Massac, Pulaski, St. Clair.
Conco-Western Stone Co.....	111 North Spaulding St. Spring Valley, Ill. 61362	Underground mine; stationary plant.	Monroe.
East St. Louis Stone Co.....	528 Murphy Bldg. East St. Louis, Ill. 62201	Quarry; portable plant...	Kane.
Elmhurst-Chicago Stone Co...	400 West 1st St. Elmhurst, Ill. 61026	Quarry; stationary plant.	St. Clair.
D-P Indian Point Limestone Products, Inc.	Box 126 Mason City, Ill. 62664	.....do.....	Du Page.
Industrial Chemicals Div., Allied Chemicals Corp.	Box 70 Morristown, N.J. 07960	.....do.....	Menard.
General Dynamics Corp.:	4226 Lawndale Ave. Lyons, Ill. 60534	.....do.....	Randolph.
Marblehead Lime Co., Material Service Division.		Underground mine; stationary plant.	Adams.
Lincoln Stone Quarry, Inc....	Box 69 Hillside, Ill. 60162	Quarries; stationary plants.	Cook, Vermilion, Will.
Manteno Limestone Co.....	Box 509 Manteno, Ill. 60950	Quarry; stationary.....	Will.
Marquette Cement Mfg. Co.	20 North Wacker Dr. Chicago, Ill. 60606	.....do.....	Kankakee.
Medusa Portland Cement Co.	Box 5668 Cleveland, Ohio 44101	.....do.....	La Salle.
Lehigh Stone Corp. Div.....	Box 669 Kankakee, Ill. 60901	.....do.....	Lee.
Midwest Stone Co.....	Box 180, Anna, Ill. 62906	Quarries; stationary plants.	Clark, Kankakee.
Mississippi Lime Co.....	7 Alby St., Box 247 Alton, Ill. 62002	Quarry; portable plant...	Union.
Missouri Portland Cement Co.	7751 Carondelet Ave. St. Louis, Mo. 63105	Underground mine; stationary plant.	Madison.
Moline Consumers Co.....	313 16th St. Moline, Ill. 61265	Quarry; stationary plant.	Hardin.
		Quarries; stationary and portable plants.	Adams, Brown, Henry, Pike, Rock Island, Warren.
Pontiac Stone Co.....	Route 3, Box 412 Pontiac, Ill. 61764	Quarry; stationary plant.	Livingston.
Rein, Schultz & Dahl, Inc....	6217 Nesbitt Rd. Madison, Wis. 53711	Quarries; portable plants.	Carroll, Jo Daviess, Stephenson, Whiteside.
River Sand & Stone Co., Inc. (Ryan Contracting Co., Inc.)	Box 5271, Lawndale Branch 5416 Boonville Hwy. Evansville, Ind. 47715	Quarry; underground mine; stationary plant.	Hardin.

Table 14.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Limestone and dolomite—			
Continued			
Rockford Blacktop Construction Co.	600 Boylston St. Loves Park, Ill. 61111	Quarries; portable plants.	Boone, Winnebago.
Southern Illinois Stone Co.	Box 38 Buncombe, Ill. 62912	Quarry; stationary plant.	Johnson.
Vulcan Materials Co., Midwest Division.	29 North Wacker Dr. Chicago, Ill. 60606	Quarries; stationary plants.	Cook, Will.
Sandstone: Virgil Bridges	Elco, Ill. 62929	Underground mine	Alexander.
Recovered sulfur:			
The Anlin Company of Illinois	Box 6554 Houston, Tex. 77005	Byproduct sulfur recovery.	Madison.
Union Oil Co. of California	Box 239 Lemont, Ill. 60439	do	Will.
Tripoli (amorphous silica):			
Illinois Minerals Co.	218 10th St. Cairo, Ill. 62914	Underground mine	Alexander.
Tammseo Division (Lowe's Inc.)	North Edward St. Cassopolis, Mich. 49031	do	Do.
Exfoliated vermiculite:			
International Vermiculite Co.	1st and Mound Sts. Girard, Ill. 62640	Processing plant	Macoupin.
Mica Pellets, Inc.	1008 Oak St. De Kalb, Ill. 60115	do	De Kalb.
Zonolite Division, W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 01109	do	Cook.



# The Mineral Industry of Indiana

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

By Brinton C. Brown <sup>1</sup>

Indiana's mineral production value reached an alltime high of \$255.8 million in 1970, surpassing the previous record of \$245 million in 1967 by 4.4 percent and surpassing the mineral production value of 1969 by 6 percent. Increased coal production was solely responsible for the new record because the production and value of the other mineral commodities decreased, with the exception of gypsum and lime. The combined value of seven nonmetallic minerals, which accounted for 50 percent of the 1970 State mineral production value, decreased 3 percent below the 1969 value. Although production and value of crude petroleum, natural gas and peat were down, the value of mineral fuels increased 17 percent because of increased output of coal at a higher price. No me-

tallic minerals were mined in Indiana in 1970.

The total values of the State's mineral production was as follows: coal 40 percent; stone 18 percent; cement 16 percent; sand and gravel 10 percent; crude petroleum 9 percent; lime, gypsum, masonry cement, peat, natural gas, clay, and abrasives the remainder.

**Legislation and Government Programs.**—The Indiana Legislature was not in session in 1970. Legislative actions and Government programs had little immediate impact on Indiana mineral producers in 1970, however, the following Federal legislation passed during the year can affect mineral producing operations.

<sup>1</sup> Mining engineer, Division of Nonmetallic Minerals.

Table 1.—Mineral production in Indiana <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasives (whetstones).....short tons..	5	\$17	W	W
Cement, portland.....thousand 376-pound barrels..	14,497	45,264	12,432	\$41,810
Clays.....thousand short tons..	1,483	2,264	1,335	2,139
Coal (bituminous).....do.....	20,086	82,902	22,263	102,371
Natural gas.....million cubic feet..	171	40	153	36
Peat.....thousand short tons..	38	515	W	W
Petroleum (crude).....thousand 42-gallon barrels..	7,841	25,013	7,487	23,958
Sand and gravel.....thousand short tons..	26,218	27,438	23,476	25,796
Stone.....do.....	25,559	45,400	25,818	45,215
Value of items that cannot be disclosed:				
Masonry cement, gypsum, lime and values indicated by symbol W.....	XX	13,018	XX	14,461
Total.....	XX	241,871	XX	255,786
Total 1967 constant dollars.....	XX	228,399	XX	231,486

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed." XX Not applicable.

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

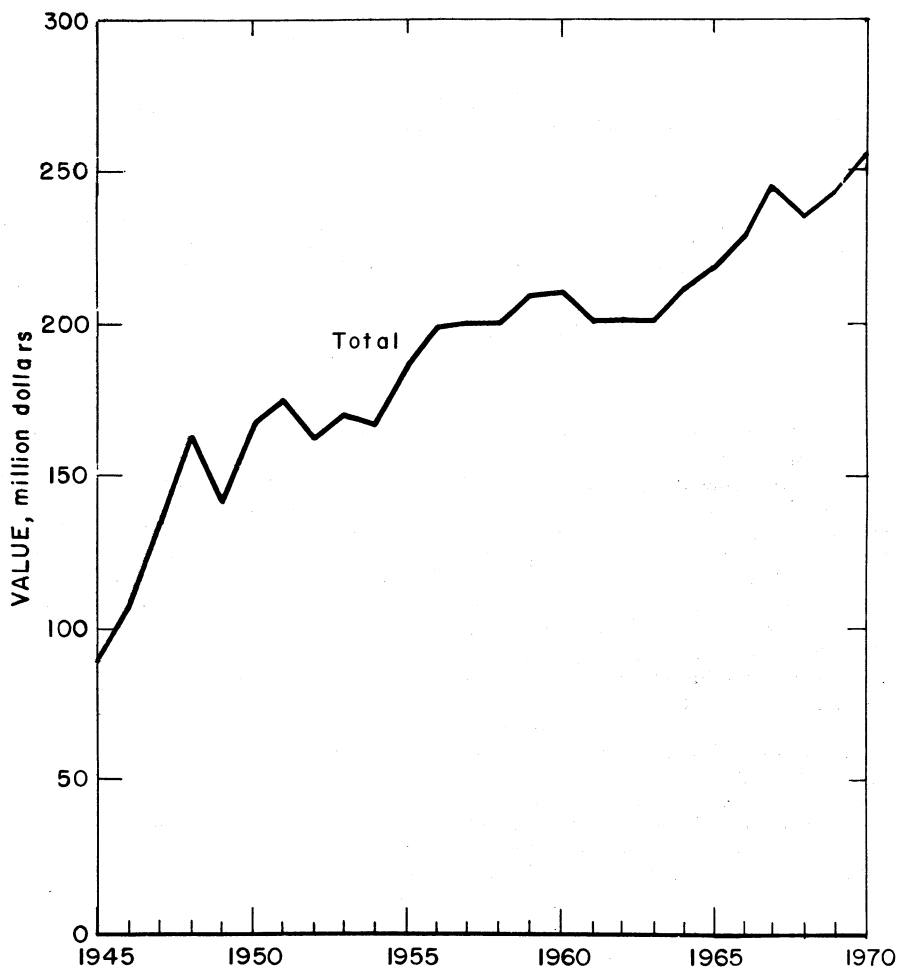


Figure 1.—Total value of mineral production in Indiana.

Table 2.—Value of mineral production in Indiana, by counties <sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Adams.....	\$719	\$629	Stone, clays, sand and gravel.
Allen.....	3,504	3,259	Stone, sand and gravel.
Bartholomew.....	671	731	Stone.
Blackford.....	W	W	Stone, clays.
Boone.....	177	W	Sand and gravel.
Carrroll.....	W	W	Stone.
Cass.....	W	W	Cement, stone, sand and gravel, clays.
Clark.....	W	W	Cement, stone, clays, sand and gravel.
Clay.....	W	W	Coal, clays.
Clinton.....	10	11	Sand and gravel.
Crawford.....	W	W	Stone.
Daviess.....	W	W	Sand and gravel.
Dearborn.....	372	W	Do.
Decatur.....	374	W	Stone.
De Kalb.....	295	254	Sand and gravel.
Delaware.....	1,333	1,355	Stone, sand and gravel, peat.
Dubois.....	W	W	Clays.

See footnotes at end of table.

Table 2.—Value of mineral production in Indiana, by counties 1—Continued  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Elkhart	\$612	W	Sand and gravel, stone.
Fayette	369	W	Sand and gravel.
Floyd	W	-----	
Fountain	W	\$604	Sand and gravel, coal, clays.
Franklin	156	W	Sand and gravel, stone, clays.
Fulton	197	W	Sand and gravel.
Gibson	W	W	Coal, sand and gravel.
Grant	W	W	Stone, sand and gravel, peat.
Greene	W	W	Coal, sand and gravel, clays.
Hamilton	3,601	3,957	Sand and gravel, stone.
Hancock	W	W	Sand and gravel.
Harrison	1,504	W	Sand and gravel, stone.
Hendricks	1	W	Sand and gravel.
Henry	379	W	Do.
Howard	W	W	Stone, sand and gravel.
Huntington	W	W	Stone, sand and gravel, clays.
Jackson	568	385	Sand and gravel, clays.
Jasper	W	W	Stone, sand and gravel.
Jay	W	W	Do.
Jefferson	11	W	Sand and gravel.
Jennings	W	W	Stone.
Johnson	W	W	Sand and gravel.
Knox	560	543	Do.
Kosciusko	879	696	Sand and gravel, stone.
Lagrange	246	W	Do.
Lake	W	W	Cement, lime, sand and gravel, clays.
La Porte	1,206	W	Sand and gravel, stone.
Lawrence	15,821	13,834	Cement, stone.
Madison	1,984	W	Stone, sand and gravel.
Marion	W	3,240	Sand and gravel.
Marshall	541	W	Sand and gravel, stone, peat.
Martin	W	W	Gypsum, stone.
Miami	W	683	Sand and gravel, stone.
Monroe	7,078	6,169	Stone.
Montgomery	W	W	Clays, sand and gravel.
Morgan	1,186	W	Clays, sand and gravel, stone.
Newton	W	W	Stone.
Noble	387	242	Sand and gravel, stone.
Orange	773	W	Stone, abrasives.
Owen	918	851	Stone, sand and gravel.
Parke	481	523	Sand and gravel, clays, coal.
Perry	W	W	Stone, sand and gravel.
Pike	W	W	Coal, stone.
Porter	W	W	Sand and gravel, clays.
Posey	W	W	Sand and gravel.
Pulaski	W	W	Stone, clays.
Putnam	13,033	W	Cement, stone, sand and gravel.
Randolph	W	W	Stone, sand and gravel.
Ripley	W	W	Stone.
Rush	292	236	Stone, sand and gravel.
St. Joseph	818	W	Sand and gravel, stone.
Scott	W	W	Stone.
Shelby	1,336	W	Stone, sand and gravel.
Spencer	W	W	Coal.
Starke	32	W	Sand and gravel.
Steuben	230	190	Sand and gravel, stone.
Sullivan	W	22,687	Coal, sand and gravel, stone.
Switzerland	W	W	Sand and gravel, stone.
Tippecanoe	1,264	W	Sand and gravel.
Union	13	21	Do.
Vermillion	513	4,944	Coal, sand and gravel, clays.
Vigo	1,528	W	Sand and gravel, coal.
Wabash	291	340	Stone, sand and gravel.
Warren	W	W	Sand and gravel, peat.
Warrick	W	W	Coal, stone.
Washington	W	W	Stone.
Wayne	869	W	Sand and gravel, stone.
Wells	W	W	Stone, peat.
White	W	W	Stone.
Whitley	83	78	Sand and gravel.
Undistributed <sup>2</sup>	174,658	189,326	
Total <sup>3</sup>	241,871	255,786	

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

<sup>1</sup> Data for petroleum and natural gas are not available on a county basis; however, value for these commodities are included with "Undistributed." Benton, Brown, Ohio, Tipton and Vanderburgh Counties are not listed because no production was reported.

<sup>2</sup> Includes value for petroleum, natural gas, and values indicated by symbol W.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Indiana business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total labor force..... thousands...	2,160.2	2,175.7	+ .7
Unemployment..... do.....	57.8	104.2	+80.3
<b>Employment:</b>			
Manufacturing..... do.....	752.3	712.8	-5.3
Construction..... do.....	87.0	78.9	-9.3
Mining..... do.....	7.4	6.9	-6.8
Transportation and public utilities..... do.....	101.1	100.9	-.2
Wholesale and retail trade..... do.....	365.3	367.8	+ .7
Finance, insurance, and real estate..... do.....	74.8	75.8	+1.3
Services..... do.....	211.6	217.7	+2.9
Government..... do.....	280.9	286.2	+1.9
<b>Personal income:</b>			
Total..... millions.....	\$18,868	\$19,651	+4.1
Per capita..... do.....	\$3,669	\$3,773	+2.8
<b>Construction activity:</b>			
<b>Building permits:</b>			
Valuation of authorized nonresidential construction..... millions...	\$226.6	\$196.7	-13.2
Number of private and public residential units authorized.....	29,990	23,336	-22.2
State highway commission contracts awarded..... do.....	\$127.9	\$150.0	+17.3
Portland cement shipments to and within Indiana thousand 376-pound barrels.....	9,510	8,530	-10.3
Farm marketing receipts..... millions.....	\$1,487.1	\$1,510.3	+1.6
Mineral production..... do.....	\$241.9	\$255.8	+5.7

Sources: Area Trends in Employment and Unemployment; Employment and Earnings; Construction Review; Survey of Current Business; Streets and Roads; Farm Income Situation; and U.S. Bureau of Mines.

The Clean Air Act of 1970 (PL 91-604) provides for the establishment of ambient air quality standards; authorizes the administrator to monitor emission sources; authorizes any person to bring suit against the administrator or others to enforce emission standards; and establishes penalties for violation of air quality standards. The Occupational Safety and Health Act (PL 91-596) empowers the Secretary of Labor to inspect any factory or plant and enforce compliance with Federal safety standards.

A new series of publications of interest to the mineral industry was issued during 1970 by the Indiana Geological Survey, Department of Natural Resources: Bulletin 42A- "Gypsum Resources of Indiana;" Bulletin 42B- "High-Calcium Limestone and High-Magnesium Dolomite Resources of Indiana;" Bulletin 42C- "Dimension Limestone Resources of Indiana;" and Bulletin 44 - "Stratigraphy of the New Albany Shale in Indiana".

**Employment and Injuries.**—In the mineral industries, 6,920 men worked 15,202,000 man-hours compared with 6,841 men and 14,761,000 man-hours in 1969, an increase of 3 percent. Employment increased 7 percent at coal mines, 6 percent at stone quarries, and 2 percent at peat mines, but de-

creased 7 percent at sand and gravel mines and 9 percent at other nonmetal mines.

There were 350 lost-time injuries in the mineral industries, including five fatalities, compared with 357 injuries and three fatalities in 1969.

Mill Creek Stone & Gravel Corp.'s limestone quarry in Wabash won top safety honors in the 1970 National Limestone Institute Safety Competition in the Class IV division for plants working 10,001 to 20,000 man-hours. Indiana had 21 plants competing in the nationwide annual contest conducted by the Bureau of Mines in cooperation with the National Limestone Institute. Certificates of Achievements in Safety were made to contestants who operated throughout 1970 without a disabling work injury. The following limestone producers received Certificates of Achievement in Safety: Class II, working 60,001 to 120,000 man-hours—May Stone & Sand, Inc., Ardmore stone plant, Fort Wayne; Class III, working 20,001 to 60,000 man-hours—Meshberger Stone, Inc., Columbus quarry; Calcar Quarries, Inc., Paoli quarry; Berry Materials Corp., North Vernon quarry, New Point Stone Co., Marion quarry; Clayton Winder and Sons, Spencer plant; H. & R. Stone Co., Ridgeville quarry; and Class IV, Kixmiller Brothers, Inc., Free-landville quarry.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1969:								
Coal.....	2,178	277	603	4,652	-----	194	41.70	2,128
Peat.....	26	210	5	44	-----	1	22.91	641
Nonmetal.....	666	266	177	1,412	-----	20	14.17	789
Sand and gravel.....	992	246	230	2,009	-----	1	37	18.91
Stone.....	3,039	273	830	6,644	-----	2	102	15.65
Total.....	6,841	270	1,845	14,761	-----	3	354	24.19
1970: <sup>p</sup>								
Coal.....	2,365	273	645	4,988	-----	2	206	41.70
Peat.....	6	219	6	45	-----	1	22.09	3,893
Nonmetal.....	560	289	162	1,282	-----	8	6.24	751
Sand and gravel.....	875	252	221	1,871	-----	2	9.62	290
Stone.....	3,095	275	850	7,016	-----	1	114	8,153
Total <sup>1</sup> .....	6,920	272	1,883	15,202	-----	5	345	1,637
<sup>p</sup> Preliminary. <sup>1</sup> Data may not add to totals shown because of independent rounding.								

## REVIEW BY MINERAL COMMODITIES

## NONMETALS

**Abrasive Stone.**—Reorganization of the Indiana Sandstone Co., Inc. separated ownership of the Hindostan Whetstone Co. whose operation near Orleans is one of the oldest in the State. Although whetstones fabricated from sandstone quarried in Orange County decreased 40 percent in quantity, the value remained the same as in 1969.

**Cement.**—Portland cement shipments, comprising the majority of State cement production, decreased nearly 2.1 million barrels below 1969 shipments and the value dropped about \$3.5 million. Adverse weather and strikes by truck drivers and construction workers delayed many construction projects. High interest rates and shortage of mortgage money during the first half of the year had a depressing effect on construction and caused a lower demand for cement.

Universal Atlas Cement Division of United States Steel Corp. shut down its Mill No. 6 at Buffington in Lake County but continued to operate the remaining portland cement plant. The company started up its new calcium-aluminate refractory facilities at Buffington, which will replace an old plant and double its capacity. Lone Star Cement Corp. operated its new Greencastle plant in Putnam County for the first full year. Production was curtailed by a 10-week strike at Lehigh Port-

land Cement Co.'s Mitchell plant in Lawrence County. Louisville Cement Co. operated its plants at Logansport in Cass County and at Speed in Clark County. Plans were announced to replace three small old kilns at the Speed plant with one kiln that has an annual capacity of 2 million barrels. The new kiln is expected to be in operation by the end of 1973. Discussions were terminated on the proposed merger with Kaiser Cement & Gypsum Corp.

About 80 percent of all the cement produced and shipped was Type I (general construction use) and Type II (moderately low heat and moderate degree of resistance to sulfate attack); 6 percent was Type III (high-early-strength); 11 percent was masonry cement; and the remainder comprised special types of cement.

Disposition of portland cement shipped was as follows: 84 percent went to building materials dealers, concrete products manufacturers, and ready-mix concrete companies; 14 percent went to highway contractors and Federal, State, and other government agencies; the remaining 2 percent went for miscellaneous uses. Apparent consumption of portland cement in Indiana during 1970 was 8,526,000 barrels. Indiana customers received portland cement from plants in Ohio and Michigan. Cement produced in Indiana was shipped to other States including Illinois, Kentucky, Wisconsin, and Ohio. The average mill



value of portland cement for all types was \$3.36 a barrel in Indiana, up slightly above the \$3.32 average for the United States, and 24 cents higher than the 1969 average for the State. Price increases to be effective January 1, 1971, were announced and ranged from 15 to 25 cents a barrel.

About 93 percent of the cement was shipped in bulk and 7 percent was shipped in bags. About 94 percent of the cement was shipped by truck; the remainder, by rail.

Masonry cement produced and shipped by three plants decreased in quantity about 6 percent below 1969 shipments, but the value increased nearly 7 percent.

**Clays.**—Combined clay and shale output declined 10 percent below that of the preceding year and the value decreased 6 percent. Common clay and shale sold or used was 1.26 million tons, of which shale was the largest amount. Shale was produced by 13 companies at 15 pits in nine counties; common clay was produced by 11 companies at 13 pits in nine counties; and undifferentiated clay and shale was mined in two counties. Leading producers were Hydraulic Press Brick Co. and Log Cabin Coal Co. Fire clay sold or used totaled 75,403 tons, down more than 90,000 tons below 1969. Seven companies produced fire clay from nine pits in five counties. Leading producers were Arketex Ceramic Corp. and Log Cabin Coal Co. In summary, 28 companies operated 35 clay and shale mines in 18 counties. About 59 percent of the clay production came from Morgan and Clay Counties.

Nearly 34 percent of the common clay and shale was used to manufacture building bricks; 25 percent was used in making portland cement; and the remainder was used for lightweight aggregate, drain tile, sewer pipe, and miscellaneous uses. About 45 percent of the fire clay was used in making bricks; 9 percent was used to man-

ufacture floor and wall tile; and the remainder was used for foundry refractories, pottery, and other uses.

The Old Glory No. 69 pit in Owen County, active in 1969, was shut down permanently and did not operate in 1970. Brick sales were down partly because of strikes in the building trades but mainly because high interest rates and shortage of mortgage money had a depressing effect on housing construction.

**Gypsum.**—Production of crude gypsum increased 3 percent, but the value increased only 1 percent. National Gypsum Co. and United States Gypsum Co. operated underground mines near Shoals in Martin County and calcined gypsum in plants adjacent to the mine sites. United States Gypsum Co. also operated a calcining plant near East Chicago in Lake County. Plaster, lath, and wallboard were produced in the three plants. Calcined gypsum production decreased 3 percent below that of 1969, but the value increased slightly above that in 1969. Uncalcined gypsum was sold for use as a portland cement retarder and for agricultural use.

**Lime.**—Indiana ranked fifth in the Nation as a lime consumer, using 1,265,000 tons of quicklime and 78,000 tons of hydrated lime. Marblehead Lime Co. operated the only lime plant in the State at Buffington in Lake County. Limestone quarried in Michigan was transported by lake freighters to Buffington and processed in rotary kilns using bituminous coal for fuel. Production of quicklime increased nearly 10 percent above the quantity made in 1969. Although some lime produced in Indiana was shipped to Illinois, large quantities were shipped into the State from producers in Illinois, Ohio, and Missouri. Most of the quicklime was used by the steel industry; however, a small amount was used for soil stabilization and water purification.

Table 5.—Indiana: Clays sold or used by producers, by kinds  
(Thousand short tons and thousand dollars)

Year	Fire clay		Common clay		Total <sup>1</sup>	
	Quantity	Value	Quantity	Value	Quantity	Value
1966.....	314	\$511	1,177	\$1,685	1,491	\$2,196
1967.....	247	420	1,242	1,706	1,489	2,126
1968.....	182	340	1,369	2,015	1,550	2,355
1969.....	166	314	1,317	1,950	1,483	2,264
1970.....	75	202	1,259	1,936	1,335	2,139

<sup>1</sup> Data may not add to totals shown because of independent rounding.

**Perlite.**—Crude perlite, mined mostly in New Mexico, was expanded at six plants as follows: United States Gypsum Co. at gypsum plants in Lake and Martin Counties; Federal Cement Products, Inc., in Lake County; National Gypsum Co. at its gypsum plant in Martin County; Airlite Processing Corp. in Scott County; and Chemrock Corp. in Tippecanoe County. Expanded perlite production increased in 1970 above that of the preceding year. The principal use was for plaster aggregate; other uses included concrete aggregate and insulation.

**Sand and Gravel.**—Although sand and gravel production decreased 10 percent below that of the preceding year, the value decreased only 6 percent. Sand and gravel was produced in 64 counties by 151 operators at 202 locations. In addition to one Federal agency, one city and 20 counties reported production at 24 municipal operations. Sand and gravel producers reported operating 127 stationary plants, 73 portable units, and 26 dredges. Production ranged from 2,000 tons in one county to 2,651,000 tons in Marion County. Only three commercial operations produced 800,000 tons

or more each; four, between 600,000 and 800,000 tons each; 56, between 100,000 and 500,000 tons each; and 63, less than 25,000 tons.

About 55 percent of Indiana's sand and gravel production was used for paving; another 33 percent was used by the building industry; 10 percent for fill; and the remainder for railroad ballast and ground and unground industrial uses, such as molding and glass manufacturing. Nearly 93 percent of the sand and gravel was transported by truck; the remainder was divided between rail and water transportation.

The J. K. Hall and Sons Sand and Gravel Co., near Lowell in Lake County, was taken over by the M and W Corp. American Aggregates Corp. started erection on a Marion 7400 walking dragline with a 15-cubic-yard bucket on a 175-foot boom. Increased excavating capacity is anticipated at the South Indianapolis operation when this machine is put into service in mid-1971. American Aggregates announced a new operational plan for the Carmel pit making it possible to release reclaimed areas as quickly as possible for other uses.

**Table 6.—Indiana: Sand and gravel sold or used by producers, by classes of operations and uses**  
(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	4,809	\$4,520	4,208	\$4,071
Fill.....	1,528	976	828	583
Paving.....	4,587	4,243	4,680	4,568
Other uses <sup>1</sup> .....	665	2,062	524	1,625
Total <sup>2</sup> .....	11,588	11,801	10,240	10,848
<b>Gravel:</b>				
Building.....	3,493	4,528	3,390	4,577
Fill.....	2,471	1,680	1,481	1,038
Paving.....	7,793	8,934	7,381	8,740
Other uses <sup>3</sup> .....	8	9	75	77
Total <sup>2</sup> .....	13,764	15,150	12,326	14,432
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Paving.....	11	5	22	11
Other uses.....	14	9	1	1
Total <sup>2</sup> .....	24	15	23	12
<b>Gravel:</b>				
Building.....			95	42
Fill.....	9	4		
Paving.....	833	469	792	462
Total <sup>2</sup> .....	842	473	887	504
<b>Total sand and gravel <sup>2</sup>.....</b>	<b>26,218</b>	<b>27,438</b>	<b>23,476</b>	<b>25,796</b>

<sup>1</sup> Revised.

<sup>2</sup> Includes engine, fire or furnace, glass, molding, railroad ballast, and other sands.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

<sup>4</sup> Includes railroad ballast and other gravel.

Table 7.—Indiana: Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Adams.....	2	61	\$85	1	W	W
Allen.....	7	1,148	W	7	1,052	\$1,030
Bartholomew.....	1	34	17	-----	-----	-----
Boone.....	4	174	177	4	W	W
Cass.....	2	108	97	2	101	91
Clinton.....	1	10	10	1	11	11
Daviess.....	1	75	82	1	W	W
Dearborn.....	3	289	372	2	W	W
De Kalb.....	4	355	295	5	273	254
Delaware.....	4	386	409	3	W	W
Elkhart.....	18	625	601	18	546	569
Fayette.....	3	307	369	3	W	W
Fountain.....	1	442	W	2	W	W
Franklin.....	2	136	W	2	W	W
Fulton.....	3	238	197	2	W	W
Greene.....	2	205	W	2	W	W
Hamilton.....	5	1,847	W	5	1,957	2,431
Hancock.....	2	79	W	2	W	W
Hendricks.....	1	1	1	1	W	W
Henry.....	4	333	379	3	W	W
Howard.....	3	366	389	3	W	W
Huntington.....	3	95	W	3	W	W
Jackson.....	3	W	412	2	W	243
Jay.....	1	31	34	1	31	34
Jefferson.....	1	15	11	1	W	W
Knox.....	5	613	560	5	590	543
Kosciusko.....	7	1,026	878	7	815	695
Lagrange.....	8	268	239	9	235	215
La Porte.....	4	857	1,206	3	W	W
Lawrence.....	1	1	( <sup>1</sup> )	-----	-----	-----
Madison.....	7	822	W	6	539	640
Marion.....	5	W	W	4	2,651	3,240
Marshall.....	3	505	534	3	W	W
Miami.....	3	314	391	3	W	W
Monroe.....	1	1	( <sup>1</sup> )	-----	-----	-----
Montgomery.....	2	33	33	2	W	W
Morgan.....	4	W	W	4	427	335
Noble.....	9	439	385	6	295	239
Parke.....	4	396	379	4	W	W
Perry.....	1	24	17	1	24	17
Randolph.....	1	20	19	1	W	23
Rush.....	1	14	13	1	10	9
St. Joseph.....	8	850	817	4	W	W
Scott.....	4	317	380	-----	-----	-----
Shelby.....	-----	-----	-----	5	555	571
Starke.....	2	44	32	2	W	W
Steuben.....	4	220	227	4	189	185
Sullivan.....	3	184	119	3	W	115
Tippecanoe.....	5	1,131	1,264	5	W	W
Union.....	1	24	13	1	32	21
Vigo.....	8	1,108	W	5	874	865
Wabash.....	4	65	W	4	54	42
Warren.....	2	574	614	2	575	W
Washington.....	1	5	2	-----	-----	-----
Wayne.....	8	504	597	7	602	661
Whitley.....	2	74	83	1	66	78
Undistributed <sup>2</sup> .....	25	8,427	14,701	24	10,974	12,635
Total <sup>3</sup> .....	224	26,218	27,438	202	23,476	25,796

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

<sup>1</sup> Less than ½ unit.

<sup>2</sup> Includes Carroll (1969), Clark, Gibson, Grant, Harrison, Jasper, Johnson, Lake, Owen, Porter, Posey, Pulaski (1969), Putnam, Switzerland, and Vermillion Counties.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

**Slag.**—About 4 million tons of blast furnace slag was produced in Lake and Porter Counties as a byproduct of pig iron production. Most of the slag was used for land-fill reclamation. Nearly 1.5 million tons of slag was used in making cement or

marketed for mineral wool, roofing granules, aggregate, and railroad ballast; or expanded for lightweight aggregate.

**Stone.**—Production of stone, comprising mostly limestone and dolomite, increased 1 percent, but the value decreased slightly

below that of the preceding year. Although stone was produced by 92 companies at 135 quarries in 53 counties, eight companies mined 53 percent of the output at 29 limestone quarries. Limestone was produced by 76 operators at 106 quarries in 41 counties. Only four counties has an output exceeding 1 million tons: Putnam, Lawrence, Clark, and Allen. Six companies quarried 1,066,000 tons of dolomite at seven quarries in Adams, Cass, Jay, Pulaski, Randolph, and Rush Counties. Twelve operators produced 23,208 tons of marl from 15 quarries in Elkhart, Kosciusko, Lagrange, La Porte, Marshall, Noble, St. Joseph, and Steuben Counties. Five companies produced 13,554 tons of sandstone from seven quarries in Lawrence, Martin, Morgan, Orange, and Pike Counties.

Principal uses of stone were as follows: 62 percent for road-base and paving materials; 13 percent for concrete aggregate; 10 percent for manufacturing portland cement; 8 percent for agricultural uses; and the remainder for railroad ballast, rough and dressed architectural dimension stone,

riprap and jettystone, and for miscellaneous chemical and industrial uses.

Salem Limestone, generally known in the trade as Indiana limestone, has dominated the domestic dimension limestone market for years and has accounted for more than half of the production in the United States. It has lost steadily in its share of the construction market to other building materials such as concrete, glass, and metal. Dimension stone declined 24 percent in quantity and 16 percent in value below that of 1969. Although dimension limestone was produced at 28 quarries in seven counties, most of the output was from Monroe and Lawrence Counties. Indiana Limestone Co., Inc., was the largest producer of dimension limestone.

Trucks transported about 82 percent of the stone; the remainder was divided between railroad and waterway transportation.

In 1970 Northern Indiana Stone Co. began operating a new quarry near Lowell in Lake County in a dolomite reef discovered by the Indiana Geological Survey in 1969. Muncie Stone & Lime Co. discontinued operations in January 1970.

Table 8.—Indiana: Limestone and dolomite sold or used by producers, by uses  
(Thousand short tons and thousand dollars unless otherwise specified)

Use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Rough architectural.....thousand cubic feet..	2,439	\$3,989	1,895	\$3,118
Irregular shaped stone:				
Rubble.....	4	88	4	92
Other rough.....	8	29	7	27
Dressed architectural:				
Cut.....thousand cubic feet..	419	3,386	460	3,132
House stone veneer.....do....	763	2,602	458	977
Sawed.....do....	540	1,179	558	2,035
Flagging.....do....	60	11	W	14
Total (approximate).....	357	11,285	273	9,433
<b>Crushed and broken:</b>				
Bituminous aggregate.....	2,357	3,154	2,101	3,124
Concrete aggregate.....	3,439	4,614	3,433	4,789
Dense graded road base stone.....	7,208	9,550	6,953	9,536
Macadam aggregate.....	1,962	2,841	1,369	2,098
Surface treatment aggregate.....	2,718	3,920	2,802	3,989
Unspecified aggregate and roadstone.....	2,295	3,029	2,779	3,859
Agricultural limestone <sup>2</sup> .....	1,389	2,065	1,980	3,422
Cement <sup>3</sup> .....	2,644	2,570	2,561	2,315
Filter stone.....	W	W	4	5
Flux.....	41	60	35	52
Railroad ballast.....	452	590	434	591
Riprap and jetty stone.....	242	476	136	454
Other <sup>4</sup> .....	409	1,016	920	1,364
Total <sup>5</sup> .....	25,157	33,885	25,508	33,597
Grand total.....	25,514	45,170	25,781	45,030

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

<sup>1</sup> Includes flagging.

<sup>2</sup> Includes other soil conditioners and poultry grit for 1970.

<sup>3</sup> Includes lime for 1970.

<sup>4</sup> Includes stone used for asphalt filler; mine dusting; stone sand; other and unspecified uses; also, filter stone (1969) and building products (1970).

<sup>5</sup> Data may not add to totals shown because of independent rounding.

Table 9.—Indiana: Limestone<sup>1</sup> sold or used by producers, by counties  
(Thousand short tons and thousand dollars)

County	1969		1970		Type of stone produced in 1970
	Quantity	Value	Quantity	Value	
Adams.....	W	W	W	W	Dimension and crushed and broken.
Allen.....	W	W	1,474	\$2,229	Crushed and broken.
Bartholomew.....	432	\$654	466	731	Do.
Blackford.....	W	W	W	W	Do.
Carroll.....	W	W	W	W	Do.
Cass.....	709	849	712	797	Dimension and crushed and broken.
Clark.....	2,496	3,145	2,293	2,806	Crushed and broken.
Crawford.....	W	W	W	W	Do.
Decatur.....	232	374	W	W	Do.
Delaware.....	646	911	W	W	Do.
Floyd.....	W	W	-----	-----	-----
Franklin.....	2	32	6	82	Dimension.
Grant.....	W	W	W	W	Dimension and crushed and broken.
Hamilton.....	W	W	948	1,526	Crushed and broken.
Harrison.....	237	W	297	463	Do.
Howard.....	W	W	W	W	Do.
Huntington.....	W	W	W	W	Do.
Jasper.....	W	W	W	W	Do.
Jay.....	106	W	124	W	Do.
Jennings.....	W	W	W	W	Do.
Lawrence.....	2,410	7,665	2,329	6,943	Dimension and crushed and broken.
Madison.....	W	W	W	W	Crushed and broken.
Miami.....	35	W	36	W	Do.
Monroe.....	1,036	7,016	W	6,160	Dimension and crushed and broken.
Morgan.....	W	W	W	W	Do.
Newton.....	W	W	W	W	Crushed and broken.
Orange.....	569	W	586	813	Dimension and crushed and broken.
Owen.....	W	W	W	W	Crushed and broken.
Perry.....	W	W	W	W	Dimension and crushed and broken.
Pulaski.....	W	W	W	W	Crushed and broken.
Putnam.....	2,810	3,608	2,626	3,703	Do.
Randolph.....	206	W	213	W	Do.
Ripley.....	W	W	W	W	Do.
Rush.....	W	279	W	227	Dimension and crushed and broken.
Scott.....	W	W	W	W	Crushed and broken.
Shelby.....	623	956	W	W	Dimension and crushed and broken.
Sullivan.....	16	37	14	32	Crushed and broken.
Switzerland.....	60	W	60	W	Do.
Wabash.....	149	W	180	298	Do.
Warrick.....	W	W	W	W	Do.
Washington.....	W	W	W	W	Do.
Wayne.....	172	272	150	W	Do.
Wells.....	W	W	W	W	Do.
White.....	W	W	W	W	Do.
Total.....	25,514	45,170	25,781	45,030	

<sup>1</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included in "Total."  
<sup>1</sup> "Limestone" used generally to include dolomite.

**Sulfur.**—American Oil Co. recovered by-product sulfur from crude petroleum by the Mathieson-Fluor process at its Whiting refinery in Lake County. Although the sales of elemental sulfur increased 23 percent in quantity above that of 1969, the total value of sales decreased 22 percent.

#### MINERAL FUELS

**Coal (Bituminous).**—Responding to increased demand, Indiana's coal production was the highest since 1948, rising 11 percent above that in 1969 and the value increased 23 percent reflecting higher prices for the coal produced. Strip mine production reported at 32 mines in nine counties increased 12 percent above that of the preceding year; underground production from

six mines in five counties declined slightly. About 34 percent of the coal production came from Warrick County; followed by Sullivan County, 20 percent; Pike County, 19 percent; Greene County, 12 percent; Clay County, 6 percent; and the remainder from Vermillion, Gibson, Vigo, Spencer, Fountain, and Parke Counties.

Underground mine coal seams ranged in thickness from 65 to 80 inches. Thickness of strip coal seams ranged from 23 to 80 inches. Overburden thickness at the strip mines ranged from 15 to 99 feet.

Strip mining equipment in operation during the year included 58 power shovels, 48 draglines, 37 frontend loaders, and one carryall scraper. The bucket capacities of the 104 power shovels and dragline excavators were reported as follows: 11 exceeding

50 cubic yards; 11 between 16 and 50 cubic yards; 26 between 6 and 15 cubic yards; and 56 less than 6 cubic yards. Shovels and draglines were powered as follows: 44 electric, seven diesel electric, 43 diesel, and 10 gasoline. All underground coal was mechanically loaded.

Nearly 78 percent of Indiana's coal production was transported by rail or water; 15 percent by truck; and the remainder was conveyed to mine-mouth electric power-generating plants. Consumption of Indiana's coal, mostly by electric power utilities, increased nearly 1 million tons above that of the preceding year. However, coal imported from other States remained about the same. Of the 24,167,000 tons of coal shipped from other States for Indiana's consumption in 1970, 28 percent was supplied from mines in western Kentucky; 27 percent from Illinois mines; 26 percent from District 8 (eastern Kentucky, part of Virginia, southern West Virginia, and north-central Tennessee); and 18 percent from District 7 (southern West Virginia and part of southwestern Virginia). Electric utility companies used 54 percent of the coal; coke and gas plants used 30 percent; and the remainder was consumed for other uses.

Three new strip mines were opened during the year: Peabody Coal Co.'s Universal mine in Vermillion County; L. R. Chapman, Inc., mine and Thornberry Construction Co. Inc., mine in Pike County.

During the year, three mines shut down after small production: two strip mines—Burcham in Owen County and Blanton in Greene County; and one underground mine—Boon in Warrick County. Another five mines were abandoned with no production reported: J. and H. Coal Co. in Daviess County; Sassy Ann mine and R. S. and K. Mine No. 1 in Sullivan County; Somerville No. 1 mine in Gibson County; and the Smith mine.

Ayrshire Coal Co. completed erection of a large stripping machine at the Ayrco mine in Pike County. Two new stripping machines were under construction—one at Peabody Coal Co.'s Universal mine and the other at Enos Coal Corp.'s Northwest Field Pit in Pike County.

In June the Louisville and Nashville Railroad inaugurated a 60-car unit train haul between Peabody Coal Co.'s Universal mine and Public Service Indiana's (PSI) new Cayuga generating station. When PSI's second 500,000-kilowatt unit starts operation in 1972 the train will be increased to 100 cars hauling 10,000 tons each trip.

By yearend 28 companies or individuals were operating six underground mines and 32 strip mines or pits.

**Coke.**—Indiana moved ahead of Ohio in 1970 to become the second largest coke producer in the Nation (Pennsylvania was still the No. 1 coke producer). Output of coke produced at six plants increased 10 percent above 1969 production.

Table 10.—Indiana: Coal (bituminous) production in 1970, by counties

(Excludes mines producing less than 1,000 short tons)

County	Number of mines operated		Production (thousand short tons)			Value (thousands)
	Underground	Strip	Underground	Strip	Total	
Clay.....		6		1,237	1,237	\$6,408
Fountain.....		1		W	W	W
Gibson.....	1		W		W	W
Greene.....		4		2,748	2,748	W
Parke.....		1		8	8	28
Pike.....	1	8	68	4,190	4,258	18,948
Spencer.....		1		W	W	W
Sullivan.....	2	5	1,135	3,434	4,569	22,525
Vermillion.....		1		953	953	W
Vigo.....	1		W		W	W
Warrick.....	1	7		7,506	7,514	31,559
Undistributed.....			883	92	975	29,337
Total.....	6	32	2,094	20,169	22,263	108,805

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

<sup>1</sup> Data may not add to totals shown because of independent rounding.

Table 11.—Indiana: Shipments of bituminous coal for consumption, by district of origin and consumer use  
(Thousand short tons)

Use	District of origin <sup>1</sup>							Total
	2	3 and 6	4	7 and 8	9	10	11	
<b>1966:</b>								
Electric utilities.....				450	5,591	2,861	9,698	18,600
Coke and gas plants.....		622		11,083		541		12,246
Retail dealers.....		8		695	17	24	419	1,163
All others.....	10			422	306	1,197	4,480	6,415
<b>Total.....</b>	<b>10</b>	<b>630</b>		<b>12,650</b>	<b>5,914</b>	<b>4,623</b>	<b>14,597</b>	<b>38,424</b>
<b>1967:</b>								
Electric utilities.....				650	5,408	3,767	10,799	20,624
Coke and gas plants.....		393		11,288		640		12,321
Retail dealers.....		5		632	8	19	406	1,070
All others.....		4		432	263	1,090	4,637	6,426
<b>Total.....</b>	<b>402</b>			<b>13,002</b>	<b>5,679</b>	<b>5,516</b>	<b>15,842</b>	<b>40,441</b>
<b>1968:</b>								
Electric utilities.....				1,254	5,601	3,125	11,526	21,506
Coke and gas plants.....		253		10,132		1,103		11,538
Retail dealers.....		4	10	602	2	51	329	998
All others.....				388	230	1,133	4,452	6,203
<b>Total.....</b>	<b>257</b>		<b>10</b>	<b>12,426</b>	<b>5,833</b>	<b>5,412</b>	<b>16,307</b>	<b>40,245</b>
<b>1969:</b>								
Electric utilities.....				1,209	6,331	2,623	12,226	22,389
Coke and gas plants.....		380		9,380		1,806		11,566
Retail dealers.....		2		457	1	14	182	656
All others.....				551	367	938	4,832	6,688
<b>Total.....</b>	<b>382</b>			<b>11,597</b>	<b>6,699</b>	<b>5,381</b>	<b>17,240</b>	<b>41,299</b>
<b>1970:</b>								
Electric utilities.....			119	272	6,508	2,667	13,217	22,733
Coke and gas plants.....		107		9,691		2,871		12,669
Retail dealers.....				414		22	390	826
All others.....		3		301	345	844	4,614	6,107
<b>Total.....</b>	<b>110</b>	<b>119</b>	<b>10,678</b>	<b>6,853</b>	<b>6,404</b>	<b>18,221</b>	<b>42,385</b>	

<sup>1</sup> States or portion of States represented by each district are as follows: District 2—Western Pennsylvania; 3 and 6—Northern West Virginia; 4—Ohio; 7 and 8—Eastern Kentucky, Virginia, Southern West Virginia, and North Central Tennessee; 9—Western Kentucky; 10—Illinois; 11—Indiana.

Although only 14,000 tons of Indiana coal was used to make coke, 13,071,000 tons of coal was carbonized to produce 8,929,000 tons of coke, a yield of 68.31 percent. About 45 percent of the coking coal came from West Virginia; 24 percent from Kentucky; 23 percent from Illinois; and the remainder from Pennsylvania and Virginia. A small quantity of anthracite coal was used in the bituminous coking coal blend. The value of the coal carbonized was \$11.84 a ton, or \$154,720,000.

Nearly 95 percent of the coke production was consumed by blast furnaces in making iron and steel. The value of the 8,457,000 tons of coke used in blast furnaces was \$168,469,000.

Coke was produced by Inland Steel Co., United States Steel Corp., and Youngstown Sheet and Tube Co. in Lake County; Citizens Gas and Coke Utility in Marion County; Bethlehem Steel Corp. in Porter

County; and Indiana Gas & Chemical Corp. in Vigo County.

In addition to coke production, 809,000 tons of coke breeze was produced and used for steam plants, agglomeration plants, and for other industrial uses.

Inland Steel Co. was constructing a new battery of 51 coke ovens at its Indiana Harbor Works in East Chicago to replace a 31-year-old battery of 12-foot ovens. When completed in 1971, the 20-foot high ovens will have capacity to bake 2,300 tons of coal a day.

Peat.—Peat moss and humus sales decreased 11 percent in quantity, but the value decreased 21 percent below that of 1969. Five companies produced peat moss from bogs in Delaware, Grant, Marshall, Warren, and Wells Counties. A small amount of humus was produced in Delaware County. About 98 percent of the peat was sold for soil improvement; the remainder as an ingredient for potting soils.

**Petroleum and Natural Gas.**—Production of crude petroleum continued to decline during 1970, but at a lesser rate than in previous years. The total amount produced was 7,486,798 barrels, or 4.5 percent less than that produced in 1969. Although the price increased slightly, to \$3.20 a barrel, the total value was \$23,958,000, 4.2 percent below that in the preceding year. Operations in the Plummer field, Greene County, are credited with being the major restraining influence on the declining production in the State.

For the first time in 10 years primary production showed an increase—from 3,362,768 barrels in 1969 to 3,636,489 barrels in 1970, a gain of 8.1 percent, also attributable to the Plummer development. Estimated secondary oil production amounted to 3,850,300 barrels, or 51.4 percent of the total produced during the year.

Of the 414 wells drilled, 146 were exploratory, 138 for primary development, 100 for secondary recovery operations, and 30 in connection with gas storage operations. The total number of wells drilled decreased 16.5 percent from that of the previous year. The success ratio of exploratory drilling was 7.5 percent with eight oil wells—two in Posey County and one each in Daviess, Gibson, Greene, Knox, Pike and Spencer Counties; three gas wells—two in Pike County and one in Warrick County, and 135 dry holes. Two new-field discoveries produced oil from Mississippian

rocks; one new pool each in Pennsylvanian and Devonian rocks produced oil, and two in Mississippian rocks produced gas. Five extensions to existing pools were completed in Mississippian strata—four producing oil and one producing gas.

Results of primary development drilling were as follows: 79 oil wells; one gas well; eight holes for saltwater disposal; and 50 dry holes. Drilling for secondary recovery resulted in 12 oil producers, 78 input, water supply, and saltwater disposal wells, and 10 dry holes.

Continued development drilling in the Plummer field, discovered in 1969, resulted in a total of 43 producing wells from the Salem Limestone (Mississippian formation) and one well that tested oil from Devonian limestone at yearend. The success in this field encouraged increased exploration efforts in other areas of Greene County and adjacent Daviess County during the year.

Reported production of natural gas amounted to 237 million cubic feet, valued at \$34,400.<sup>2</sup>

The proved oil reserve at the end of 1970 was 37,009,000 barrels, and the total liquid hydrocarbon reserve was 37,043,000 barrels.<sup>3</sup>

<sup>2</sup> Geological Survey, Indiana Department of Natural Resources, Bloomington, Ind.

<sup>3</sup> American Gas Association, American Petroleum Institute, and Canadian Petroleum Association. Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States and Canada and United States Productive Capacity as of December 31, 1970. V. 25, May 1971, pp. 23, 131.

Table 12.—Indiana: Crude petroleum production in 1970, by major fields

Field	Year discovered	Area (acres)	County	Number of wells		Production (barrels)
				Producing	Completed	
Black River Consolidated	1950	700	Posey	NA	1	133,085
Caborn Consolidated	1940	1,870	do	NA	0	126,209
Coe, South	1961	440	Pike	NA	0	159,752
Griffin Consolidated	1938	7,420	Gibson, Posey	NA	5	1,442,077
Heuster Consolidated	1938	2,220	Posey			
			Vanderburgh	NA	2	319,024
Mt. Carmel Consolidated	1941	2,090	Gibson, Knox	NA	2	109,198
Mt. Vernon Consolidated	1941	2,350	Posey	NA	1	262,725
Oliver, South	1950	310	do	NA	1	101,455
Plummer	1969	880	Greene	44	30	562,777
Springfield Consolidated	1946	2,640	Posey	NA	0	529,672
Union-Bowman (New) Consolidated	1941	15,600	Gibson, Knox, Pike	NA	9	392,722
Welborn Consolidated	1941	1,820	Posey	NA	1	172,698
Wheatonville Consolidated	1949	1,660	Gibson	NA	0	178,031
Undistributed	XX	XX			47	4,489,425
Total	XX	XX		15,000	99	7,486,798

NA Not available. XX Not applicable.

<sup>1</sup> Estimate. Division of Oil and Gas, Indiana Department of Natural Resources.

<sup>2</sup> Includes workovers without newly drilled footage.

Source: Petroleum Section, Indiana Geological Survey.



Table 13.—Oil and gas wells drilled in 1970

County	Proved field wells			Exploratory wells			Total	Footage
	Oil	Gas	Dry	Oil	Gas	Dry		
Allen.....						1	1	1,506
Clay.....	1					1	2	2,144
Crawford.....						2	2	4,052
Daviess.....			2	1		28	31	29,522
Dubois.....			1			5	6	3,814
Elkhart.....						1	1	628
Gibson.....	24		10	1		15	50	82,174
Grant.....	1		2				3	2,015
Greene.....	29		4	1			19	51,776
Hamilton.....			1					1,892
Hancock.....			1					991
Huntington.....	3		1					3,972
Jay.....			2			1	3	2,375
Knox.....	2		3	1			1	18,329
Kosciusko.....							1	355
Lawrence.....							1	285
Martin.....						2	2	1,358
Miami.....	1							980
Owen.....						2	2	1,619
Perry.....						1	1	550
Pike.....	4		2	1	2	5	14	17,104
Porter.....						1	1	265
Posey.....	14		10	2		17	43	91,888
Scott.....						1	1	1,405
Spencer.....	4	1	7	1		11	24	23,640
Sullivan.....	2		7			7	16	12,186
Vanderburgh.....	5		4			2	11	17,963
Vigo.....			1			1	2	2,205
Wabash.....	1		2			3	6	6,523
Warrick.....					1	2	3	3,429
Wells.....						1	1	1,250
White.....						2	2	1,275
Whitley.....						1	1	1,695
Total.....	1 291	1	60	8	3	2 135	2 298	386,165

<sup>1</sup> Includes oil wells completed in secondary recovery projects.

<sup>2</sup> Includes workovers without newly drilled footage.

<sup>3</sup> Includes dry holes completed in secondary recovery projects.

Ten petroleum refineries operated during the year with a total crude capacity of 604,000 barrels<sup>4</sup> per calendar-day or approximately 623,000 barrels per stream-day. In the fall of 1970, the R. J. Oil and Refining Co., Inc., Gibson County, shut down its 4,500 barrel-per-day capacity refinery. The nine refineries that operated the entire year are listed as follows (capacities are given in barrels per calendar day): American Oil Co., 303,000; Atlantic Richfield Co., 140,000; Cities Service Oil Co., 56,000; Mobil Oil Corp., 47,000; Witco Chemical Co., Inc., 10,000 all in Lake County; Rock Island Refining Corp., 22,000 in Marion County; Indiana Farm Bureau Coop. Association, Inc., 12,500 in Posey County; Laketon Asphalt Refining Inc., 6,000 in Wabash County; and Gladioux Refining Inc., 3,000 in Allen County.

#### METALS

**Aluminum.**—Aluminum ingots were produced at the Aluminum Co. of America (Alcoa) smelter in Warrick County using

alumina barged from Mobile, Ala., and Point Comfort, Tex. Although production decreased 5 percent below that of 1969, the value was down only 1 percent. The fifth and sixth potlines were under construction and when completed in 1971 the primary smelting capacity will be increased to 275,000 tons a year. This will equal the aluminum industry's largest domestic smelter. The current expansion project includes an expenditure of more than \$12 million for pollution control facilities. Alcoa's aluminum can recycling project at the Warrick operation received shipments from as far away as Dallas, Tex., and San Diego, Calif. The world's fastest multistand cold-rolling mill for light-gauge aluminum sheet production was under construction at this plant. Most of the light-gauge sheet production is used by the packaging industry.

**Pig Iron and Steel.**—Pig iron production in Indiana reached an alltime record high

<sup>4</sup> U.S. Bureau of Mines. Petroleum Refineries in the United States and Puerto Rico. Mineral Industry Survey, Jan. 1, 1971, 15 pp.

of 13,348,000 tons in 1970, an increase of 5 percent above that of the preceding year. Although shipments of pig iron increased 5 percent, the value rose to \$874.7 million, 17 percent above the 1969 value, reflecting an average price increase of \$6.81 a ton.

Inland Steel Co., United States Steel Corp., and Youngstown Sheet and Tube Co. produced pig iron and steel in Lake County; and Bethlehem Steel Corp. produced iron and steel in Porter County. The American Iron and Steel Institute reported steel production in Indiana was 18,528,000 tons; 4.6 percent below 1969 production. All four companies produced steel using basic oxygen furnaces (BOF)

and United States Steel Corp., Inland Steel Co., and the Youngstown Sheet and Tube Co. also operated open-hearth furnaces. The Youngstown Sheet and Tube Co. operated the BOF for the first time in 1970. Steel was produced from scrap in electric arc furnaces by Borg-Warner Corp. in Henry County; Continental Steel Corp. in Howard County; and Joslyne Manufacturing Supply Co. in Allen County.

**Other Metals.**—United States Smelting Lead Refinery, Inc., subsidiary of United States Smelting, Refining and Mining Co., recovered antimonial lead, bismuth, gold, lead, silver, and tellurium at its electrolytic refinery in Lake County.

Table 14.—Principal producers <sup>1</sup>

Commodity and company	Address	Type of activity	County
Abrasive Stone: Hindostan Whetstone Co.	Box 501 Bedford, Ind. 47421	Quarry; station- ary plant.	Orange.
Cement: Lehigh Portland Cement Co.-----	Young Bldg. 718 Hamilton St. Allentown, Pa. 18105	Portland, dry process.	Lawrence.
Lone Star Cement Corp.-----	2511 East 46th St., Suite K Indianapolis, Ind. 46205	Portland and masonry, wet process.	Putnam.
Louisville Cement Co.-----	501 South 2nd St. Louisville, Ky. 40202	Portland and masonry, wet and dry process.	Cass, Clark.
Universal Atlas Cement Div., United States Steel Corp.	600 Grant St. U.S. Steel Bldg. Pittsburgh, Pa. 15230	Portland and masonry, dry process.	Lake.
Clays and shale:			
Adams Clay Products Co.-----	Box 32 Martinsville, Ind. 46151	Pits and plant....	Morgan.
American Brick Co.-----	6558 West Fullerton Ave. Chicago, Ill. 60635	Pit and plant....	Lake.
AMVIT, Div. of Amvit Corp.-----	2480 Lakeland Blvd. Euclid, Ohio 44123	---do-----	Montgomery.
Arketex Ceramic Corp.-----	Box 347 Brazil, Ind. 47834	Pit and plants....	Vermillion.
Colonial Brick Corp.-----	Box 365 Cayuga, Ind. 47928	Pits and plants...-	Do.
Hydraulic-Press Brick Co.-----	705 Olive St. St. Louis, Mo. 63101	Pit and plant....	Morgan.
The Krick-Tyndall Co., Sub. Han- cock Brick & Tile Co.	Box 450 Findlay, Ohio 45840	---do-----	Adams.
Lehigh Portland Cement Co.-----	Young Bldg. 718 Hamilton St. Allentown, Pa. 18105	Pit-----	Jackson.
Log Cabin Coal Co.-----	304 South Depot St. Brazil, Ind. 47834	Pits-----	Clay.
Louisville Cement Co.-----	501 South 2nd St. Louisville, Ky. 40202	---do-----	Cass, Clark.
S. L. Turner Coal & Clay Co., Inc.---	Box 337 Carbon, Ind. 47837	Pit-----	Parke.
Coal (bituminous):			
Ayrshire Coal Co., Div. of Ameri- can Metal Climax, Inc.	430 Big Four Bldg. Indianapolis, Ind. 46225	Strip mine; cleaning plant.	Clay.
Chinook-----		Strip mine-----	Pike.
Ayrcoe-----		Strip mine; cleaning plant.	Sullivan.
Minnehaha-----		Underground mine; cleaning plant.	Do.
Thunderbird-----		Strip mine-----	Warrick.
Wright-----		---do-----	Do.
Cornell Excavating, Inc.-----	Route 4 Boonville, Ind. 47601		

See footnote at end of table.

Table 14.—Principal producers <sup>1</sup>—Continued

Commodity and company	Address	Type of activity	County
Coal (bituminous)—Continued			
Enos Coal Corp., Old Ben Coal Corp.	10 South Riverside Plaza Chicago, Ill. 60606	Strip mine; cleaning plant.	Pike.
Enos	-----	-----do-----	Do.
Blackfoot No. 5	-----	Strip mine	Warrick.
J. R. Coal Corp.	Route 1 Chandler, Ind. 47610	-----	-----
Kings Station Coal Corp.	10 South Riverside Plaza Chicago, Ill. 60606	Underground mine; cleaning plant.	Gibson.
Lemmons & Co., Inc.	535 South Second St. Boonville, Ind. 47601	Strip mine	Warrick.
Mount Pleasant Mining	Route 25, Box 19 Terre Haute, Ind. 48701	Underground mine; cleaning plant.	Vigo.
Mulzer Crushed Stone Co.	Box 248 Tell City, Ind. 47586	Strip mine	Spencer.
Parke Coal Co.	Box 236 Petersburg, Ind. 47567	-----do-----	Pike.
Peabody Coal Co.:	301 North Memorial Dr. St. Louis, Mo. 63102	-----	-----
Hawthorn	-----	-----do-----	Greene.
Latta	-----	Cleaning plant	Do.
-----	-----	Strip mine; coal cleaned at Miller plant.	Do.
Universal	-----	Strip mine	Vermillion.
Miller Preparation Plant	-----	Cleaning plant	Greene.
Dugger	-----	Strip mine; coal cleaned at Miller plant.	Sullivan.
Lynnville	-----	Strip mine; cleaning plant.	Warrick.
Squaw Creek	-----	-----do-----	Do.
R & H Mining, Inc.	Route 1 Jasper, Ind. 47546	Underground mine.	Pike.
R. S. & K. Coal Corp.	Route 2 Shelburn, Ind. 47879	-----do-----	Sullivan.
Coke:			
Citizens Gas & Coke Utility	2020 North Meridian Indianapolis, Ind. 46209	Coke ovens	Marion.
Indiana Gas & Chemical Corp.	1341 Hulman St. Terre Haute, Ind. 47802	-----do-----	Vigo.
Inland Steel Co.	3210 Watling St. East Chicago, Ind. 46312	-----do-----	Lake.
United States Steel Corp.	Gary, Ind. 46400	-----do-----	Do.
The Youngstown Sheet & Tube Co.	Box 900 Youngstown, Ohio 44501	-----do-----	Do.
Gypsum:			
National Gypsum Co.	325 Delaware Ave. Buffalo, N.Y. 14202	Underground mine; calcin- ing plant.	Martin.
United States Gypsum Co.	101 South Wacker Dr. Chicago, Ill. 60606	Underground mine; 2 calcin- ing plants.	Lake, Martin.
Iron and Steel:			
Bethlehem Steel Corp., Burns Harbor Plant.	701 East 3rd St. Bethlehem, Pa. 18016	Iron blast fur- nace and basic- oxygen steel furnace.	Porter.
Inland Steel Co.	3210 Watling St. East Chicago, Ind. 46312	Iron blast fur- naces and open-hearth steel furnaces.	Lake.
United States Steel Corp., Gary Steel Works.	Gary, Ind. 46400	-----do-----	Do.
The Youngstown Sheet & Tube Co.	Box 900 Youngstown, Ohio 44501	-----do-----	Do.
Lime: Marblehead Lime Co.	300 West Washington St. Chicago, Ill. 60606	Quicklime, 3 rotary kilns.	Lake.
Peat:			
Glacier Peat Moss Corp.	Route 1 Jonesboro, Ind. 46938	Bog; processing plant.	Grant.
Millburn Peat Co., Inc.	Box 297 Otterbein, Ind. 47970	-----do-----	Warren.
Plant Organic Products Co.	Route 1 Gaston, Ind. 47372	-----do-----	Delaware.

See footnote at end of table.

Table 14.—Principal producers <sup>1</sup>—Continued

Commodity and company	Address	Type of activity	County
<b>Expanded perlite:</b>			
Airlite Processing Corp.....	P.O. Scottsburg Vienna, Ind. 47170	Processing plant..	Scott.
Chemrock Corp.....	End of Osage St. Nashville, Tenn. 37208	....do.....	Tippecanoe.
Federal Cement Products, Inc.....	24 Marble St. Hammond, Ind. 46320	....do.....	Lake.
National Gypsum Co.....	325 Delaware Ave. Buffalo, N.Y. 14202	....do.....	Martin.
United States Gypsum Co.....	101 South Wacker Dr. Chicago, Ill. 60606	....do.....	Lake, Martin.
<b>Petroleum Refineries:</b>			
American Oil Co.....	2400 New York Ave. Box 710 Whiting, Ind. 46394	.....	Lake.
Atlantic Richfield Co.....	3500 Indianapolis Blvd. East Chicago, Ind. 46312	.....	Do.
Cities Service Oil Co.....	4900 Cline Ave., Box 718 East Chicago, Ind. 46312	.....	Do.
Mobil Oil Corp.....	3821 Indianapolis Blvd. East Chicago, Ind. 46312	.....	Do.
Roofing granules: H. B. Reed & Co., Inc.	6937 Kennedy Ave. Hammond, Ind. 46323	2 plants; pro- duced from slag.	Do.
<b>Sand and gravel:</b>			
Aggregate Service McMahan Constr. Co.	Box 378 Rochester, Ind. 47975	Pit; portable and stationary plants.	Marshall.
American Aggregates Corp.....	Garst Ave. at Ave. B Greenville, Ohio 45331	Pits; stationary plants.	Hamilton, Marion, Wayne.
Paul C. Brudi Stone & Gravel Co., Inc.	Box 2837 Fort Wayne, Ind. 46808	....do.....	Allen.
Concrete Materials Div., Martin Marietta Corp.	4096 First Ave., N.E. Cedar Rapids, Iowa 52406	Pits; portable and stationary plants.	Hamilton, Marion, Shelby, Vermillion, Vigo.
Driftwood Gravel, Inc., Jefferson Corp.	Box 9 Columbus, Ind. 47201	Pit; stationary plant.	Johnson.
Fidler Sand & Gravel, Inc.....	1700 Egbert Ave. Goshen, Ind. 46526	Pit; dredge; sta- tionary plant.	Elkhart.
Hilltop Concrete Corp.....	Box 11056 Cincinnati; Ohio 45211	Pit; stationary plant.	Switzerland.
Interstate Sand & Gravel Co., Inc....	Box 38 Covington, Ind. 47932	....do.....	Warren.
Irving Bros. Gravel Co., Inc.....	Route 3 Marion, Ind. 46952	....do.....	Grant.
Irving Materials, Inc., No. 2.....	Box 369 Greenfield, Ind. 46140	Pits; portable and stationary plants.	Hamilton, Henry.
Knox County Sand Co., Ralph Rogers & Co., Inc.	Box 483 Vincennes, Ind. 47591	Pit; stationary plant.	Knox.
May Stone & Sand, Inc.....	Box 2927 Fort Wayne, Ind. 46809	Pits; stationary plants.	Allen.
Myers Sand & Gravel Corp.....	Box 212 Anderson, Ind. 46015	Pit; stationary plant.	Madison.
Neal Gravel Co., Inc., Interstate Sand & Gravel Co., Inc.	Box 38 Covington, Ind. 47932	....do.....	Fountain.
S & G Excavating, Inc.....	Route 21, Box 698 Terre Haute, Ind. 47801	....do.....	Vigo.
South Bend Sand & Gravel Corp....	3113 Lincoln Way West South Bend, Ind. 46628	Pits; stationary plant.	St. Joseph.
Spray Sand & Gravel, Inc.....	Route 4 Seymour, Ind. 47274	Pits; dredges; stationary plants.	Jackson.
Western Indiana Aggregates, Inc., Medusa Portland Cement Co.: Anderson Gravel Division.....	500 North 6th St. Lafayette, Ind. 47901	.....	Madison.
Eagle Materials, Inc.....	.....	Pits; stationary plant. Dredge; sta- tionary plant.	Lake.
Hanna Sand & Gravel Co., Inc....	.....	....do.....	La Porte.
Lafayette No. 1 Gravel Divi- sion.	.....	Pit; stationary plant.	Tippecanoe.
Lafayette Portable Gravel Division.	.....	Pit; portable plant.	Do.
Leesburg Gravel Division.....	.....	Pit; stationary plant.	Kosciusko.

See footnote at end of table.

Table 14.—Principal producers<sup>1</sup>—Continued

Commodity and company	Address	Type of activity	County
<b>Sand and gravel—Continued</b>			
Western Indiana Aggregates, Inc., Medusa Portland Cement Co.— Continued			
Montezuma Gravel Division.....	-----	do.....	Parke.
South Bend Gravel Division.....	-----	do.....	St. Joseph.
<b>Nonferrous Smelters and Refineries:</b>			
Aluminum Company of America.....	Newburgh, Ind. 47630	Aluminum smelter.	Warrick.
American Smelting & Refining Co....	2230 Indianapolis Blvd. Whiting, Ind. 46394	Lead secondary plant.	Lake.
National Lead Co., American Lead Plant.	Beech Grove, Ind. 46107	do.....	Marion.
United States Smelting Lead Re- finery, Inc.	5300 Kennedy Ave. East Chicago, Ind. 46312	Lead primary and secondary plant.	Lake.
<b>Stone:</b>			
<b>Limestone and dolomite:</b>			
American Aggregates Corp.....	Garst Ave. at Avenue B Greenville, Ohio, 45331	Quarries; sta- tionary plants.	Hamilton, Owen.
Bloomington Crushed Stone Co., Inc., Ralph Rogers & Co., Inc.	Box 849 Bloomington, Ind. 47401	do.....	Lawrence, Monroe.
Bloomington Limestone Corp..	Box 250 Bloomington, Ind. 47401	Quarry; sta- tionary plant.	Monroe.
Empire Stone Co.....	Box 788 Bloomington, Ind. 47401	do.....	Do.
Independent Limestone Co.....	Route 5, Box 395 Bloomington, Ind. 47401	do.....	Do.
Indiana Limestone Co., Inc.....	405 North 1st St. Bedford, Ind. 46421	Quarries; sta- tionary plants.	Lawrence, Monroe.
Irving Bros. Gravel Co. Inc:	Route 3 Marion, Ind. 46952		
Erie Stone, Inc.....	-----	Quarries; sta- tionary plants.	Huntington, Wells.
Irving Bros. Stone & Gravel	-----	Quarry; sta- tionary plant.	Delaware.
Pipe Creek Stone Co.....	-----	do.....	Grant.
Lehigh Portland Cement Co....	Young Bldg. 718 Hamilton St. Allentown, Pa. 18105	do.....	Lawrence.
Lone Star Cement Corp.....	2511 East 46th St. Suite K, Indianapolis, Ind. 46205	do.....	Putnam.
Louisville Cement Co.....	501 South 2nd St. Louisville, Ky. 40202	Quarries; sta- tionary plants.	Cass, Clark.
May Stone & Sand, Inc.....	Box 2927 Fort Wayne, Ind. 46800	do.....	Allen.
Midwest Aggregates Corp., Old Fort Industries, Inc.	2013 S. Anthony Blvd. Fort Wayne, Ind. 46805	Quarry; sta- tionary plant.	Do.
Mitchell Crushed Stone Co., Inc., Ralph Rogers & Co., Inc.	Box 849 Bloomington, Ind. 47401	do.....	Lawrence.
Mulzer Crushed Stone Co.....	Box 248 Tell City, Ind. 47586	Quarries; under- ground mine; stationary plants.	Crawford, Perry.
Newton County Stone Co., Inc., Ralph Rogers & Co., Inc.	Box 147 Kentland, Ind. 47951	Quarry; sta- tionary plant.	Newton.
Victor Oolitic Stone Co.....	Box 668 Bloomington, Ind. 47401	do.....	Monroe.
Reed Quarries, Inc.....	Box 64 Bloomington, Ind. 47401	do.....	Do.
Standard Materials Corp., Martin Marietta Corp.	11 North Penn St. Indianapolis, Ind. 46204	Quarries; sta- tionary plants.	Clark, Madison, Putnam,
Western Indiana Aggregates, Inc., Medusa Portland Ce- ment Co., Francesville Stone Division.	500 North 6th St. Lafayette, Ind. 47901	Quarry; sta- tionary plant.	Pulaski.
Wooley Stone Co., Inc.....	Box 40 Bloomington, Ind. 47401	do.....	Monroe.
<b>Marl:</b>			
Vernon M. Kaufman.....	Route 1 Topeka, Ind. 46571	Pit.....	Noble.
Miller Marl.....	Middlebury, Ind. 46540	Pit.....	Lagrange.
Willis Speicher.....	Middlebury, Ind. 46540	Pit.....	Do.
Taylor and Son.....	Route 1 Orland, Ind. 46776	Pit.....	Steuben.

See footnote at end of table.

Table 14.—Principal producers <sup>1</sup>—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Sandstone:			
High Bluff Quarry.....	Route 3, Box 267 Mooresville, Ind. 46158	Quarry; finishing plant.	Morgan.
Indiana Sandstone Co., Inc....	Box 501 Bedford, Ind. 47421	.....do.....	Lawrence.
Springs Valley Sandstone Co....	Route 1 West Baden Springs, Ind. 47469	Quarries.....	Lawrence, Martin, Orange.
Sulfur (recovered): American Oil Co....	910 South Michigan Ave. Chicago, Ill. 60680	Finishing plant... Mathieson-Fluor Process.	Martin. Lake.

<sup>1</sup> Data regarding producers of natural gas and petroleum not available.



# The Mineral Industry of Iowa

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

By Brinton C. Brown<sup>1</sup>

Iowa's mineral production value reached an alltime high of \$120.8 million in 1970, surpassing by nearly 1 percent the 1969 record of \$119.9 million. Sand and gravel and coal production increased in quantity, but output of all other commodities decreased slightly. Both the value of cement shipped and gypsum produced were below that of the preceding year; production of all other commodities increased in value. Nonmetallic minerals comprised nearly 97 percent of the State's total mineral production value, with mineral fuels comprising the remainder. The value of the State's total mineral production was distributed as follows: cement 39 percent; stone 34 percent; sand and gravel 17 percent; gypsum 3.5 percent; clay 1.5 percent; and the remainder, lime, coal, and peat. Coal was the principal mineral fuel produced, with a small quantity of peat production recorded. No petro-

leum has been produced in the State since 1963. However, three dry exploration wells were drilled, one in Appanoose County and two in Keokuk County. Total footage drilled was 4,292 feet.

In 1967 the General Assembly appropriated \$30,000 to the Iowa Department of Mines and Minerals to demonstrate methods for rehabilitating strip mined land. About 40 acres of a strip coal area 4 miles west of Oskaloosa in Mahaska County, known as the Hull Mine Site, was leased for 5 years. The site is highly acid. Work comprised mostly grading, applying lime, seeding grass, planting trees, and fertilizing. The first two growing seasons were reported to be successful. Information gained from the demonstration area will be used in reclaiming other Iowa land.

<sup>1</sup> Mining engineer, Division of Nonmetallic Minerals.

Table 1.—Mineral production in Iowa<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland..... thousand 376-pound barrels...	14,084	\$47,265	12,744	\$45,432
Masonry..... thousand 280-pound barrels...	606	1,912	520	1,753
Clays..... thousand short tons.....	1,199	1,660	1,181	1,823
Coal (bituminous)..... do.....	903	3,392	987	4,059
Gypsum..... do.....	1,169	5,274	1,136	4,223
Sand and gravel..... do.....	18,391	17,867	21,058	20,642
Stone..... do.....	26,233	40,895	25,305	41,119
Value of items that cannot be disclosed:				
Other nonmetals and peat.....	XX	1,665	XX	1,766
Total.....	XX	119,930	XX	120,822
Total 1967 constant dollars.....	XX	113,250	XX	<sup>p</sup> 109,344

<sup>p</sup> Preliminary. XX Not applicable.

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



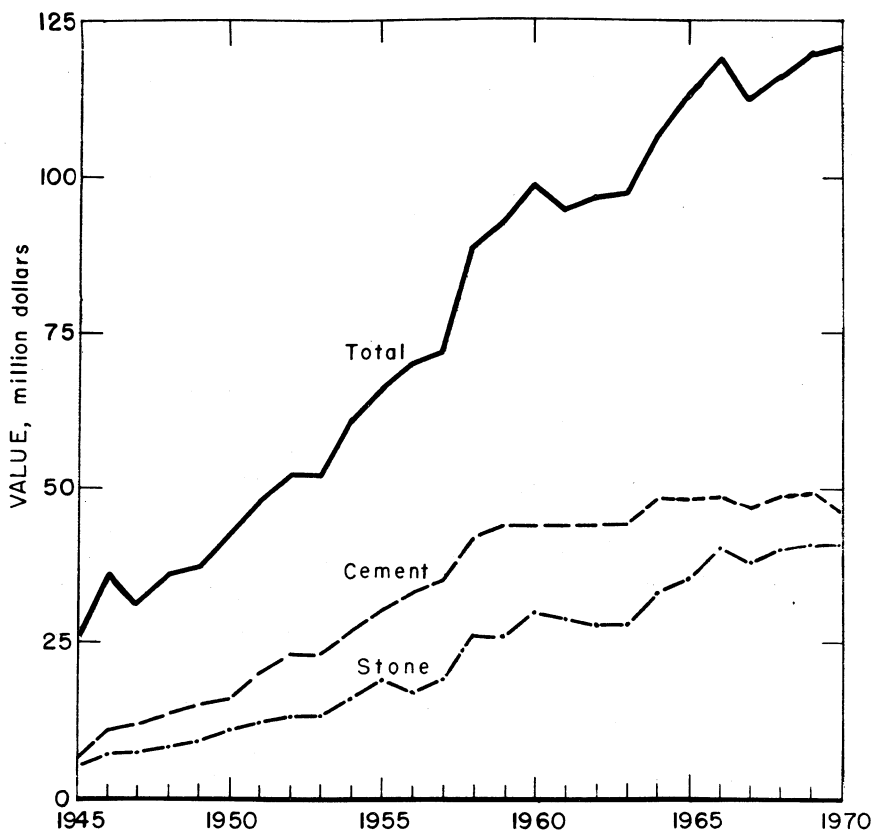


Figure 1.—Value of cement, stone, and total value of mineral production in Iowa.

Table 2.—Value of mineral production in Iowa, by counties <sup>1</sup>

(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Adair.....	W	W	Stone.
Adams.....	W	W	Do.
Allamakee.....	\$279	W	Stone, sand and gravel.
Appanoose.....	740	W	Stone, clays, coal.
Audubon.....	W	\$200	Sand and gravel.
Benton.....	W	W	Sand and gravel, stone.
Black Hawk.....	2,081	W	Stone, sand and gravel.
Boone.....	W	W	Sand and gravel, clays.
Bremer.....	W	279	Stone, sand and gravel.
Buchanan.....	321	W	Do.
Buena Vista.....	149	102	Sand and gravel.
Butler.....	467	W	Stone, sand and gravel.
Calhoun.....	45	W	Sand and gravel.
Carroll.....	215	301	Do.
Cass.....	W	W	Stone, sand and gravel.
Cedar.....	W	W	Stone.
Cerro Gordo.....	27,001	28,334	Cement, stone, sand and gravel, clays, lime.
Cherokee.....	494	497	Sand and gravel.
Chickasaw.....	162	W	Stone, sand and gravel.
Clarke.....	W	W	Stone.
Clay.....	205	282	Sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Iowa, by counties <sup>1</sup>—Continued  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Clayton	\$733	\$951	Sand and gravel, stone.
Clinton	1,161	W	Stone, sand and gravel.
Crawford	W	W	Sand and gravel.
Dallas	584	562	Sand and gravel, clays, stone.
Decatur	W	W	Stone, sand and gravel.
Delaware	312	W	Do.
Des Moines	2,015	1,722	Stone, gypsum, sand and gravel.
Dickinson	252	354	Sand and gravel.
Dubuque	743	859	Stone, sand and gravel.
Emmet	281	208	Sand and gravel.
Fayette	697	988	Stone, sand and gravel.
Floyd	396	344	Stone, clays, sand and gravel.
Franklin	384	W	Sand and gravel, stone, clays.
Fremont	W	W	Stone, sand and gravel.
Greene	270	326	Sand and gravel.
Grundy	167	W	Stone, sand and gravel.
Guthrie	88	172	Sand and gravel.
Hamilton	W	W	Sand and gravel, stone.
Hancock	210	W	Do.
Hardin	1,623	W	Stone, sand and gravel.
Harrison	756	915	Do.
Henry	279	W	Sand and gravel, stone.
Howard	148	180	Stone, sand and gravel.
Humboldt	1,161	W	Do.
Ida	W	W	Sand and gravel.
Iowa	W	W	Do.
Jackson	326	W	Stone, sand and gravel.
Jasper	W	W	Sand and gravel, stone.
Jefferson	203	W	Stone, sand and gravel.
Johnson	1,354	1,550	Stone, sand and gravel.
Jones	563	662	Do.
Keokuk	W	W	Stone, clays.
Kossuth	269	296	Sand and gravel.
Lee	608	375	Stone, sand and gravel.
Linn	3,020	3,253	Do.
Louisa	W	W	Stone.
Lucas	596	686	Coal.
Lyon	194	315	Sand and gravel.
Madison	3,705	W	Stone, clays.
Mahaska	1,576	1,782	Coal, stone, sand and gravel, clays.
Marion	1,528	W	Coal, stone, sand and gravel.
Marshall	1,172	W	Stone, sand and gravel.
Mills	W	W	Do.
Mitchell	554	W	Do.
Monona	W	187	Sand and gravel.
Monroe	802	1,094	Coal.
Montgomery	W	W	Stone.
Muscatine	1,122	W	Stone, sand and gravel.
O'Brien	99	101	Sand and gravel.
Osceola	203	381	Do.
Page	W	W	Stone, sand and gravel.
Palo Alto	203	250	Sand and gravel.
Plymouth	497	571	Do.
Pocahontas	W	W	Stone, sand and gravel.
Polk	16,964	16,058	Cement, sand and gravel, clays.
Pottawattamie	W	W	Stone, sand and gravel.
Poweshiek	W	W	Stone.
Sac	768	691	Sand and gravel.
Scott	15,420	14,557	Cement, stone, lime, clays, sand and gravel.
Shelby	W	W	Sand and gravel.
Sioux	821	885	Do.
Story	1,109	1,107	Sand and gravel, stone, clays.
Tama	W	W	Sand and gravel, stone.
Taylor	W	W	Stone.
Union	W	W	Do.
Van Buren	778	808	Stone, sand and gravel, coal.
Wapello	425	W	Sand and gravel, clays, stone.
Warren	W	W	Sand and gravel, clays.
Washington	W	W	Stone.
Wayne	183	W	Do.
Webster	5,385	4,670	Gypsum, stone, sand and gravel, clays.
Winnebago	W	W	Sand and gravel, peat.
Winneshiek	676	W	Stone, sand and gravel.
Woodbury	334	370	Sand and gravel, clays.
Worth	344	765	Stone, sand and gravel, peat.
Wright	166	271	Sand and gravel.
Undistributed <sup>2</sup>	13,544	31,561	
Total	119,930	120,822	

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

<sup>1</sup> Davis and Ringgold counties are not listed because no production was reported.

<sup>2</sup> Includes some sand and gravel and stone that cannot be assigned to specific counties and values indicated by symbol W.

Table 3.—Indicators of Iowa business activity

	1969	1970	Change, percent
Employment and labor force, annual average:			
Total labor force..... thousands.....	1,236.0	1,243.5	+ .6
Unemployment..... do.....	33.7	44.3	+31.5
Employment:			
Manufacturing..... do.....	224.7	214.3	-4.6
Construction..... do.....	40.9	41.3	+ .9
Mining..... do.....	3.1	3.0	-3.2
Transportation and public utilities..... do.....	51.1	50.5	-1.2
Finance, insurance, and real estate..... do.....	40.4	41.2	+1.9
Wholesale and retail trade..... do.....	204.9	208.6	+1.8
Services..... do.....	142.2	145.9	+2.6
Government..... do.....	171.4	176.0	+2.7
Personal income:			
Total..... millions.....	\$9,870	\$10,499	+6.4
Per capita..... do.....	\$3,579	\$3,714	+3.8
Construction activity:			
Valuation of nonresidential construction..... millions.....	\$130.5	\$105.0	-19.5
New housing units authorized..... do.....	10,937	10,957	+ .2
State highway commission contracts awarded..... millions.....	\$109.4	\$149.0	+36.2
Portland cement shipments to and within Iowa thousand 376-pound barrels.....	8,865	8,482	-4.3
Farm marketing receipts..... millions.....	\$3,788.0	\$3,882.3	+2.5
Mineral production..... do.....	\$119.9	\$120.8	+1.0

Sources: Survey of Current Business, Construction Review, Iowa State Highway Commission, Farm Income Situation, and Bureau of Mines.

Iowa House File 1220, Surface Mining Safety Regulation, was approved May 10, 1970, by the 63d General Assembly. It is an act relating to the regulation of surface mining and making surface mines, as well as underground mines, subject to safety regulations by the Department of Mines and Minerals.

No fatalities occurred in Iowa mines in 1970.

The Iowa Geological Survey issued a 1:500,000-scale map, "Mineral Resources of Iowa," that shows the location of mining and processing sites, contours on the Mississippian and Devonian gypsum formations, outlines of coal areas, location of underground gas storage facilities, stream flow rates, ground water provinces, and al-

luvial aquifers. Two environmental geologic studies were instituted to obtain knowledge of the surficial sediments. An understanding of the nature of water flow in the sediments is critical to many current land-use practices such as landfill site selection and location of sewer lagoons. Understanding this occurrence is necessary for land-use planning and water resource management in the State and for optimum long-term development of various regions. The Linn and Plymouth-Woodbury County regions were selected for the studies because the two areas are geologically and climatically quite different. Both regions have efficient planning organizations that can be expected to use the information obtained from the studies.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non-fatal	Frequency	Severity
1969:								
Coal and peat.....	175	244	43	364	-----	7	19.22	868
Nonmetal.....	535	251	134	1,075	1	33	31.62	6,171
Sand and gravel.....	933	206	193	1,781	1	28	16.28	5,268
Stone.....	2,472	273	676	5,844	1	87	15.06	2,429
Total <sup>1</sup> .....	4,115	254	1,046	9,065	3	155	17.43	3,368
1970: <sup>p</sup>								
Coal and peat.....	190	243	46	391	-----	8	20.46	1,514
Nonmetal.....	505	263	133	1,068	-----	44	41.22	693
Sand and gravel.....	950	201	191	1,787	-----	40	22.38	1,263
Stone.....	2,475	271	670	5,782	1	109	19.03	1,615
Total <sup>1</sup> .....	4,120	252	1,040	9,027	1	201	22.38	1,432

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

## NONMETALS

**Cement.**—Rainfall, setting a record high in Iowa in 1970, and a nationwide slowdown in the construction industry had an adverse effect on cement sales. Shipments of portland cement, comprising the majority of the State's cement production, decreased nearly 10 percent below that of the preceding year. However, the value decreased only 4 percent.

There was no change in production capacity; five companies operated a total of 19 kilns, as in the previous year. Lehigh Portland Cement Co. operated its plant at Mason City in Cerro Gordo County and a distribution terminal at Cedar Rapids. Pollution control facilities were installed at the Mason City plant. Dewey Portland Cement Co., Division of Martin Marietta Corp., produced cement near Buffalo in Scott County. Near Mason City, Northwestern States Portland Cement Co. operated its cement plant, where an electrostatic precipitator was installed on a clay dryer during the year. Marquette Cement Mfg. Co. operated its cement plant at Des Moines in Polk County. Near West Des Moines in Polk County, Penn-Dixie Cement Corp. produced cement; an electrostatic precipitator was installed for its No. 3 kiln. A 12- by 36-foot F. L. Smidth Unidan finish mill with a 2,750-horsepower Symetro gear drive is scheduled for operation early in 1971.

About 96 percent of the portland cement sold or used was Type I (general construction use) and Type II (moderately low heat and moderate degree of resistance to sulfate attack). About 3 percent sold or used was Type III (high-early-strength) cement. Nearly 1 percent of the portland cement was expansive cement.

Nearly 88 percent of the portland cement was shipped to concrete products manufacturers, ready-mix concrete companies, and building materials dealers. Highway contractors and Federal, State, and other government agencies used 12 percent of Iowa's portland cement. More than 4 million barrels of the cement produced in Iowa was shipped into the following States: Illinois, Indiana, Minnesota, Nebraska, North and South Dakota and Wisconsin. Despite the fact that Iowa's cement consumption was 4.256 million barrels less

that production, nevertheless, some Iowa customers received cement from plants in Kansas, Missouri, and Nebraska.

Masonry cement production decreased more than 14 percent below that of 1969, but the value decreased only 8 percent. Penn-Dixie Cement Corp. was the only company reporting no production of masonry cement.

**Clays and Shale.**—Production of clays and shale decreased nearly 2 percent in quantity, however, the value increased nearly 10 percent. Common clay, amounting to about 63 percent of the total output, was produced at 14 mines in 10 counties. About 49 percent of the clay was produced in Cerro Gordo County. Shale, accounting for 27 percent of the total production, was produced at seven mines in seven counties. Undifferentiated clays and shale were mined at two deposits in two counties. In 1970, 17 companies operated 23 opencut clay and shale mines in 16 counties. Cerro Gordo County was the largest producer, followed by Dallas, Appanoose, and Scott Counties, all with production exceeding 100,000 tons.

About 41 percent of all production was used in manufacturing portland cement, 22 percent for making building bricks, 17 percent for making drain tile, 10 percent for lightweight aggregates, 9 percent for manufacturing sewer pipe, and the remaining 1 percent for masonry mortar and other uses.

Carlisle Brick and Tile Co. did not operate its plant in Warren County in 1970.

Can-Tex Industries Brick and Tile Division of the Harsco Corp. completed installation of a new 51,000-square-foot, automated, brick facility with the capacity to produce 22 million bricks per year at its Redfield Adel Plant. The old 10- to 12-million-brick-per-year-capacity plant will remain in operation. The manufacturing complex including the tile plant, which was recently automated, is located east of Redfield.

**Gem Stones.**—Small quantities of gem stones and mineral specimens were collected by rockhounds and amateur collectors.

**Gypsum.**—Iowa continued to be the third largest producer of crude gypsum in the Nation. Crude gypsum production decreased about 3 percent, and the value de-

creased 20 percent. Gypsum was produced from the United States Gypsum Co.'s underground mine in Des Moines County. It was also produced from four opencut mines operated by United States Gypsum Co., National Gypsum Co., Georgia-Pacific Corp., and the Celotex Corp. near Fort Dodge in Webster County.

Calcined gypsum production dropped about 13 percent, and the value of calcined products sold was down nearly 24 percent. No equipment changes were reported at the five calcining plants operating 22 kettles, four hydrocal digestors, and six board machines. The major use of calcined gypsum was for building purposes, mainly in the manufacture of wallboard, lath, and sheathing, and in smaller quantities, for basecoat plasters, mill mixed basecoats, veneer plaster, gaging and molding plasters, and prepared finishes. Calcined gypsum was also sold for industrial uses in manufacturing plate glass and terra cotta items, dental and orthopedic plasters, industrial molding, art and casting plasters, and other nonbuilding industrial uses. Uncalcined gypsum was sold in smaller quantities

for portland cement retarder and for agricultural use.

**Lime.**—Although the production of quicklime and hydrated lime decreased 4 percent, the value of sales increased 6 percent. About 46 percent of the lime sold was used for water purification. Nearly 30 percent of the lime was used by the steel industry in basic oxygen furnaces and electric arc furnaces. Other uses were in the paper and pulp industry, sugar refining, soil stabilization, and sewage treatment.

Customers in the State consumed 53 percent of Iowa's lime sold, including all of the hydrated lime. Shipments of quicklime were made to other States, with Illinois receiving 30 percent, Wisconsin, Indiana, Minnesota, Michigan, and Nebraska, the remainder.

Linwood Stone Products Co., Inc., with a plant near Buffalo in Scott County, was the State's only producer of quicklime and hydrated lime for commercial sale. At its plant at Mason City in Cerro Gordo County, American Crystal Sugar Co. produced quicklime for its own use in sugar refining.

**Table 5.—Iowa: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building.....	3,396	\$3,487	3,069	\$3,405
Fill.....	1,472	1,026	971	724
Paving.....	3,106	3,339	3,186	3,553
Other uses <sup>1</sup> .....	166	390	1,214	1,417
Total <sup>2</sup> .....	8,140	8,243	8,441	9,099
Gravel:				
Building.....	1,362	2,419	1,208	2,184
Paving.....	6,939	5,871	3,897	4,018
Other uses <sup>3</sup> .....	287	221	2,787	2,081
Total <sup>2</sup> .....	8,589	8,510	7,892	8,234
<b>Government-and-contractor operations:</b>				
Sand:				
Building.....	-----	-----	6	8
Fill.....	2	1	-----	-----
Paving.....	37	21	399	466
Other uses.....	3	1	2	1
Total <sup>2</sup> .....	42	24	408	476
Gravel:				
Building.....	-----	-----	7	8
Fill.....	-----	-----	14	3
Paving.....	1,611	1,086	4,283	2,804
Other uses.....	9	4	13	19
Total <sup>2</sup> .....	1,620	1,091	4,318	2,834
Total sand and gravel <sup>2</sup> .....	18,391	17,867	21,058	20,642

<sup>1</sup> Includes blast, filtration, molding, railroad ballast, and other sands.

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

<sup>3</sup> Includes fill, railroad ballast, miscellaneous, and other gravel.

**Table 6.—Iowa: Sand and gravel sold or used by producers, by counties**  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Audubon.....	4	W	W	6	157	\$200
Black Hawk.....	9	781	\$706	9	522	539
Boone.....	7	W	W	9	481	461
Buchanan.....	1	2	1	1	W	W
Buena Vista.....	5	222	149	6	236	102
Butler.....	6	137	141	9	191	191
Calhoun.....	3	64	45	1	W	W
Carroll.....	5	290	215	6	341	301
Cerro Gordo.....	5	214	216	10	1,009	1,131
Cherokee.....	8	505	494	15	597	497
Chickasaw.....	3	52	W	1	W	W
Clay.....	3	265	205	8	420	282
Clayton.....	4	W	W	5	157	486
Clinton.....	5	282	281	4	191	257
Dallas.....	10	407	408	8	368	323
Decatur.....	1	1	( <sup>1</sup> )	1	16	24
Des Moines.....	1	210	162	2	W	W
Dickinson.....	5	282	252	7	412	354
Emmet.....	7	360	281	10	331	208
Fayette.....	8	116	137	8	124	156
Franklin.....	6	190	203	7	231	235
Greene.....	3	275	270	9	532	326
Grundy.....	1	10	12	4	81	79
Guthrie.....	3	116	88	6	200	172
Hamilton.....	3	116	W	6	W	W
Hancock.....	8	255	W	8	324	217
Hardin.....	9	269	W	10	301	246
Harrison.....	3	203	W	2	W	W
Henry.....	1	127	141	1	W	W
Howard.....	4	17	15	4	W	W
Ida.....	1	64	W	1	W	W
Jackson.....	2	25	37	3	W	W
Jefferson.....	---	---	---	3	18	40
Jones.....	4	48	59	6	67	79
Kossuth.....	7	383	269	12	534	296
Lee.....	3	84	106	4	W	W
Linn.....	5	454	502	6	450	545
Lyon.....	12	291	194	12	482	315
Mahaska.....	2	176	W	2	W	W
Marion.....	4	164	W	5	140	153
Marshall.....	3	273	W	8	343	286
Mills.....	1	96	132	1	W	W
Mitchell.....	3	75	54	3	W	W
Monona.....	3	269	W	4	221	187
Muscatine.....	5	612	W	7	540	589
O' Brien.....	5	138	99	4	197	101
Osceola.....	6	218	203	9	423	381
Palo Alto.....	3	217	203	4	287	250
Plymouth.....	5	592	497	10	732	571
Pocahontas.....	1	29	20	4	W	W
Polk.....	12	2,061	2,378	11	1,896	2,649
Sac.....	12	703	768	13	679	691
Sioux.....	7	832	821	7	856	885
Story.....	7	864	729	16	756	756
Tama.....	6	83	W	3	192	176
Van Buren.....	1	75	105	2	W	W
Webster.....	12	319	226	14	418	273
Winnebago.....	6	183	128	3	W	W
Winneshiek.....	2	130	157	2	W	W
Woodbury.....	8	442	288	7	487	318
Worth.....	2	74	W	3	W	W
Wright.....	6	283	166	7	373	271
Undistributed <sup>2</sup> .....	32	2,365	5,311	44	3,740	4,039
<b>Total <sup>3</sup>.....</b>	<b>329</b>	<b>18,391</b>	<b>17,867</b>	<b>423</b>	<b>21,058</b>	<b>20,642</b>

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

<sup>1</sup> Less than ½ unit.

<sup>2</sup> Includes Allamakee, Benton, Bremer, Cass (1970), Crawford, Delaware, Dubuque, Floyd, Fremont, Humboldt, Iowa, Jasper, Johnson, Page, Pottawattamie, Scott, Shelby, Wapello, and Warren counties, and some sand and gravel that cannot be assigned to specific Counties."

<sup>3</sup> Data may not add to totals shown because of independent rounding.

**Perlite.**—Crude perlite, mined mostly in New Mexico, was expanded at the four gypsum plants near Fort Dodge. Although expanded perlite production decreased 23

percent in quantity, the value decreased only 10 percent below that of the preceding year. The principal use was in the manufacture of building plaster.

**Sand and Gravel.**—Sand and gravel production increased 14 percent above that of the preceding year to a record 21.1 million short tons. The value of production rose nearly 16 percent in 1970. Sand and gravel was produced in 81 counties by 186 operators at 423 locations. Three cities and 51 counties reported production at 138 municipal operations. Sand and gravel producers reported operating 102 stationary plants, 168 portable plants, and 23 dredges.

About 56 percent of Iowa's sand and gravel production was used for paving, another 20 percent was used by the building industry, 6 percent for fill, and 1 percent for ground and unground industrial uses such as molding, sand blasting, and filtration. The remaining 17 percent was used for railroad ballast and miscellaneous construction uses. Nearly 99 percent of the sand and gravel was transported by truck; the remainder was moved by rail and barge.

Pella Limestone Co. sold its sand and gravel operation near Olivell in Mahaska County to Kaser Conet Co. in May 1970.

**Stone.**—Although production of stone, comprising mostly limestone and some dolomite, decreased about 3 percent below that of the preceding year, the value rose slightly in 1970. The average price for

crushed and broken stone was \$1.61 per ton, up from \$1.55 in 1969.

Stone was quarried in 66 counties by 80 operators at 295 quarries. Dolomite was produced at 21 quarries and limestone was quarried at all the others. Only four counties produced 1 million tons or more of rock each: Scott, Cerro Gordo, Madison, and Linn.

Principle uses of stone were as follows: 59 percent for road base and paving materials, 13 percent for concrete aggregates, 14 percent for manufacturing portland cement, 7 percent for agricultural purposes, and the remaining 7 percent for dressed architectural and construction uses, railroad ballast, riprap, and other uses.

River Products Co. modernized its Iowa City plant and doubled crushed limestone production to 600 tons per day. Gendler Stone Products Co. opened a new quarry west of Bedford in Taylor County; production was scheduled to begin in 1971. Iowa Limestone Co. produced 26 different ground calcium products for agricultural uses, mainly for inclusion in animal feeds. The plant located near Alden markets products in Iowa and other States, including North and South Dakota, Minnesota, Wisconsin, Missouri, Illinois, and Indiana.

**Table 7.—Iowa: Limestone and dolomite sold or used by producers, by uses**  
(Thousand short tons and thousand dollars unless otherwise specified)

Use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Rubble.....	W	W	3	\$38
Cut stone.....thousand cubic feet..	6	\$19	8	W
House stone veneer.....do.....	26	62	W	W
Sawed stone.....do.....	W	W	4	27
Total <sup>1</sup> (approximate).....	13	255	11	284
<b>Crushed &amp; broken:</b>				
Bituminous aggregate.....	2,234	3,649	1,638	2,829
Concrete aggregate.....	2,945	5,649	3,210	6,279
Dense graded road base stone.....	5,693	8,263	5,046	7,966
Macadam aggregate.....	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )
Surface treatment aggregate.....	7,032	10,373	6,645	10,171
Unspecified aggregate & roadstone <sup>2</sup> .....	1,415	1,849	1,669	2,389
Agricultural limestone.....	1,970	3,558	1,855	3,401
Cement.....	3,680	4,637	3,574	4,196
Railroad ballast.....	216	241	( <sup>3</sup> )	( <sup>3</sup> )
Riprap and jetty stone.....	569	941	197	336
Other <sup>4</sup> .....	415	1,480	1,460	3,266
Total <sup>5</sup> .....	26,219	40,640	25,293	40,835
<b>Grand Total <sup>5</sup>.....</b>	<b>26,233</b>	<b>40,895</b>	<b>25,305</b>	<b>41,119</b>

W Withheld to avoid disclosing individual company confidential data; included with Dimension total.

<sup>1</sup> Includes rough architectural stone, flagging and other dressed construction stone.

<sup>2</sup> Macadam aggregate combined with "Unspecified aggregate and roadstone" to avoid disclosing individual company confidential data.

<sup>3</sup> Railroad ballast combined with "Other" to avoid disclosing individual company confidential data.

<sup>4</sup> Includes stone used for asphalt filler and other fillers or extenders; flux, lime, poultry grit and mineral food; other and unspecified uses (1969-1970); and mine dusting (1969).

<sup>5</sup> Data may not add to totals shown because of independent rounding.

Table 8.—Iowa: Limestone sold or used by producers, by counties  
(Thousand short tons and thousand dollars)

County	1969			1970			Type of stone produced in 1970 <sup>1</sup>
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value	
Allamakee	12	212	W	5	158	\$228	Crushed and broken.
Appanoose	3	320	W	3	319	594	Crushed and broken.
Black Hawk	4	805	\$1,375	6	W	W	Crushed and broken.
Buchanan	11	252	320	9	213	299	Crushed and broken.
Butler	6	250	326	5	W	W	Crushed and broken.
Cedar	4	198	W	4	W	W	Crushed and broken.
Cerro Gordo	7	1,796	2,041	8	1,952	2,674	Crushed and broken.
Clayton	18	258	W	26	320	465	Crushed and broken.
Clinton	11	582	880	11	W	W	Crushed and broken.
Delaware	7	204	W	6	221	305	Crushed and broken.
Dubuque	9	443	W	9	477	765	Dimension, crushed and broken.
Fayette	21	478	560	21	584	832	Crushed and broken.
Franklin	5	W	128	5	61	85	Crushed and broken.
Grundy	1	76	155	1	40	W	Crushed and broken.
Harrison	2	320	W	2	W	W	Crushed and broken.
Henry	1	138	138	1	W	49	Crushed and broken.
Howard	7	92	133	9	W	W	Crushed and broken.
Humboldt	5	859	W	5	792	1,184	Crushed and broken.
Jackson	8	W	289	7	W	314	Dimension, crushed and broken.
Jefferson	2	127	203	2	W	W	Crushed and broken.
Johnson	4	696	W	4	W	W	Crushed and broken.
Jones	8	272	504	11	335	583	Dimension, crushed and broken.
Lee	3	298	502	3	W	W	Crushed and broken.
Linn	10	1,862	2,518	10	1,829	2,708	Crushed and broken.
Madison	9	2,190	3,703	9	1,925	3,376	Crushed and broken.
Mitchell	12	337	500	9	244	367	Crushed and broken.
Scott	5	2,062	3,207	8	2,085	2,807	Crushed and broken.
Story	2	237	W	2	W	W	Crushed and broken.
Van Buren	5	396	602	5	W	W	Crushed and broken.
Wayne	1	104	183	1	W	W	Crushed and broken.
Webster	2	370	W	3	W	W	Crushed and broken.
Winneshek	11	353	519	11	368	533	Crushed and broken.
Worth	3	127	246	2	W	W	Crushed and broken.
Undistributed <sup>2</sup>	102	9,518	21,864	72	13,382	22,951	-----
Total <sup>3</sup>	321	26,233	40,895	295	25,305	41,119	-----

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

<sup>1</sup> "Limestone" used generally to include dolomite.

<sup>2</sup> Includes Adair, Adams, Benton, Bremer, Cass, Chickasaw, Clarke, Dallas, Decatur, Des Moines, Floyd, Fremont, Hamilton, Hancock, Hardin, Jasper, Keokuk, Louisa, Mahaska, Marion, Marshall, Mills, Montgomery, Muscatine, Page, Pocahontas, Pottawattamie, Poweshick, Tama, Taylor, Union, Wapello and Washington Counties and production for which no county breakdown is available.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

#### MINERAL FUELS

**Coal (Bituminous).**—Underground production of coal increased nearly 15 percent, and strip mine production increased about 6 percent from the previous year. Combined production was the highest since 1966, up more than 9 percent above that of 1969; the value rose nearly 20 percent. The average price for all coal increased from \$3.76 per ton in 1969 to \$4.11 in 1970. The price for underground coal rose 26 cents per ton to \$4.03; the price for strip mine coal increased 42 cents per ton to \$4.17.

About 57 percent of Iowa's coal was produced by 10 strip mines operated by eight companies in four counties. Nearly 43 percent of the coal was produced at three underground mines in three counties.

Michigan Coal Co. in Monroe County had its first full year of production at its new No. 3 strip mine.

Underground coal seams ranged in thickness from 32 to 68 inches. Thickness of strip coal seams ranged from 33 to 66 inches. Overburden thickness at the strip mines ranged from 35 to 60 feet.

Nearly 65 percent of Iowa's coal production was transported by rail and the remainder, by truck. Consumption of Iowa's coal, mostly by electric utilities, remained about the same as the previous year. However, coal imported from other States for use by electric utilities increased 10 percent. Of the 5,277,000 tons of coal shipped from other States for Iowa's consumption in 1970, 77 percent was supplied from Illinois mines.



The New Gladstone Coal Co. underground operation 8 miles west of Centerville in Appanoose County is the last coal mine in Iowa to use the old-style advancing longwall (or longface) method of mining. The mine was scheduled to close in April 1971.

Peat.—Production of peat increased about 7 percent above that of 1969, and value rose 4 percent. Eli Colby Co., the largest of the State's two producers, mined

peat moss near Lake Mills in Winnebago County and processed it in its plant in Hanlontown, Worth County. Colby Pioneer Peat Co. produced reed-sedge, peat moss, and humus near Joice in Worth County and processed it in its plant, also located in Hanlontown. About 87 percent of the peat was sold for soil improvement; the remainder was sold for packing flowers, plants and shrubs and as an ingredient for potting soils.

**Table 9.—Iowa: Coal (bituminous) production in 1970 by counties**  
(Excludes mines producing less than 1,000 short tons)

County	Number of mines		Production (short tons)			Value (thousands)
	Underground	Strip	Underground	Strip	Total	
Appanoose.....	1	-----	2,000	-----	2,000	\$16
Lucas.....	1	-----	169,796	-----	169,796	686
Mahaska.....	-----	5	-----	315,398	315,398	1,280
Marion.....	-----	3	-----	213,256	213,256	914
Monroe.....	1	-----	250,841	21,000	271,841	1,094
Van Buren.....	-----	1	-----	15,146	15,146	70
Total.....	3	10	422,637	564,800	987,437	4,060

**Table 10.—Iowa: Shipments of bituminous coal for consumption in Iowa, by district of origin and consumer use<sup>1</sup>**  
(Thousand short tons)

Use	District of origin <sup>2</sup>								Total	
	7 and 8	9	10	11	12	15	17	19		20
<b>1966:</b>										
Electric utilities.....	---	179	1,653	---	731	352	---	---	---	2,915
Retail dealers.....	185	127	98	4	1	21	6	---	---	442
All others.....	97	67	1,577	29	260	53	---	---	---	2,083
Total.....	282	373	3,328	33	992	426	6	---	---	5,440
<b>1967:</b>										
Electric utilities.....	---	225	1,950	---	683	369	---	---	---	3,227
Retail dealers.....	133	136	75	---	---	5	6	---	---	355
All others.....	67	58	1,544	77	191	30	---	---	---	1,967
Total.....	200	419	3,569	77	874	404	6	---	---	5,549
<b>1968:</b>										
Electric utilities.....	---	W	2,240	---	666	W	---	17	---	3,426
Retail dealers.....	112	W	56	---	---	W	6	---	---	263
All others.....	56	W	1,485	29	124	W	---	---	---	1,788
Total.....	168	418	3,781	29	790	268	6	17	---	5,477
<b>1969:</b>										
Electric utilities.....	---	312	2,204	---	776	229	---	155	---	3,676
Retail dealers.....	98	54	62	---	---	2	16	---	---	232
All others.....	79	84	1,368	108	108	18	---	---	---	1,765
Total.....	177	450	3,634	108	884	249	16	155	---	5,673
<b>1970:</b>										
Electric utilities.....	---	---	2,731	---	812	---	---	373	---	4,190
Retail dealers.....	76	332	40	230	1	48	51	1	---	210
All others.....	75	---	1,320	---	69	---	---	---	---	1,759
Total.....	151	332	4,091	230	882	48	51	374	---	6,159

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

<sup>1</sup> Data are based on voluntary reports submitted on separate distribution survey, and may not agree with data derived from mine production survey.

<sup>2</sup> States or portion of States represented by each district are as follows: District 7 and 8—Eastern Kentucky, Virginia, Southern West Virginia, and North Central Tennessee; 9—Western Kentucky; 10—Illinois; 11—Indiana; 12—Iowa; 15—Kansas, Missouri, and Northeastern Oklahoma; 17—Western Colorado and Northeastern New Mexico; 19—Wyoming and Idaho; 20—Utah.

## METALS

**Ferroalloys.**—Kemco Division of Foote Mineral Co. produced ferrosilicon and silvery pig iron in its electric arc furnace at the Keokuk plant. Although production was up, sales were curtailed in the fourth quarter because of the General Motors strike. Silvery pig iron is a specialized silicon product widely accepted as a premium form of silicon additive in foundries and

steel mills because of its size uniformity, magnetic qualities, and superior silicon recoveries. It is also ground to a fine mesh and utilized as media in the heavy media separation process for beneficiation of ores.

The company-owned steam power plant, built during World War II, was closed down in September, and replacement power was purchased. Facilities for finished-product handling were being installed at the Keokuk plant.

Table 11.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Dewey Portland Cement Co. Div. Martin Marietta Corp.	Box 4288, 802 Kahl Bldg. Davenport, Iowa 52808	Portland and masonry, wet process.	Scott.
Lehigh Portland Cement Co.	Young Bldg., 718 Hamilton St. Allentown, Pa. 18105	Portland and masonry, dry process.	Cerro Gordo.
Marquette Cement Mfg. Co.	20 N. Wacker Dr. Chicago, Ill. 60606	Portland and masonry, wet process.	Polk.
Northwestern States Portland Cement Co.	Box 1008, 12-2nd St. N.E. Mason City, Iowa 50401	Portland and masonry, dry process.	Cerro Gordo.
Penn-Dixie Cement Corp.	Box 152 Nazareth, Pa. 18064	Portland, wet process.	Polk.
<b>Clays and shale:</b>			
Ballou Brick Co.	Sergeant Bluff, Iowa 51054	Pit and plant.	Woodbury.
Can-Tex Industries, Brick and Tile Division, Harsco Corp.	Box 556 Ottumwa, Iowa 52501	6 pits and plants.	Cerro Gordo, Dallas, Keokuk, Mahaska, Polk, Wapello.
Carter-Waters Corp.	2440 Pennway Kansas City, Mo. 64100	-----do-----	Appanoose.
Dewey Portland Cement Co. Div. Martin Marietta Corp.	Box 4288, 802 Kahl Bldg. Davenport, Iowa 52808	Pit.	Scott.
W. S. Dickey Clay Mfg. Co.	1818 Commerce Tower Kansas City, Mo. 64105	Pit and plant.	Webster.
Kalo Brick & Tile Co.	1230 E. First Ave. South Fort Dodge, Iowa 50501	-----do-----	Do.
Lehigh Portland Cement Co.	Young Bldg., 718 Hamilton St. Allentown, Pa. 18105	Pit.	Cerro Gordo.
Northwestern States Portland Cement Co.	Box 1008, 12-2nd St. N.E. Mason City, Iowa 50401	Pit.	Do.
Rockford Brick & Tile Co.	Rockford, Iowa 50468	Pit and plant.	Floyd.
Sheffield Brick & Tile Co.	Sheffield, Iowa 50475	-----do-----	Franklin.
United Brick & Tile Co. of Iowa.	209 Benson Bldg. Sioux City, Iowa 51102	-----do-----	Dallas.
<b>Coal (bituminous):</b>			
Beard Coal Co.	Route 2 Knoxville, Iowa 51038	Strip mine.	Marion.
Big Ben Coal Co.	Route 3 Chariton, Iowa 50049	Underground mine.	Lucas.
Jude Coal Co.	Box 265 Bussey, Iowa 50044	Strip mine.	Mahaska.
Lovilia Coal Co.	Route 2 Melrose, Iowa 52569	Underground mine.	Monroe.
Mich Coal Co.	Box 16 Oskaloosa, Iowa 52577	Two strip mines.	Mahaska, Marion.
Weldon Coal Co.	Harvey, Iowa 50119	-----do-----	Marion.
<b>Ferroalloys:</b>			
Foote Mineral Co.	320 Concert St. Keokuk, Iowa 52632	Electric furnace.	Lee.
<b>Gypsum:</b>			
The Celotex Corp.	1500 N. Dale Mabry Tampa, Fla. 33607	Open pit mine, and calcining and board plants.	Webster.
Georgia-Pacific Corp., Gypsum Division.	P.O. Box 311 Portland, Ore. 97204	-----do-----	Do.
National Gypsum Co.	325 Delaware Ave. Buffalo, N.Y. 14202	-----do-----	Do.
United States Gypsum Co.	101 S. Wacker Dr. Chicago, Ill. 60606	-----do-----	Do.
		Underground mine, and calcining and board plant.	Des Moines.

Table 11.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Lime:</b>			
American Crystal Sugar Co.	Boston Bldg. Denver, Colo. 80201	Quicklime, shaft kiln.	Cerro Gordo.
Linwood Stone Products Co., Inc.	Route 2 Davenport, Iowa 52804	Quicklime and hydrated lime, three rotary kilns.	Scott.
<b>Peat:</b>			
Eli Colby Co.....	Box 248 Lake Mills, Iowa 50450	Bog.....	Winnebago.
Colby Pioneer Peat Co....	Box 8 Hanlontown, Iowa 50444	Processing plant.... Bog, processing plant.	Worth. Do.
<b>Expanded Perlite:</b>			
The Celotex Corp.....	1500 N. Dale Mabry Tampa, Fla. 33607	Processing plant....	Webster.
Georgia-Pacific Corp., Gypsum Division.	P.O. Box 311 Portland, Ore. 97204	.....do.....	Do.
National Gypsum Co.....	325 Delaware Ave. Buffalo, N.Y. 14202	.....do.....	Do.
United States Gypsum Co.	101 S. Wacker Dr. Chicago, Ill. 60606	Processing plant....	Webster.
<b>Sand and Gravel:</b>			
Acme Fuel & Material Co. (W. G. Block Co.).	Box 34 Muscatine, Iowa 52761	Dredges; stationary plants.	Muscatine.
K. H. Buttler.....	Box 204 State St. Guthrie Center, Iowa 50115	Pits; portable plants	Dallas, Guthrie.
Clear Lake Materials Corp.	Box 105 Clear Lake, Iowa 50428	Stationary plant....	Cerro Gordo.
Concrete Materials Div., Martin Marietta Corp.	4096 First Ave., NE. Cedar Rapids, Iowa 52401	Pits, underground mine; portable and stationary plants.	Black Hawk, Clayton, Linn, Mahaska, Marshall, Polk, Wapello, Worth, Various.
Concrete Sand & Materials Co.	Box 288 Spencer, Iowa 51301	Pits; stationary plants.	Clay, Dickinson.
Coon Valley Gravel Co. (E. W. Hallett).	1108-30th St., SE. Des Moines, Iowa 50317	Pit; stationary plant.	Polk.
Elmer Dole Co.....	Irvington, Iowa 50550.....	Pits; portable plants.	Kossuth.
L. G. Everist, Inc.....	302 Paulton Bldg. Sioux Falls, South Dakota 57102.	Pit; stationary plant.	Sioux.
G. A. Finley, Inc.....	Harlan, Iowa 51537.....	Pits; portable and stationary plants.	Audubon, Crawford, Dallas, Pottawattamie, Sac, Shelby.
Hallett Construction Co....	Crosby, Minn. 56441.....	.....do.....	Boone, Buena Vista, Cherokee, Decatur, Franklin, Fremont, Iowa, Marshall, Osceola, Page, Polk, Sac, Story, Winnebago.
Higman Sand & Gravel Co.	Akron, Iowa 51001.....	Pit; stationary plant.	Plymouth.
Hogan Construction Co....	Rock Rapids, Iowa 51246..	Pits; portable plants.	Dickinson, Lyon, Osceola, Plymouth.
Hyman Construction Co., Inc.	Box 146 Sioux Center, Iowa 51250	Pits; portable and stationary plants.	Ida, Lyon, Osceola, Sioux.
Ronald Kenyon Construction Co.	1211 Grand Ave. West Des Moines, Iowa 50265.	.....do.....	Dallas, Polk.
LaHarv Construction Co..	Box 173 Forest City, Iowa 50436	.....do.....	Hancock, Winnebago.
Maudlin Construction Co..	Box 134 Webster City, Iowa 50595	.....do.....	Audubon, Boone, Buena Vista, Butler Carroll, Cerro Gordo, Cherokee, Clay, Crawford, Dallas, Dickinson, Emmet, Franklin, Hamilton, Hardin, Harrison, Ida, Kossuth, Lyon, Marshall, Monona, O'Brien, Plymouth, Polk, Pottawattamie, Sac, Story, Webster, Woodbury, Wright.

Table 11.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and Gravel—Continued			
Peters Construction Co.---	5225 E. University Des Moines, Iowa 50317	Pits; portable and stationary plants.	Monona, Polk.
Pound Construction Co., Inc.	Box 217 Scranton, Iowa 51462	-----do-----	Carroll, Greene, Webster.
Raid Quarries Corp.-----	Farmers & Merchants Bank Bldg. Box 1085 Burlington, Iowa 52601	-----do-----	Des Moines, Henry, Lee.
Stevens Sand & Gravel Co., Inc.	Route 4 Iowa City, Iowa 52240	Dredge; portable plant.	Johnson.
Van Dusseldorp Sand & Gravel, Inc.	Box 156 Colfax, Iowa 50054	Dredges; stationary plants.	Jasper.
Welp & McCarten, Inc.---	522 S. 22nd St. Fort Dodge, Iowa 50501	Pits; portable plants.	Cerro Gordo, Han- cock, Howard, Webster.
West Des Moines Sand Co.	Box 98 West Des Moines, Iowa 50265.	Pit; stationary plant.	Polk.
White Materials Corp.-----	SE. 36th & Carlisle Road Des Moines, Iowa 50317	Dredge; stationary plant.	Do.
Stone: Limestone and dolomite:			
B. L. Anderson, Inc.-----	327 Guaranty Bldg. Cedar Rapids, Iowa 52400	Quarries; portable plants.	Linn, Jones.
Concrete Materials Div. Martin Marietta Corp.	4096 First Ave. NE. Cedar Rapids, Iowa 52401	Quarries; portable and stationary plants.	Black Hawk, Bremer, Chickasaw, Johnson, Hancock, Linn, Madison, Marshall, Tama, Worth, Various.
DeWees Potthoff Stone Co.	Box 39 Marion, Iowa 52302	Quarries; portable plants.	Cedar, Dubuque, Jones, Linn.
Dewey Portland Cement Co. Div. Martin Marietta Corp.	Box 4288, 802 Kahl Bldg. Davenport, Iowa 52800	Quarry; stationary plant.	Scott.
Douds Stone, Inc.-----	611 Church St., Box 187 Ottumwa, Iowa 52501	Quarries; under- ground mine; portable and stationary plants.	Van Buren, Wapello.
Gendler Stone Products Co.	1075 Polk Blvd. Des Moines, Iowa 50311	Quarries; portable plants.	Dallas, Madison, Page, Taylor.
Kaser Construction Co.---	3111 Ingersol Des Moines, Iowa 50312	-----do-----	Des Moines, Fre- mont Jasper, Keo- kuk, Mahaska, Marion, Mills, Montgomery, Poweshiek, Wash- ington.
Lehigh Portland Cement Co.	Young Bldg., 718 Hamilton St. Allentown, Pa. 18105	Quarry; stationary plant.	Cerro Gordo.
Linwood Stone Products Co., Inc. (McCarthy Improvement Co.).	Route 2 Davenport, Iowa 52804	Underground mine and stationary plant.	Scott.
Lowe & Eschman Construction Co.	Box 267 Marion, Iowa 52302	Quarries; portable plants.	Clinton.
Marquette Cement Mfg. Co.	20 N. Wacker Dr. Chicago, Ill. 60606	Quarry; stationary plant.	Madison.
Paul Niemann Construction Co.	Box 38 Sumner, Iowa 50674	Quarries; portable plants.	Bremer, Buchanan, Butler, Fayette.
Northwestern States Portland Cement Co.	Box 1008, 12-2nd St., NE. Mason City, Iowa 50401	Quarry; stationary plant.	Cerro Gordo.
P & M Stone Co., Inc.---	Box 569 Humboldt, Iowa 50548	Quarries; portable plants.	Cerro Gordo, Humboldt.
Penn-Dixie Cement Corp.---	Box 152 Nazareth, Pa. 18064	Quarry; stationary plant.	Madison.
Raid Quarries Corp.-----	217 Farmers & Merchants Bank Bldg., Box 1085 Burlington, Iowa 52601	Quarries; portable and stationary plants.	Des Moines, Jefferson, Lee, Van Buren.
The River Products Co.---	220 Savings & Loan Bldg. Iowa City, Iowa 52240	Quarries, under- ground mines; portable and stationary plants.	Johnson, Louisa, Washington.
E. I. Sargent Quarries, Inc.	2525 W. Euclid St. Des Moines, Iowa 50310	Quarries; portable plants.	Clarke, Decatur, Madison.
Schildberg Construction Co., Inc.	Box 358 Greenfield, Iowa 50849	-----do-----	Adair, Adams, Cass, Madison, Union.
Schildberg Rock Products Co., Inc.	-----do-----	-----do-----	Adams, Pottawat- tawmie.

Table 11.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone: Limestone and dolomite—Continued			
Weaver Construction Co.-	Box 817 Iowa Falls, Iowa 50126	Quarries, portable and stationary plants.	Cedar, Cerro Gordo, Franklin, Hamilton, Hardin, Scott, Story.
Welp & McCarten, Inc.---	522 S. 22nd St. Fort Dodge, Iowa 50501	-----do-----	Black Hawk, Cerro Gordo, Hancock, Howard, Humboldt, Mitchell, Webster, Worth.

# The Mineral Industry of Kansas

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

By Lawrence G. Southard <sup>1</sup> and Linda A. Flueckinger <sup>2</sup>

Mineral production value in Kansas in 1970 reached a high of \$586.2 million, exceeding the previous high of \$577.8 million recorded in 1969. A record output of natural gas and natural gas liquids and strong market prices for both helped compensate for declines in crude oil, metal, and industrial mineral production. The principal mineral commodities, in order of descending value, were petroleum, natural gas, natural gas liquids, helium, cement, stone, and salt. Mineral fuels and related products comprised about 85 percent of the total value; nonmetals, about 15 percent;

and metals, less than 1 percent. Kansas ranked seventh among the States in crude oil production, fifth in natural gas production, and sixth in natural gas liquid production. Other Kansas mineral products, listed in order of decreasing contribution to the total value, include clay and shale, sand and gravel, gypsum (raw and calcined), carbon black, salt brine, sulfur, lime, pumice, lead and zinc.

<sup>1</sup> Mineral specialist, Division of Fossil Fuels.

<sup>2</sup> Geologist, State Geological Survey of Kansas, University of Kansas, Lawrence, Kans.

Table 1.—Mineral production in Kansas <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland..... thousand 376-pound barrels...	9,764	\$29,365	9,197	\$28,177
Masonry..... thousand 280-pound barrels...	348	1,023	328	1,029
Clays <sup>2</sup> ..... thousand short tons...	797	1,070	713	946
Coal (bituminous)..... do.....	1,313	7,108	1,627	9,102
Helium:				
High-purity..... million cubic feet...	330	7,578	354	8,137
Crude..... do.....	2,669	32,667	2,609	32,777
Lead (recoverable content of ores, etc.)... short tons...	395	118	80	25
Lime..... thousand short tons...	7	W	6	W
Natural gas..... million cubic feet...	883,156	122,759	899,955	125,994
Natural gas liquids:				
Natural gasoline and cycle products				
thousand 42-gallon barrels...	4,855	11,848	6,549	14,617
LP gases..... do.....	19,574	26,229	20,814	30,597
Petroleum (crude)..... do.....	88,716	283,891	84,853	277,469
Salt <sup>3</sup> ..... thousand short tons...	1,270	17,090	1,230	18,206
Sand and gravel..... do.....	12,029	10,061	12,968	12,351
Stone..... do.....	15,828	22,645	15,161	22,406
Zinc (recoverable content of ores, etc.)... short tons...	1,900	555	1,186	364
Value of items that cannot be disclosed:				
Natural cement (1969), fire clay, gypsum, pumice, salt (brine), and values indicated by symbol W...	XX	3,808	XX	3,964
Total.....	XX	577,815	XX	586,161
Total 1967 constant dollars.....	XX	545,631	XX	\$ 530,476

<sup>p</sup> Preliminary. <sup>r</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included in "Value of items that cannot be disclosed." 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 included with "Value of items that cannot be disclosed."

<sup>3</sup> Excludes salt in brine included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Kansas, by counties  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Allen	\$13,819	\$11,519	Cement, petroleum, stone, clays, natural gas.
Anderson	750	983	Petroleum, stone, natural gas.
Atchison	528	393	Stone.
Barber	8,413	7,784	Natural gas, petroleum, gypsum, natural gas liquids, sand and gravel.
Barton	17,544	19,766	Petroleum, salt, sand and gravel, natural gas, clays.
Bourbon	989	W	Stone, petroleum.
Brown	36	W	Do.
Butler	13,654	13,053	Petroleum, stone, sand and gravel, natural gas.
Chase	W	W	Petroleum, stone, sand and gravel.
Chautauqua	1,984	1,989	Petroleum, stone, natural gas.
Cherokee	W	7,129	Coal, zinc, clays, stone, lead.
Cheyenne	99	W	Sand and gravel.
Clark	1,549	1,404	Natural gas, petroleum, sand and gravel.
Clay	203	198	Sand and gravel, stone.
Cloud	W	W	Sand and gravel, clays, stone.
Coffey	93	W	Petroleum, stone.
Comanche	1,435	1,536	Natural gas, petroleum, sand and gravel.
Cowley	9,004	8,364	Petroleum, natural gas, sand and gravel, stone.
Crawford	W	2,810	Coal, petroleum, clays, stone.
Decatur	1,781	2,191	Petroleum, sand and gravel.
Dickinson	614	740	Stone, petroleum, sand and gravel.
Doniphan	785	613	Stone, sand and gravel.
Douglas	299	272	Sand and gravel, petroleum.
Edwards	1,213	1,637	Natural gas, petroleum, sand and gravel.
Elk	1,500	1,695	Stone, petroleum, natural gas, sand and gravel.
Ellis	25,658	24,535	Petroleum, sand and gravel, stone.
Ellsworth	22,782	26,798	Natural gas liquids, helium, petroleum, salt, clays, sand and gravel, natural gas.
Finney	15,488	12,494	Natural gas, petroleum, natural gas liquids, sand and gravel.
Ford	484	420	Natural gas liquids, sand and gravel, petroleum, natural gas.
Franklin	893	1,242	Stone, petroleum, clays.
Geary	W	W	Sand and gravel, petroleum.
Gove	701	W	Petroleum, sand and gravel.
Graham	12,904	12,813	Do.
Grant	33,525	46,219	Natural gas, natural gas liquids, helium, petroleum, sand and gravel.
Gray	W	W	Sand and gravel.
Greeley	W	W	Do.
Greenwood	8,425	7,210	Petroleum, stone, sand and gravel, natural gas.
Hamilton	1,352	2,698	Natural gas, sand and gravel, petroleum.
Harper	3,738	5,086	Petroleum, natural gas liquids, natural gas, sand and gravel.
Harvey	2,576	2,658	Petroleum, natural gas, natural gas liquids.
Haskell	16,522	11,652	Natural gas, petroleum, sand and gravel.
Hodgeman	4,499	W	Petroleum, sand and gravel.
Jackson	151	W	Stone, petroleum, sand and gravel.
Jefferson	W	867	Stone.
Jewell	W	W	Stone, sand and gravel.
Johnson	2,290	2,339	Stone, sand and gravel, petroleum, natural gas.
Kearny	13,941	18,297	Natural gas, petroleum, natural gas liquids, sand and gravel.
Kingman	19,181	14,329	Petroleum, natural gas, natural gas liquids, sand and gravel, stone.
Kiowa	4,818	5,795	Natural gas, petroleum, sand and gravel.
Labette	331	390	Stone, petroleum.
Lane	154	128	Petroleum.
Leavenworth	W	W	Stone, sand and gravel, petroleum.
Lincoln	W	W	Stone, pumicite.
Linn	W	W	Stone, petroleum, sand and gravel.
Logan	W	16	Sand and gravel.
Lyon	1,444	1,092	Petroleum, stone, sand and gravel.
McPherson	7,151	5,897	Petroleum, natural gas, sand and gravel, stone, clays.
Marion	4,335	3,061	Petroleum, stone, natural gas, natural gas liquids, sand and gravel.
Marshall	W	W	Gypsum, sand and gravel, stone.
Meade	4,012	4,415	Natural gas, petroleum, sand and gravel.
Miami	1,019	552	Petroleum, stone.
Mitchell	86	W	Sand and gravel.
Montgomery	4,716	5,643	Cement, petroleum, stone, clays.
Morris	985	992	Petroleum, stone, sand and gravel.
Morton	29,453	22,770	Natural gas, petroleum, helium, natural gas liquids.
Nemaha	100	85	Stone, petroleum, sand and gravel.
Neosho	W	W	Cement, stone, petroleum, clays.
Ness	8,548	8,216	Petroleum, sand and gravel, stone.
Norton	1,305	1,634	Petroleum, sand and gravel, stone, pumicite.
Osage	3	W	Stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Kansas, by counties—Continued  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Osborne.....	\$199	W	Petroleum, sand and gravel.
Ottawa.....	74	\$74	Sand and gravel.
Pawnee.....	3,069	3,806	Petroleum, natural gas, sand and gravel.
Phillips.....	6,399	6,550	Petroleum, sand and gravel.
Pottawatomie.....	171	W	Stone, sand and gravel.
Pratt.....	5,282	4,903	Petroleum, natural gas, sand and gravel.
Rawlins.....	1,169	2,206	Petroleum, sand and gravel.
Reno.....	15,417	16,385	Salt, petroleum, sand and gravel, natural gas.
Republic.....	W	W	Sand and gravel.
Rice.....	21,076	19,942	Petroleum, salt, stone, sand and gravel, natural gas.
Riley.....	1,327	983	Stone, petroleum, sand and gravel.
Rooks.....	14,754	13,525	Petroleum, sand and gravel.
Rush.....	6,749	6,706	Petroleum, helium, natural gas, natural gas liquids.
Russell.....	25,367	22,374	Petroleum, sand and gravel, natural gas.
Saline.....	1,304	1,593	Petroleum, sand and gravel.
Scott.....	5,812	7,348	Helium, natural gas liquids, petroleum, sand and gravel, natural gas.
Sedgwick.....	10,247	10,761	Petroleum, salt, natural gas liquids, sand and gravel, natural gas.
Seward.....	34,040	31,539	Helium, natural gas liquids, natural gas, petroleum, sand and gravel.
Shawnee.....	1,519	1,941	Stone, sand and gravel.
Sheridan.....	1,950	2,233	Petroleum, sand and gravel.
Sherman.....	487	278	Sand and gravel, lime, petroleum.
Smith.....	17	W	Stone, sand and gravel.
Stafford.....	12,643	12,142	Petroleum, natural gas, natural gas liquids, sand and gravel.
Stanton.....	5,364	5,567	Natural gas, petroleum, natural gas liquids.
Stevens.....	18,047	26,103	Natural gas, petroleum, sand and gravel.
Sumner.....	6,212	5,955	Petroleum, natural gas, sand and gravel.
Thomas.....	91	W	Sand and gravel, petroleum.
Trego.....	3,821	5,315	Petroleum, sand and gravel.
Wabaunsee.....	864	1,021	Do.
Wallace.....	W	W	Sand and gravel, stone.
Washington.....	W	W	Do.
Wichita.....	W	65	Sand and gravel, petroleum.
Wilson.....	5,537	5,164	Cement, stone, petroleum, clays.
Woodson.....	2,940	2,974	Petroleum, stone, natural gas.
Wyandotte.....	9,338	9,977	Cement, sand and gravel, stone.
Undistributed <sup>1</sup> .....	26,668	24,314	
Total <sup>2</sup> .....	\$777,815	586,161	

<sup>r</sup> Revised.

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

<sup>1</sup> Includes some sand and gravel and stone that cannot be assigned to specific counties and values indicated by symbol W.

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

Table 3.—Indicators of Kansas business activity

	1969	1970	Change, percent
Employment and labor force, annual average:			
Total civilian labor force..... thousands.....	877.3	883.1	+ .7
Unemployment..... do.....	26.0	43.5	+67.3
Employment..... do.....	77.9	75.1	-3.6
Agricultural..... do.....			
Nonagricultural:			
Construction..... do.....	34.1	31.0	-9.1
Mining..... do.....	11.6	11.0	-5.2
Manufacturing..... do.....	147.6	134.0	-9.2
Services..... do.....	100.6	103.7	+3.1
Finance, insurance, and real estate..... do.....	29.7	30.3	+2.0
Wholesale and retail trade..... do.....	157.8	159.6	+1.1
Transportation and public utilities..... do.....	52.1	52.8	+1.3
Government..... do.....	150.8	154.3	+2.3
Personal income:			
Total..... millions.....	\$8,096	\$8,562	+5.8
Per capita..... do.....	\$3,621	\$3,804	+5.1
Construction activity:			
Building permits, total private nonresidential..... millions.....	\$91.2	\$77.3	-15.2
Cement shipments to and within Kansas..... thousand 376-pound barrels.....	5,656	5,127	-9.4
Farm marketing receipts..... millions.....	\$1,718	\$1,745	+1.6
Mineral production..... do.....	\$577.8	\$586.2	+1.5

Sources: Survey of Current Business; Construction Review; Kansas Employment Security Division; Employment and Earnings and Monthly Report on the Labor Force; Farm Income Situation; and U.S. Bureau of Mines.



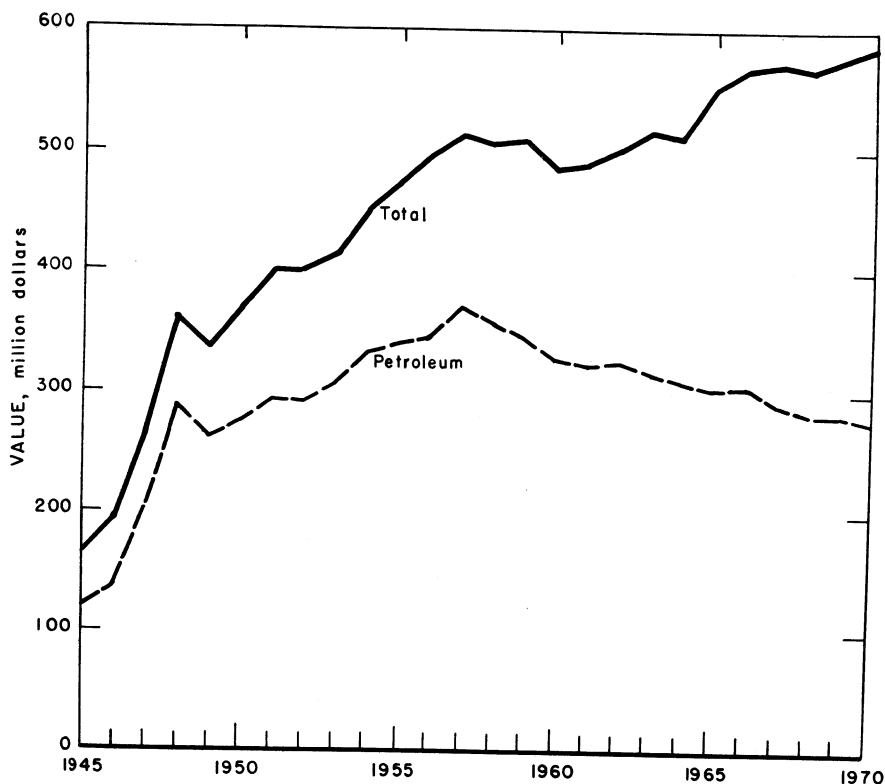


Figure 1.—Value of petroleum, and total value of mineral production in Kansas.

According to the Kansas Highway Commission, highway construction contracts awarded during 1970 totaled \$75.4 million. Contract work performed totaled \$77 million. Authorized projects included 303 miles of State highways with 73 bridges, 351 miles of county secondary roads with 66 bridges, and 1,030 miles of resurfacing on State roads. An additional 21 miles of Interstate Highway was opened to traffic during 1970. Since enactment of the Federal Highway Act in 1956, \$403.9 million has been allocated to Kansas.

**Trends and Developments.**—Industry was concerned with depressed prices, increased freight rates, high wages, problems of obsolescence and pollution abatement, and overcapacity. Several industries, particularly those related to the building industry, experienced the first period of reduced volume in several years. A general economic slowdown and a prolonged construction strike in the Kansas City metropolitan area

was a significant factor in a major decrease in construction contracts.

Kansas Gas & Electric Co. and Kansas City Power & Light Co. continued joint construction of an 840-megawatt, mine-mouth, coal-fueled generating station near La Cygne. A 3,000-acre reservoir to supply water for the plant was completed. The plant will utilize limestone for desulfurization of combustion gases. Completion is scheduled for mid-1972. Initially projected construction costs of \$125 million, the largest for any single project ever undertaken in Kansas, have already been exceeded.

Limestone for desulfurization of combustion gases was also being tested by the Kansas Power & Light Co. in Lawrence, using limestone quarried nearby.

Hutco, Inc., of Medicine Lodge, manufactured bonded modular units of polyurethane and building materials. These units were used in residential construction. Excellent growth potential is expected for

this type of building material and for molded combinations of plastics using volcanic ash as a filler.

The Pittsburg & Midway Coal Mining Co., incorporated in 1885 and operating continuously in southeast Kansas since that time, requested a permit to strip-mine 400 acres of land in Cherokee County. The company's Mine 19, located near Hallowell, is the largest and most modern coal mine in the State.

**Employment.**—According to the Employment Security Division of the Kansas Department of Labor, average annual employment in the mining industries decreased by 600 workers in 1970. A 4-percent decline in crude petroleum and natural gas employment, the main industry component, was the main cause. Employment in the mining industry stood at 11,000 in 1970.

**Legislation and Government Programs.**—The Minerals Resources Section of the Kansas Geological Survey, continued work aimed at development and improvement of the Kansas mineral industry during 1970. Research continued in exploration and development of clay and volcanic ash resources. Absorbent granules were made from mixtures of bentonite and volcanic ash. The Materials Development Division researched rapid-fired ceramics. Colored ceramic chips for planters and patios were being evaluated; a procedure for slip casting and decoration of ceramic art objects was set up for patients at the Norton State Hospital.

In a cooperative program, the U.S. Bureau of Mines, local power companies, and Kansas State University investigated the feasibility of using fly ash on coal strip mine spoil banks. Fly ash may provide a source of nutrients and/or alkaline material for correction of acid soil conditions, and may also provide a method of solid waste disposal for the mine-mouth power plants. Results of Bureau of Mines work in West Virginia gave impetus to the use of fly ash for soil conditioning.

Studies of methods and procedures for redeveloping mined land in southeast Kansas continued for the second year. The Kansas Geological Survey is working to satisfy increased mineral demand; to resolve increasing resource conflicts related to surface disturbance, air and water pollution, and waste disposal in the mineral industries; and to determine the best use of land in order to protect nonrenewable mineral resources.

**Drilling and Exploration.**—During 1970 a total of 2,421 oil and gas wells were drilled in Kansas. Of these, 1,588 were production wells and 833 were exploratory wells; 1,152 resulted in oil or gas recovery and 1,269 were dry. Drilling activity resulted in 1,044 new oil wells and 108 new gas wells. Of these, 131 oil wells and 26 gas wells were the result of exploratory drilling.

Total footage attributable to oil and gas drilling activity was 7,602,813 feet, of which 4,525,296 feet was for production and 3,077,517 feet was exploration. Total

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non-fatal	Frequency	Severity
1969:								
Coal.....	213	297	63	457	--	7	15.32	85
Metal.....	28	256	7	57	--	4	69.69	2,230
Nonmetal.....	932	256	238	1,899	--	65	34.23	516
Sand and gravel.....	637	229	146	1,289	1	22	17.85	8,018
Stone.....	1,611	263	424	3,509	--	35	9.97	366
Total.....	3,421	257	878	7,211	1	133	18.58	1,770
1970: <sup>p</sup>								
Coal.....	260	291	75	547	--	10	18.27	110
Metal.....	30	259	8	60	--	--	--	--
Nonmetal.....	780	247	193	1,531	--	67	43.75	905
Sand and gravel.....	645	221	143	1,276	--	21	16.46	492
Stone.....	1,545	267	412	3,414	--	47	13.77	385
Total <sup>1</sup> .....	3,260	255	830	6,829	--	145	21.23	496

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

footage declined 2,023,453 feet in 1970 compared with that of the previous year.

Ellis County ranked first in drilling activity with 149 wells—101 production and 48 exploratory. Exploration resulted in 10

new wells in the County. Ellis, Graham, Linn, and Sumner Counties accounted for 19 percent of the wells drilled. Footage drilled in these counties totaled 1,192,533 feet, an average of 2,638 feet per well.

## REVIEW BY MINERAL COMMODITIES

### MINERAL FUELS

**Carbon Black.**—Columbian Carbon Co., a subsidiary of Cities Service Oil Co. and sole producer of carbon black in Kansas, continued production at its Hickok plant. Feedstocks were liquid hydrocarbons and natural gas.

Carbon black was consumed by the Goodyear Tire & Rubber Co. in the manufacture of tires at its Topeka plant.

**Coal.**—Coal production has continued to gain from the 54-year-low of 663,758 tons in 1961, to 1.6 million tons in 1970. Production increased 24 percent between 1969 and 1970, and growth was expected to continue. Demand for Kansas coal will be strengthened by consumption of about 4,000 tons per day by the steam-electric plant at La Cygne being built jointly by Kansas City Power & Light Co. and Kansas Gas & Electric Co. The Kansas Power & Light Co. at Lawrence consumes 5,000 tons of coal per day. Successful restoration of land strip-mined for coal since January 1, 1969 was demonstrated in compliance with the standards set by the State Mined-Land Conservation and Reclamation Board under the Kansas Mined-Land Law. Small parts of the strip pits have been utilized for parks and fishing. The strip pits or wastelands of southeast Kansas amount to an estimated 50,000 acres. During 1970, four companies operated five strip mines in the State. Average per-ton value of coal was \$5.59.

**Helium.**—A total of 354 million cubic feet of high-purity helium valued at about \$8.1 million was produced at plants in Morton, Rush, and Scott Counties in 1970. Crude helium production amounted to 2,609 million cubic feet valued at \$32.8 million. Crude helium was produced in Ellsworth, Grant, Scott, and Seward Counties.

**Natural Gas.**—Natural gas production in Kansas reached a new high in 1970, amounting to 900 billion cubic feet, com-

pared with 883 billion feet in 1969. Value of the natural gas was \$126.0 million, an increase of about 3 percent above the 1969 value. The Kansas Corporation Commission reports that natural gas was produced from 8,605 wells throughout the State.

Reserves of natural gas as of December 31, 1970, according to the American Gas Association, Inc., amounted to 13.3 trillion cubic feet.

**Natural Gas Liquids.**—Natural gas liquids production increased almost 3 million barrels, or about 12 percent above the 1969 total. Total output in 1970 was about 27.4 million barrels. Prices were strong, as indicated by the substantial increase from \$38 million in 1969 to \$45 million in 1970, a gain of about 18 percent.

Reserves of natural gas liquids increased from 269.3 million barrels in 1969 to 294.1 million barrels as of December 31, 1970, based on data released by the American Gas Association, Inc.

**Petroleum.**—Crude oil production in Kansas declined for the fourth consecutive year. In 1970, production was 84.9 million barrels, 3.9 million barrels less than in 1969. In the period from 1960 through 1970, annual crude oil output has decreased 25 percent from the 113.5 million barrels in 1960; however, Kansas retained its rank of seventh in the Nation in crude oil production. As listed by the National Stripper Well Association, Kansas ranked third in crude oil production from stripper wells, with 59.4 million barrels from 39,851 wells. As of January 1, 1970, average production of crude oil per stripper well amounted to 4.1 barrels per day. Notwithstanding the loss in crude oil production, petroleum remains the most important Kansas mineral product.

The decline in crude oil production, which began in 1957, was accompanied by a continuing decrease in proved crude oil reserves. The estimated proved crude oil reserves for Kansas as of December 31, 1970 was 539,305 thousand barrels, as com-

Table 5.—Kansas: Natural gasoline and LP gases produced in 1970  
(42-gallon barrels)

Company	Location		Natural gasoline	Butane	Propane	LP gases	Total
	Nearest town	County					
Alamo Chemical Co.	Elkhart	Morton	509,440	--	--	--	509,440
Anadarko Production Co.	Liberal	Seward	106,388	--	87,791	--	194,179
Cities Service Helix, Inc.	Elkhart	Morton	91,501	--	59,361	--	150,862
Cities Service Oil Co.	Ulysses	Grant	--	--	--	3,575,450	3,575,450
	Scott City	Scott	--	--	--	1,962,127	1,962,127
	Cheney	Kingman	--	--	--	620,000	620,000
	Midway	do	--	--	--	248,000	248,000
	Wichita	Sedgwick	392,000	385,000	399,000	--	1,176,000
	Wilburton	Morton	--	--	--	89,000	89,000
	Lakin	Kearny	146,210	--	--	--	146,210
Colo. Interstate Gas Co.	Otis	Rush	41,787	--	--	--	41,787
Kans. Refined Helium Co.	St. John	Stafford	15,727	5,815	19,654	--	41,196
Kathol Natural Gas, Inc.	Ulysses	Grant	230,546	232,664	232,703	--	695,913
Mesa Petroleum Co.	Hickok	do	173,205	1,886	95,522	440,696	711,309
Mobil Oil Corp.	Spivey	Harper	314,825	146,431	267,864	--	729,120
National Helium Corp.	Liberal	Seward	997,345	1,102,330	1,732,384	--	3,832,059
Northern Gas Products Co.	Bushton	Ellsworth	783,214	2,098,307	5,611,436	--	8,492,957
Northern Natural Gas Co.	Holcomb	Finney	209,848	--	--	--	209,848
Amoco Production Co.	Sublette	Seward	498,580	40,071	59,442	156,135	498,580
	Ulysses	Grant	808,897	1,092,233	797,623	--	2,698,803
	do	do	4,969	--	--	--	4,969
Peoples Natural Gas Division.	Burrton	Harvey	--	--	--	21,996	21,996
Rounds & Stewart Natural Gasoline Co.	Johnson City	Stanton	29,274	31,047	76,440	--	136,761
Skelly Oil Co.	Medicine Lodge	Barber	24,965	17,180	45,677	7,716	95,538
	Minneola	Ford	26,677	18,861	52,626	11,059	109,223

Source: Kansas State Corporation Commission.

pared with 566,013 thousand barrels a year earlier. New field discoveries amounted to 3,249 thousand barrels and that of new reservoir discoveries in old fields amounted to 922 thousand barrels. The net change in proved crude oil reserves during 1970 was a decline of 26.7 million barrels.

Table 6.—Kansas: Crude petroleum production, indicated demand, and stocks in 1970, by months  
(Thousand 42-gallon barrels)

Month	Production	Indicated demand	End of month stocks originating within State
January	7,189	7,378	6,398
February	6,734	5,511	7,621
March	7,265	7,122	7,764
April	7,235	7,345	7,654
May	7,195	6,605	8,244
June	7,057	7,854	7,447
July	7,131	7,200	7,378
August	7,032	7,674	6,736
September	6,872	7,244	6,364
October	7,118	7,418	6,064
November	6,735	6,064	6,735
December	7,290	6,738	7,287
Total:			
1970	84,853	84,153	XX
1969	88,716	87,974	XX

XX Not applicable.

*Refineries.*—Twelve refineries operated in Kansas at the start of 1970, but during the year, two of these, the American Oil Co., Neodesha, and Century Refining Co., Inc., Scott City, shut down operations. The refineries in Kansas processed 76.2 million barrels of local crude oil, 54.2 million barrels from other States, and .9 million barrels from Canada. Kansas shipped 20.9 million barrels of crude oil to other States.

Table 7.—Kansas: Crude petroleum production by fields<sup>1</sup>  
(Thousand 42-gallon barrels)

Field <sup>2</sup>	1969	1970	Cumulative to Dec. 31, 1970
Bemis-Shutts	2,765	2,623	209,363
Chase-Silica	1,888	1,780	245,706
El Dorado	1,873	1,736	274,870
Gorham	894	791	75,651
Hall-Gurney	3,139	2,734	119,581
Kraft-Prusa	1,529	1,332	107,895
Trapp	2,175	2,033	197,671
Other fields <sup>3</sup>	74,453	71,824	NA
Total	88,716	84,853	NA

NA Not available.

<sup>1</sup> Fields with annual production in excess of 1 million barrels.

<sup>2</sup> Breakdown for individual fields from the Oil and Gas Journal.

<sup>3</sup> Bureau of Mines figures.

Table 8.—Kansas: Oil and gas well drilling completions, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
Allen	22	2	6	--	--	2	32	26,518
Anderson	11	--	1	--	--	1	13	10,123
Barber	--	2	14	2	--	10	32	146,655
Barton	36	--	27	10	4	14	87	293,549
Bourbon	--	--	4	--	--	--	4	2,657
Butler	38	--	20	5	--	16	79	217,497
Chase	3	--	--	--	--	--	3	10,795
Chautauqua	16	--	14	--	--	2	33	49,696
Clark	--	1	2	--	--	3	4	23,142
Cloud	--	--	--	--	--	1	3	9,199
Coffey	18	--	3	--	--	5	26	38,293
Comanche	6	1	7	1	2	9	26	129,066
Cowley	21	--	17	6	--	23	67	194,665
Crawford	4	--	1	--	--	--	5	1,171
Decatur	14	--	16	4	--	25	59	217,531
Dickinson	1	--	--	--	--	1	2	4,740
Douglas	--	1	--	--	--	--	1	840
Edwards	3	9	6	--	--	2	19	79,103
Elk	6	--	4	--	--	12	12	25,184
Ellis	44	--	57	10	--	38	149	532,617
Ellsworth	25	--	11	4	--	16	56	167,727
Finney	2	--	1	--	--	1	4	19,483
Ford	--	--	--	--	--	5	5	24,804
Franklin	15	--	5	--	--	1	20	13,716
Geary	--	--	--	1	--	5	12	5,132
Gove	1	--	5	1	--	1	8	50,308
Graham	20	--	19	11	--	48	98	376,598
Grant	--	11	--	--	--	--	11	38,676
Greenwood	63	--	25	1	--	23	112	234,788
Hamilton	--	1	--	--	2	3	6	23,657
Harper	1	2	5	--	1	15	24	103,850
Harvey	3	3	4	2	--	7	19	62,137
Haskell	1	1	1	1	--	2	6	32,876
Hodgeman	9	--	7	1	--	22	39	172,395
Jefferson	--	--	1	--	--	1	3	1,895
Johnson	--	--	2	--	--	1	4	1,440
Kearny	--	--	--	--	--	4	4	21,550
Kingman	4	5	15	2	1	14	41	171,141
Kiowa	5	3	3	4	--	9	24	118,217
Labette	10	--	2	--	--	--	12	8,869
Lane	--	--	--	--	--	3	3	14,050
Linn	129	1	8	--	--	3	141	47,870
Logan	1	--	1	--	--	1	3	14,132
Lyon	9	--	4	--	--	5	18	47,871
McPherson	12	--	7	1	--	10	30	95,728
Marion	17	--	5	1	--	13	36	93,499
Meade	8	--	2	1	1	8	20	111,246
Miami	5	--	4	--	1	3	13	7,612
Montgomery	21	1	15	3	--	4	44	49,054
Morris	1	--	1	--	--	7	9	24,199
Morton	1	--	4	--	--	5	10	51,282
Neosho	8	2	4	--	--	1	15	10,094
Ness	15	--	24	12	--	31	82	354,480
Norton	7	--	4	1	--	13	25	88,683
Osage	--	--	--	--	--	1	1	1,600
Osborne	--	--	--	--	--	1	1	3,950
Pawnee	6	5	6	3	6	18	44	174,660
Phillips	15	--	3	2	--	8	28	97,131
Pratt	5	--	7	1	--	10	23	95,191
Rawlins	19	--	5	5	--	9	38	162,848
Reno	21	--	6	--	--	8	35	113,768
Rice	41	--	18	4	--	16	79	257,455
Riley	--	--	--	--	--	2	2	3,857
Rooks	13	--	17	7	--	21	58	207,928
Rush	26	12	29	5	1	19	92	358,276
Russell	32	--	24	3	--	13	72	218,516
Saline	5	--	6	2	--	4	17	47,968
Scott	--	--	--	--	--	2	2	9,676
Sedgwick	6	--	4	1	--	7	18	56,067
Seward	18	5	10	3	7	4	47	268,224
Sheridan	3	--	5	1	--	27	36	145,666
Stafford	23	1	23	4	--	10	61	224,642
Stanton	--	--	--	--	--	2	2	8,125
Stevens	1	7	2	--	--	2	12	53,458
Thomas	14	4	13	4	--	29	64	235,448
Trego	--	--	4	1	--	3	8	34,128
Wabaunsee	8	--	4	--	--	8	20	76,710
Wallace	1	--	--	--	--	2	3	10,159
Wilson	--	--	--	--	--	1	1	5,517
Woodson	3	--	6	--	--	--	9	10,524
Woodson	17	2	13	--	--	10	42	49,221
Total	913	82	593	131	26	676	2,421	7,602,813

Source: American Petroleum Institute.

## NONMETALS

The total value of nonmetals produced in 1970 was approximately \$87.1 million compared with \$85.1 million in 1969. Cement, clay and shale, gypsum, lime, pumice, salt, and stone recorded production decreases, while only sand and gravel recorded an increase.

**Cement.**—Five plants, located in Neosho, Wilson, Wyandotte, Allen, and Montgomery Counties, produced 9.2 million barrels of portland cement in 1970. This represented a decrease of 5.8 percent in quantity and 4.0 percent in value from 1969, when six plants produced 9.8 million barrels. The Lehigh Portland Cement Co. plant in Iola was closed in 1970. Obsolescence of the plant and the prohibitive cost of upgrading efficiency and environmental control to modern standards contributed to the decision.

The cement industry as a whole was establishing a base for future growth as improvements were carried forward at different plants. Lone Star Cement Co., at their Bonner Springs plant, completed a single-chamber electrostatic precipitator on two wet-process kilns and were installing twin precipitators for three additional kilns. Existing facilities of Monarch Cement Co. at Humboldt were being improved by construction of a new packhouse with automatic pelletizing equipment, a package warehouse, and three additional drive-through silos. Cullor Limestone Co. purchased the assets of Fort Scott Hydraulic Cement Co. which ceased operations early in 1970 after 102 years of operation.

Production of masonry cement decreased 6 percent in quantity and increased 1 percent in value over 1969. The backlog in construction of highways, airports, buildings, and homes caused optimism concerning future demand for cement.

**Clay.**—Production of clay and shale declined 11 percent in volume and 12 percent in value below that of 1969. Five companies produced clay for building brick and tile from 12 sources, and lightweight aggregate, sewer pipe, and pottery were produced by three companies, respectively, from seven sources. Lightweight aggregate was produced by Buildex, Inc. from shale mined in Franklin and McPherson Counties.

Nearly half of Kansas clay and shale produced was used in cement; 30 percent

Table 9.—Kansas: Portland cement salient statistics

(Thousand 376-pound barrels and thousand dollars)

	1969	1970
Number of active plants.....	6	6
Production.....	9,737	8,973
Shipments from Mills:		
Quantity.....	9,764	9,197
Value.....	\$29,365	\$28,177
Stocks at Mills, Dec. 31.....	1,483	1,120

was for brick and tile; and 20 percent was for sewer pipe, heavy clay products, lightweight aggregate, stoneware, and pottery.

**Gypsum.**—Raw gypsum was mined in Barber County by National Gypsum Co. and in Marshall County by Georgia-Pacific Corp.

Increased freight rates and depressed prices reduced market areas and volume of Kansas gypsum for the first time in several years. Increased housing starts during the final months of 1970 prompted a note of optimism for reversal of the trend. Future programed expansion of the industry will depend upon increased demand.

**Lime.**—The sole producer of lime in Kansas was the Great Western Sugar Co. in Sherman County. The total output was used in sugar processing at the company's Goodland plant.

**Perlite.**—Lite-Weight Products, Inc., of Kansas City continued processing crude perlite that was mined out of state for use in lawn and garden fertilizer, perlite plaster, concrete and texture aggregate, cryogenic insulation, and for manufacture of all types of expanded perlite.

**Pumice.**—Blue Sparkle Dust Co. and Wyandotte Chemical Corp., both of Norton, continued mining and processing of pumice (volcanic ash) for dusting and abrasive compounds. Kansas pumice was also used as filler in asphalt products and molded plastics, as a filter-aid, and in insulating materials.

Interpace Corp., at Mankato, Jewell County, reportedly negotiated sale of its expanded volcanic ash filter-aid plant. Pearl-lite, Inc., of Mankato, began production of door panels after successful development of molding techniques for combinations of volcanic ash and urethane resins.

**Salt.**—The quantity of salt (excluding brine) mined in Kansas was about 40,000 tons or 3 percent less than the quantity mined in 1969, although the value in-

creased by \$1,116 thousand, or about 7.0 percent. Seven salt producers operated at localities in Rice, Reno, Barton, Ellsworth and Sedgwick Counties in the central and south-central part of the State. Two companies produced evaporated and rock salt; two produced evaporated salt; and one company produced rock salt only.

Cargill, Inc., of Pawnee Rock in Barton County produced granulated salt by evaporation, as well as water softener pellets from brine. Vulcan Materials Co. of Wichita continued to manufacture chlorine, caustic soda, and agricultural chemicals from Kansas salt brine. Morton International, Inc., is undertaking a \$1 million development program at its Hutchinson facilities.

The abundant supply of salt in the United States tends to make the industry highly competitive and, in turn, to make salt a low-priced commodity. The growth in consumption of salt will depend on demand for chlorine and caustic soda within the chemical industry, and for use in road stabilization and ice and snow removal.

**Table 10.—Kansas: Evaporated and rock salt sold or used by producers**

(Thousand short tons and thousand dollars)

Year	Evaporated salt		Rock salt	
	Quantity	Value	Quantity	Value
1966 .....	452	\$10,836	517	\$2,552
1967 .....	521	12,085	548	2,601
1968 .....	556	12,875	572	2,644
1969 .....	623	13,810	648	3,230
1970 .....	670	15,178	560	3,028

**Sand and Gravel.**—Output of sand and gravel increased by 939,000 short tons compared with the previous year's output. Production was obtained in 83 counties from 189 operations with value increasing about 23 percent above the value in 1969.

**Stone.**—Stone production decreased 4 percent in volume and 1 percent in value under that of the previous year. About 96 percent of the output was crushed limestone, the remainder included crushed quartzite and chat, and crushed sandstone. Opportunities for growth of the stone industry were present in water pollution

**Table 11.—Kansas: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building .....	3,661	\$3,374	4,089	\$4,076
Engine .....	46	42	16	24
Fill .....	1,306	659	935	528
Paving .....	2,888	2,630	3,141	3,184
Other uses <sup>1</sup> .....	207	246	583	493
Total <sup>2</sup> .....	8,108	6,951	8,765	8,305
<b>Gravel:</b>				
Building .....	253	287	207	241
Fill .....	35	32	38	40
Paving .....	1,224	1,079	1,183	1,267
Other uses <sup>3</sup> .....	115	226	264	766
Total <sup>2</sup> .....	1,626	1,625	1,692	2,314
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Building .....	75	75	-	-
Fill .....	59	30	2	1
Paving .....	965	613	1,009	683
Total <sup>2</sup> .....	1,099	719	1,011	684
<b>Gravel:</b>				
Paving .....	1,196	766	1,499	1,049
Total <sup>2</sup> .....	1,196	766	1,499	1,049
Total sand and gravel <sup>2</sup> .....	12,029	10,061	12,968	12,351

<sup>1</sup> Includes blast, filtration (1970), molding (1970), railroad ballast, and other sands.

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

<sup>3</sup> Includes miscellaneous, railroad ballast (1970), and other gravel.

Table 12.—Kansas: Sand and gravel sold or used by producers, by counties  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Barber.....	5	143	\$95	3	W	W
Barton.....	3	W	W	3	257	\$260
Butler.....	2	3	6	1	W	W
Chase.....	1	18	9	2	W	W
Cheyenne.....	3	109	99	3	W	W
Clark.....	1	20	15	1	32	24
Clay.....	2	103	W	1	102	W
Cloud.....	1	W	W	1	139	W
Comanche.....	1	58	43	1	52	35
Cowley.....	5	349	279	6	280	268
Decatur.....	2	30	15	2	W	W
Dickinson.....	1	107	107	1	W	99
Doniphan.....	1	1	1	1	2	1
Douglas.....	1	W	W	1	171	180
Edwards.....	1	47	31	1	W	22
Elk.....	1	19	9	1	53	W
Ellis.....	5	267	198	8	385	351
Ellsworth.....	1	48	36	1	30	22
Finney.....	3	267	298	3	W	298
Gove.....	3	29	22	3	35	W
Graham.....	2	44	32	2	W	W
Greenwood.....	--	--	--	1	84	63
Hamilton.....	1	25	12	1	W	W
Harper.....	2	92	57	1	W	W
Haskell.....	2	60	32	3	W	W
Hodgeman.....	1	132	99	1	W	W
Jackson.....	1	40	30	1	W	31
Jewell.....	--	--	--	1	7	3
Johnson.....	1	W	W	1	535	W
Johnson.....	1	19	15	2	W	W
Kearny.....	3	76	55	2	W	W
Kiowa.....	1	13	26	1	11	25
Leavenworth.....	1	10	7	1	7	5
Linn.....	2	W	W	3	21	16
Logan.....	3	W	W	3	93	133
Lyon.....	1	65	43	2	W	W
McPherson.....	5	W	W	5	165	220
Marshall.....	1	32	24	1	W	W
Meade.....	2	90	86	1	W	W
Mitchell.....	1	24	12	1	W	W
Morris.....	2	9	12	2	10	20
Nemaha.....	1	W	W	--	--	--
Neosho.....	3	38	34	2	W	W
Norton.....	1	36	27	2	W	W
Ottawa.....	2	55	74	1	55	74
Pawnee.....	3	87	80	3	90	81
Pottawatomie.....	2	W	W	2	60	48
Pratt.....	3	151	94	3	W	W
Rawlins.....	1	8	9	3	28	25
Reno.....	8	472	350	8	440	347
Republic.....	2	187	W	2	W	W
Rice.....	3	W	W	3	169	111
Rush.....	1	11	9	--	--	--
Russell.....	1	67	51	2	W	W
Scott.....	1	28	21	1	28	21
Sedgwick.....	14	2,482	1,614	14	2,433	1,806
Seward.....	2	77	65	2	W	W
Shawnee.....	5	593	404	5	526	417
Sheridan.....	2	65	33	2	W	W
Sherman.....	4	W	W	4	104	132
Smith.....	2	31	15	2	W	W
Stevens.....	1	62	47	1	W	4
Thomas.....	3	W	W	3	W	58
Trego.....	4	99	77	5	91	76
Wabaunsee.....	1	4	2	1	3	1
Wichita.....	2	W	W	3	69	58
Wyandotte.....	5	1,794	1,806	6	2,774	3,004
Undistributed <sup>1</sup> .....	30	3,331	3,443	29	3,626	4,014
Total <sup>2</sup> .....	183	12,029	10,061	189	12,968	12,351

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

<sup>1</sup> Includes Ford, Geary, Grant, Gray, Greeley, Kingman, Marion, Ness, Phillips, Riley, Rooks, Saline, Stafford, Sumner, Wallace, Washington, and some sand and gravel that cannot be assigned to specific counties.

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



**Table 13.—Kansas: Stone sold or used by producers, by kinds**  
(Thousand short tons and thousand dollars)

Kind of stone	1969		1970	
	Quantity	Value	Quantity	Value
Dimension stone total <sup>1</sup> .....	19	\$395	21	\$445
Crushed and broken:				
Limestone.....	15,334	21,645	14,552	21,176
Undistributed <sup>2</sup> .....	475	605	587	785
Total <sup>3</sup> .....	15,809	22,250	15,140	21,961
Grand total <sup>3</sup> .....	15,828	22,645	15,161	22,406

<sup>1</sup> To avoid disclosing individual company confidential data, dimension limestone and sandstone are combined.

<sup>2</sup> Includes quartzite, sandstone, and other stone.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

control, sewage treatment, neutralization of acidic soil in mined land, and in use of limestone for sorption of sulfur dioxide gases evolved during the burning of high-sulfur coals in power generation. The sulfur dioxide sorption method was being tested by the Kansas Power & Light Co. in Lawrence and was being considered for the proposed plant at La Cygne.

**Sulfur.**—Sulfur was recovered by Phillips Petroleum Co. of Kansas City as a byproduct of crude petroleum refining.

**Water.**—The U.S. Army Corps of Engineers continued construction of water protection levees at Kansas City, Lawrence, and Topeka, and the Melvern Dam and Reservoir in southeastern Kansas. The Soil Conservation Service continued numerous

small reservoir projects. In addition, a larger number of feedlots initiated programs of control and treatment designed to improve water quality. Other projects included watershed study and recharge projects.

#### METALS

The Kansas lead- and zinc-producing area in Cherokee County is part of the Tri-State District, which includes northeastern Oklahoma and southwestern Missouri.

**Lead and Zinc.**—Eagle-Picher Industries, Inc. closed its new Swalley zinc mine near Baxter Springs, Cherokee County, in October. Lower zinc prices and the high cost of operating the required antipollution sys-

**Table 14.—Kansas: Stone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars)

Use	1969 <sup>1</sup>		1970	
	Quantity	Value	Quantity	Value
Dimension stone total.....	19	\$395	21	\$445
Crushed and broken:				
Bituminous aggregate.....	1,229	1,871	1,521	2,510
Concrete aggregate.....	2,789	4,571	2,580	4,590
Dense graded road base stone.....	3,533	4,986	2,594	3,746
Macadam aggregate.....	263	385	414	616
Surface treatment aggregate.....	1,834	2,620	2,371	3,408
Unspecified aggregate & roadstone.....	594	692	849	1,095
Agricultural limestone.....	755	1,241	861	1,274
Cement.....	3,209	3,849	2,845	3,408
Railroad ballast.....	W	W	66	109
Riprap and jetty stone.....	959	1,150	849	943
Other <sup>2</sup> .....	171	281	188	262
Other stone <sup>3</sup> .....	475	609	--	--
Crushed total <sup>4</sup> .....	15,809	22,250	15,140	21,961
Grand total.....	15,828	22,645	15,161	22,406

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

<sup>1</sup> Limestone.

<sup>2</sup> Includes filter stone, whiting, stone sand (1970), railroad ballast (1969), asphalt filler (1969), and other uses in small quantities.

<sup>3</sup> Includes data for chat, quartzite and sandstone.

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

tem were cited as major contributors to the decision to cease mining operations. The company's mill near Cardin, Okla., where the ores were processed before smelting, was also closed in October.

The first commercial mining of lead and zinc in Kansas began in 1877. Cumulative lead production from that time to the end of 1970 totals 691,338 tons with a value in excess of \$90.4 million. Zinc production during the same period amounted to about 2.9 million tons with a value in excess of \$422.9 million. Lead and zinc ore reserves of Kansas are believed to be essentially depleted.

Table 15.—Kansas: Mine production (recoverable) of lead and zinc

	1968	1969	1970
Mines producing:			
Lode.....do.....	8	5	2
Material sold or treated:			
Lead-zinc thousand short tons...	76	--	1
Zinc.....do.....	84	59	61
Total.....do.....	160	59	62
Production (recoverable):			
Lead.....short tons...	1,227	395	80
Zinc.....do.....	3,012	1,900	1,186
Value:			
Lead.....thousands...	324	118	25
Zinc.....do.....	813	554	364
Total.....do.....	1,137	672	389

Table 16.—Principal producers

Commodity and company	Address	Type of activity	County
Carbon Black:			
Columbian Carbon Co....	380 Madison Ave. New York, N.Y. 10017	Furnace.....	Grant.
Cement:			
Ash Grove Cement Co....	1000 Tenmain Center Kansas City, Mo. 64105	Plant and quarry...	Neosho.
General Portland Cement Co.	2800 Republic Bank Tower Dallas, Tex. 75201	....do.....	Wilson.
Lehigh Portland Cement Co.	Young Bldg., 718 Hamilton Allentown, Pa. 18105	....do.....	Allen.
Lone Star Cement Corp....	2511 East 46th St., Suite "K" Indianapolis, Ind. 46205	....do.....	Wyandotte.
The Monarch Cement Co.	Humboldt, Kans. 66748....	....do.....	Allen.
Universal Atlas Cement, Div. of U.S. Steel Corp.	600 Grant Street U.S. Steel Bldg. Pittsburgh, Pa. 15230	....do.....	Montgomery.
Clays:			
Acme Brick Co.....	Box 425 Fort Worth, Tex. 76101	Mine and plant....	Cherokee, Ellsworth.
Ash Grove Cement Co....	1000 Tenmain Center Kansas City, Mo. 64105	....do.....	Neosho.
Buldex, Inc.....	Box 62299 Pittsburg, Kans. 66762	....do.....	Franklin, McPherson.
Cloud Ceramics.....	Box 417 Concordia, Kans. 66901	....do.....	Cloud.
W. S. Dickey Clay Manufacturing Co.	1818 Commerce Tower Kansas City, Mo. 64105	....do.....	Cherokee, Crawford.
Excelsior Clay Products, Inc.	342 North Waco Wichita, Kans. 67202	....do.....	Wilson.
General Portland Cement Co.	Box 479 Fredonia, Kans. 66736	....do.....	Do.
Humboldt Shale Mining Co.	Box 185 Humboldt, Kans. 66748	Mine.....	Allen.
Kansas Brick & Tile Co., Inc.	Box 126 Hoisington, Kans. 67544	Mine and plant....	Barton, Ellsworth.
Lehigh Portland Cement Co.	718 Hamilton Allentown, Pa. 18100	....do.....	Allen.
The Monarch Cement Co.	Humboldt, Kans. 66748....	....do.....	Do.
Universal Atlas Cement Co., Div. of U.S. Steel Corp.	Box 2969 Pittsburg, Pa. 15230	....do.....	Montgomery.
Wilkinsons, Inc.....	Rt. 1 Weir, Kans. 66781	Mine.....	Cherokee.
Coal:			
Cliff Carr Coal Co.....	Rt. 1 Mulberry, Kans. 66756	Strip mine.....	Crawford.
The Clemens Coal Co....	Box 62299 Pittsburgh, Kans. 66762	....do.....	Do.
Pittsburg & Midway Coal Mining Co.	Tenmain Center Kansas City, Mo. 64105	....do.....	Cherokee.
Wilkinsons, Inc.....	Rt. 1 Weir, Kans. 66781	....do.....	Do.
Gypsum:			
Georgia-Pacific Corp., Gypsum Div.	900 Southwest 5th Portland, Ore. 97204	Quarry and plant...	Marshall.
National Gypsum Co....	325 Delaware Ave. Buffalo, N.Y. 14202	....do.....	Barber.

Table 16.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Lead and Zinc:</b>			
Eagle-Picher Industries...	P.O. Box 910 Miami, Okla. 74354	Underground.....	Cherokee.
<b>Lime: The Great Western Sugar Co.</b>	Box 5308 Denver, Colo. 80217	Plant.....	Sherman.
<b>Perlite: Lite-Weight Products, Inc.</b>	707 Funston Rd. Kansas City, Kans. 66115	Expanding plant...	Wyandotte.
<b>Pumice:</b>			
Ernest Hanzlicek.....	Wilson, Kans. 67490.....	Mine.....	Lincoln.
Wyandotte Chemicals Corp.	1609 Biddle Ave. Wyandotte, Mich. 48192	Mine and plant....	Norton.
<b>Salt:</b>			
American Salt Corporation.	3142 Broadway Kansas City, Mo. 64111	Wells and under- ground.....	Rice.
The Barton Salt Company...	Box 989 Hutchinson, Kans. 67501	Wells.....	Reno.
The Carey Salt Company....	1800 Carey Blvd. Hutchinson, Kans. 67501	Well and under- ground.....	Do.
Cargill, Inc.....	Cargill Bldg. Minneapolis, Minn. 55402	Wells.....	Barton.
Independent Salt Company	Box 36 Kanopolis, Kans. 67454	Underground.....	Ellsworth.
Morton Salt Company....	110 North Wacker Drive Chicago, Ill. 60606	Wells.....	Reno.
Vulcan Materials Co., Chemicals Div.	Box 545 Wichita, Kans. 67201	Brine wells.....	Sedgwick.
<b>Sand and gravel:</b>			
John H. Alsop Sand Co....	Belleville, Kans. 66935.....	Stationary.....	Clay, Republic.
American Sand Co.....	4600 Speaker Rd. Kansas City, Kans. 66106	Dredge.....	Wyandotte.
Assoc. Material & Supply Co., Inc.	Box 4158 North Wichita Station Wichita, Kans. 67214	Stationary.....	Sedgwick.
Builders Sand Co.....	Box 658, Argentine Station Kansas City, Kans. 66106	Stationary.....	Wyandotte.
Consumers Sand Co.....	924 W. Railroad Street Topeka, Kans. 66088	Portable and 2 dredges.....	Shawnee.
Holliday Sand & Gravel Co	6811 West 63rd Street Overland Park, Kans. 66202	Stationary and portable.....	Wyandotte, Johnson, Douglas.
Miles Sand, Inc.....	4857 No. Meridian Wichita, Kans. 67204	2 dredges.....	Sedgwick.
Peck-Woolf Sand & Material Co.	7301 Kaw Dr. Kansas City, Kans. 66111	Dredge.....	Wyandotte.
Salina Sand Co., Inc.....	Mentor, Kans. 67465.....	Stationary.....	Saline.
San Ore Constr. Co., Inc....	Box 417 McPherson, Kans. 67460	Portable.....	Sherman, Ellis.
Stewart Sand & Material Co.	4049 Pennsylvania Ave. Kansas City, Mo. 66108	Stationary.....	Wyandotte.
Superior Sand Co., Inc....	6500 West 21st, Route 7 Wichita, Kans. 67212	Dredge.....	Sedgwick.
<b>Stone:</b>			
Ash Grove Cement Co....	1000 Tenmain Center Kansas City, Mo. 64105	Quarry.....	Johnson, Neosho.
General Portland Cement Co.	2800 Republic Bank Tower Dallas, Tex. 75201	....do.....	Wilson.
Hallett Construction Co....	Crosby, Minn. 56441.....	....do.....	Chase, Clay, Dick- inson, McPherson, Marion, Rice.
N. R. Hamm Quarry, Inc...	Box 17 Perry, Kans. 66073	....do.....	Jefferson, Leaven- worth, Shawnee.
Holland Quarries.....	9131 Noland Rd. Lenexa, Kans. 66215	....do.....	Johnson.
Ideal Cement Company....	420 Ideal Cement Bldg. Denver, Colo. 80202	....do.....	Jewell.
Lone Star Cement Corp....	2511 East 46th St., Suite "K" Indianapolis, Ind. 46205	....do.....	Wyandotte.
Midwest Minerals, Inc....	Box 7 Girard, Kans. 66743	....do.....	Various.
The Monarch Cement Co...	Humboldt, Kans. 66748....	....do.....	Allen.
Reno Construction Co....	Box 4278 Overland Park, Kans. 66204	....do.....	Johnson.
Thompson-Strauss Quarries	7000 Holiday Dr. Kansas City, Kans. 66106	....do.....	Wyandotte.
West-Lake Quarry & Material Co.	Rt. 1, Box 206 Taussig Rd. Bridgeton, Mo. 63042	....do.....	Doniphan.
<b>Helium:</b>			
Alamo Chemical Co., Gardner Cryogenics, Inc.	Elkhart, Kans. 67950.....	Plant.....	Morton.
Cities Service Cryogenics, Inc.	Scott City, Kans. 67871....	....do.....	Scott.
Cities Service Helex, Inc..	Ulysses, Kans. 67880.....	....do.....	Grant.

Table 16.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Helium—Continued			
Kansas Refined Helium Co.	Otis, Kans. 67565	Plant	Rush.
National Helium Corp.	Liberal, Kans. 67901	do	Seward.
Northern Helix Co.	Bushton, Kans. 67427	do	Ellsworth.
Petroleum Operators:			
Amoco Production Co.	Box 591 Tulsa, Okla. 74100		Various.
Cities Service Oil Co.	Tulsa, Okla. 74100		Do.
Continental Oil Co.	New York, N.Y. 10000		Do.
National Cooperative Refinery Association.	McPherson, Kans. 67460		Do.
Skelly Oil Co.	Tulsa, Okla. 74100		Do.
Sun Oil Co.	Philadelphia, Pa. 19100		Do.
Texaco, Inc.	New York, N.Y. 10000		Do.
Petroleum Refineries:			
American Petrofina Co. of Texas.	El Dorado, Kans. 67042	Refinery	Butler.
Apco Oil Corp.	Arkansas City, Kans. 67005	do	Cowley.
Century Refining Co.	Scott City, Kans. 67871	do	Scott.
CRA, Inc.	Coffeyville, Kans. 67337	do	Montgomery.
Derby Refining Co.	Phillipsburg, Kans. 67661	do	Phillips.
Mid-American Refining Co., Inc.	Wichita, Kans. 67200	do	Sedgwick.
	Chanute, Kans. 66720	do	Neosho.
Mobil Oil Corp.	Augusta, Kans. 67010	do	Butler.
National Cooperative Refinery Association.	McPherson, Kans. 67460	do	McPherson.
Phillips Petroleum Co.	Kansas City, Kans. 66100	do	Wyandotte.
Skelly Oil Co.	El Dorado, Kans. 67042	do	Butler.
Natural Gas Purchasers:			
Cities Service Gas Co.	Okla. City, Okla. 73100		Various.
Colorado Interstate Gas Co.	Colorado Springs, Colo. 80900		Do.
Kansas-Nebraska Natural Gas Co.	Hastings, Nebr. 68901		Do.
Northern Natural Gas Co.	Omaha, Nebr. 68100		Do.
Panhandle Eastern Pipeline Co.	Houston, Tex. 77000		Do.



# The Mineral Industry of Kentucky

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

By H. L. Riley <sup>1</sup> and Preston McGrain <sup>2</sup>

The value of mineral production in Kentucky increased 43 percent above that of 1969, reaching a record high of \$847 million. Kentucky advanced from 13th to 9th among the States in value of mineral production. Coal accounted for 84 percent of the total mineral value. Kentucky ranked second in the production of bituminous coal in the United States.

**Government Programs.**—The U.S. Geological Survey with the cooperation of the Kentucky Geological Survey continued to map the areal geology of the State on 7.5 minute topographic quadrangle maps. A total of 359 geologic maps covering all or parts of 383 quadrangles have been published.

The Kentucky Geological Survey published four reports on geology and mineral resources.<sup>3</sup>

The Bureau of Mines published an in-

formation circular on unit-train transportation of coal.<sup>4</sup>

Two of the unit-train loading installations described were in Kentucky.

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<sup>2</sup> Assistant State geologist, Kentucky Geological Survey, Lexington, Ky.

<sup>3</sup> American Geological Institute and Staff, Coal Section, Kentucky Geol. Survey, Bibliography of Coal in Kentucky. Kentucky Geol. Survey, Ser. 10, Spec. Pub. 19, 1970, 73 pp.

Hine, G. T. Relation of Fracture Traces, Joints, and Ground-Water Occurrence in the area of the Bryantsville Quadrangle, Central Kentucky. Kentucky Geol. Survey, Ser. 10, Thesis Ser. 3, 1970, 27 pp.

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Schwalb, H. R. and J. G. Smith. Catalogue of Well Samples and Cores on File at Kentucky Geological Survey. Kentucky Geol. Survey, Ser. 10, Inf. Circ. 19, 1970, 182 pp.

<sup>4</sup> Glover, T. O., M. E. Hinkle, and H. L. Riley. Unit-Train Transportation of Coal, Technology and Description of Nine Representative Operations, BuMines Inf. Circ. 8444, 1970, 109 pp.

Table 1.—Mineral production in Kentucky <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays <sup>2</sup> ..... thousand short tons...	1,232	\$2,076	1,020	\$1,793
Coal (bituminous)..... do.....	109,049	450,950	125,305	711,163
Natural gas..... million cubic feet...	81,304	20,407	77,892	19,161
Petroleum (crude)..... thousand 42-gallon barrels...	12,924	40,194	11,575	36,461
Sand and gravel..... thousand short tons...	8,364	9,628	8,760	10,474
Stone..... do.....	<sup>3</sup> 30,158	<sup>3</sup> 44,644	29,311	<sup>3</sup> 45,208
Zinc..... short tons...	W	W	4,189	1,283
Value of items that cannot be disclosed: Ball clay, cement, fluorspar, natural gas liquids, quartzite, and values indicated by symbol W.....	XX	<sup>4</sup> 23,148	XX	21,922
Total.....	XX	<sup>4</sup> 591,047	XX	847,465
Total 1967 constant dollars.....	XX	558,126	XX	<sup>p</sup> 766,956

<sup>1</sup> Preliminary <sup>r</sup> Revised. W Withheld to avoid disclosing individual company data; included with "Value of items that cannot be disclosed." 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, included with "Value of items that cannot be disclosed."

<sup>4</sup> Excludes quartzite, included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Kentucky, by counties <sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value <sup>2</sup>
Adair	W	W	Petroleum, limestone.
Allen	W	W	Limestone, petroleum.
Anderson	W	W	Limestone.
Ballard	\$10	\$10	Sand and gravel.
Barren	330	326	Limestone, petroleum.
Bath	12	12	Petroleum.
Bell	8,163	16,352	Coal, petroleum.
Boone	887	621	Sand and gravel.
Bourbon	W	W	Limestone.
Boyd	W	W	Coal, miscellaneous clay, petroleum.
Boyle	W	W	Limestone.
Breathitt	W	16,870	Coal, petroleum.
Breckinridge	499	W	Limestone, sand and gravel, petroleum.
Bullitt	1,189	W	Limestone, miscellaneous clay.
Butler	W	W	Coal, limestone, petroleum.
Caldwell	W	W	Limestone.
Calloway	W	61	Sand and gravel.
Carlisle	18	18	Do.
Carroll	--	W	Do.
Carter	2,801	W	Limestone, fire clay, coal.
Casey	W	W	Limestone, petroleum.
Christian	1,887	W	Limestone, petroleum, coal, miscellaneous clay.
Clay	2,275	3,478	Coal, petroleum.
Clinton	268	W	Coal, limestone, petroleum.
Crittenden	W	W	Limestone, fluorspar.
Cumberland	W	W	Limestone, petroleum.
Daviess	7,564	W	Coal, petroleum, sand and gravel, miscellaneous clay.
Edmonson	W	W	Limestone, petroleum.
Elliott	117	110	Petroleum.
Estill	W	W	Petroleum, limestone.
Fayette	W	W	Limestone.
Fleming	W	W	Do.
Floyd	26,390	W	Coal, petroleum, sand and gravel.
Franklin	W	795	Limestone.
Fulton	W	W	Sand and gravel.
Gallatin	W	W	Do.
Garrard	131	W	Limestone.
Graves	W	W	Ball clay, sand and gravel.
Grayson	W	W	Limestone.
Green	W	W	Limestone, petroleum.
Greenup	W	W	Fire clay, limestone, petroleum.
Hancock	694	W	Miscellaneous clay, petroleum, fire clay.
Hardin	1,309	1,250	Limestone.
Harlan	46,423	71,795	Coal, limestone.
Harrison	W	W	Limestone.
Hart	W	W	Limestone, sand and gravel, petroleum.
Henderson	7,890	W	Petroleum, sand and gravel, coal.
Henry	W	W	Limestone.
Hickman	W	W	Sand and gravel.
Hopkins	49,822	64,355	Coal, petroleum, miscellaneous clay.
Jackson	199	W	Limestone, coal.
Jefferson	13,387	W	Cement, limestone, sand and gravel, miscellaneous clay.
Jessamine	W	W	Limestone.
Johnson	W	12,239	Coal, petroleum.
Knott	11,910	22,697	Do.
Knox	544	4,878	Do.
Laurel	W	W	Coal, limestone, petroleum.
Lawrence	1,221	2,461	Coal, petroleum.
Lee	W	W	Petroleum, limestone, coal.
Leslie	7,880	17,666	Coal, petroleum.
Letcher	34,476	W	Coal, limestone, petroleum.
Livingston	8,130	8,467	Limestone, sand and gravel, zinc, quartzite, fluorspar.
Logan	W	W	Limestone, petroleum.
Lyon	5	5	Sand and gravel.
McCracken	W	W	Do.
McCreary	W	W	Coal, petroleum.
McLean	2,138	2,208	Petroleum, coal.
Madison	W	W	Limestone, clay.
Magoffin	W	W	Coal, petroleum.
Marion	W	W	Limestone.
Marshall	15	W	Sand and gravel.
Martin	4,618	8,231	Coal, sand and gravel, petroleum.
Mason	118	W	Sand and gravel.
Meade	W	W	Limestone.
Menifee	W	W	Do.
Mercer	W	W	Do.
Metcalfe	W	W	Petroleum, limestone.
Monroe	330	W	Limestone, petroleum.
Montgomery	108	105	Limestone.
Morgan	980	W	Limestone, coal, petroleum, fire clay.

See footnotes at end of table.

Table 2.—Value of mineral production in Kentucky, by counties <sup>1</sup>—Continued

(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value <sup>2</sup>
Muhlenberg	\$76,278	\$101,445	Coal, petroleum, limestone.
Nelson	W	W	Limestone.
Nicholas	W	W	Do.
Ohio	W	W	Coal, limestone, petroleum.
Oldham	1,236	839	Limestone.
Owsley	1	2	Petroleum.
Pendleton	W	W	Limestone.
Perry	26,527	54,668	Coal, petroleum.
Pike	93,637	W	Coal, limestone, petroleum.
Powell	W	W	Limestone, petroleum, miscellaneous clay.
Pulaski	W	W	Limestone, coal, petroleum.
Rockcastle	W	W	Limestone, coal.
Rowan	1,571	W	Limestone, fire clay, miscellaneous clay.
Russell	2	1	Petroleum.
Scott	W	W	Limestone.
Simpson	W	W	Limestone, petroleum.
Taylor	W	W	Do.
Todd	W	W	Limestone.
Trigg	W	W	Do.
Trimble	W	W	Sand and gravel.
Union	W	W	Coal, petroleum, sand and gravel.
Warren	1,080	991	Limestone, petroleum.
Washington	—	W	Limestone.
Wayne	W	W	Coal, limestone, petroleum.
Webster	W	8,157	Coal, petroleum.
Whitley	1,233	W	Coal, petroleum, miscellaneous clay.
Wolfe	176	259	Limestone, petroleum, coal.
Undistributed <sup>3</sup>	144,575	426,078	
Total <sup>4</sup>	\$591,047	\$847,465	

<sup>2</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

<sup>1</sup> The following counties are not listed because no production was reported: Bracken, Campbell, Clark, Grant, Kenton, Larue, Lewis, Lincoln, Owen, Robertson, Shelby, Spencer, and Woodford.

<sup>2</sup> Excludes natural gas and natural gas liquids; included in "Undistributed."

<sup>3</sup> Includes natural gas, natural gas liquids, and values indicated by symbol W.

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

**Economic Indicators.**—Personal per capita income increased 6.4 percent. Although Kentucky ranks 41st in per capita income, it is 6th in the 12-state southeastern region. Farm marketing receipts increased 4.7 percent. Portland cement shipments to and within Kentucky decreased 10.7 percent, reflecting in part a decrease of 10.9 percent in contract construction. Service employment increased 11.4 percent. Value of mineral production increased 43.3 percent, primarily due to the increase in production and the value per ton of coal. Electrical energy sales, other than to the Atomic Energy Commission, increased 5.4 percent.

**Trends and Developments.**—Kentucky Utilities Co. announced plans to construct a \$101 million, 510,000-kilowatt coal-fired plant at Ghent, Carroll County, on the Ohio River. An estimated 1.3 million tons of coal per year will be required to fuel this plant. The construction budget of the Kentucky Power Co. was \$12 million. Included were \$1.3 million for a 765-kilovolt electric transmission line connecting the

Big Sandy plant with the Appalachian Power Co. transmission lines to the south.

During the Tennessee Valley Authority's last fiscal year, 3.4 million tons of coal was purchased from the eastern Kentucky coalfield and 18.8 million tons from the western Kentucky coalfield. Duke Power Co. purchased the High Splint Coal Co. and Harlan Collieries in Harlan County to assure their coal supply. The coal reserves acquired were estimated to be up to 150 million tons.

A \$2 million contract was awarded by the Clinchfield Coal Corp. for construction of a coal preparation plant capable of processing 1.2 million tons per year of raw coal at the Feds Creek mine at Mouthcard in Pike County. United Fuel Gas Co. announced plans to drill 25 wells at an estimated cost of \$1.1 million.

Anaconda Aluminum Co., a subsidiary of Anaconda Co., announced plans to build a large aluminum reduction plant in Henderson County with an initial capacity of 120,000 tons.



Table 3.—Selected economic indicators of Kentucky business activity

	1969	1970	Change, percent
Employment and labor force, annual average: <sup>1</sup>			
Total nonagricultural employment.....thousands..	895	914	+2.1
Mining.....do.....	27	28	+3.7
Contract construction.....do.....	55	49	-10.9
Service.....do.....	123	137	+11.4
Government.....do.....	167	174	+4.2
Manufacturing.....do.....	247	251	+1.6
Personal income: <sup>2</sup>			
Total.....millions..	\$9,202	\$9,866	+7.2
Per capita.....	\$2,877	\$3,060	+6.4
New business incorporations <sup>3</sup> .....	3,657	3,747	+2.5
Construction activity:			
Housing units—private and public: <sup>4</sup>			
Number.....	14,616	16,836	+15.2
Value of nonresidential construction.....millions..	\$121	\$127	+5.0
Cement shipments to and within Kentucky: <sup>5</sup>			
Portland (includes high-early-strength) thousand 376-pound barrels..	5,804	5,181	-10.7
Masonry.....thousand 280-pound barrels..	634	584	-7.9
Farm marketing receipts <sup>6</sup> .....millions..	\$886	\$928	+4.7
Mineral production.....do.....	\$591	\$847	+43.3
Electrical energy sales (sales to AEC excluded).....million kilowatt-hours..	14,136	14,902	+5.4

<sup>1</sup> Kentucky Department of Labor, Division of Research and Statistics.

<sup>2</sup> Survey of Current Business, U.S. Department of Commerce, Office of Business Economics.

<sup>3</sup> Kentucky Economic Outlook, Kentucky Department of Labor.

<sup>4</sup> Construction Review, U.S. Department of Commerce, Bureau of Domestic Commerce.

<sup>5</sup> U.S. Bureau of Mines.

<sup>6</sup> Farm Income Situation, U.S. Department of Agriculture.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man- days worked (thou- sands)	Man- hours worked (thou- sands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non- fatal	Fre- quency	Sever- ity
1969:								
Coal.....	22,447	205	4,604	36,489	34	1,535	43.00	8,286
Metal.....	46	249	11	92	--	11	119.88	5,166
Nonmetal.....	234	236	55	440	--	19	43.19	10,925
Sand and gravel.....	303	262	79	755	--	14	18.53	716
Stone.....	2,198	251	552	4,608	6	125	28.43	9,244
Total <sup>1</sup> .....	25,228	210	5,302	42,384	40	1,704	41.15	8,276
1970: <sup>p</sup>								
Coal.....	23,100	207	4,788	38,079	88	1,450	40.36	15,350
Metal.....	35	282	9	74	--	7	94.12	417
Nonmetal.....	250	221	55	443	--	20	45.16	1,635
Sand and gravel.....	380	262	100	879	--	22	25.02	544
Stone.....	2,220	252	560	4,677	1	127	27.37	2,490
Total <sup>1</sup> .....	26,025	212	5,512	44,152	89	1,626	38.84	13,530

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

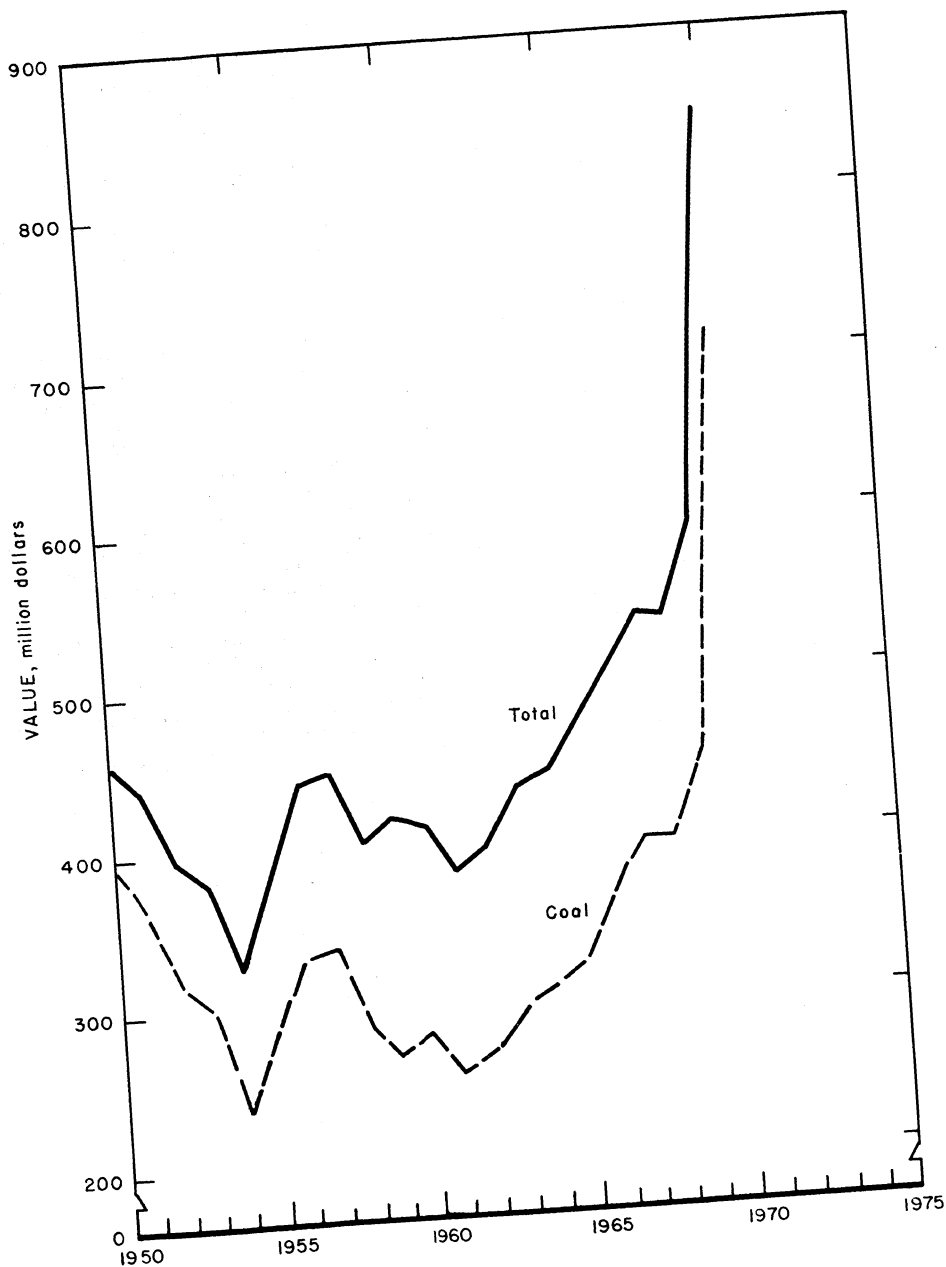


Figure 1.—Value of coal and total value of mineral production in Kentucky.

## REVIEW BY MINERAL COMMODITIES

### MINERAL FUELS

The combined value of bituminous coal, crude petroleum, and natural gas was \$767 million, 90 percent of the mineral production value of the State.

**Coal (Bituminous).**—Production of coal increased 15 percent, and its value increased 58 percent above that of 1969. Coal production was 125 million tons valued at \$711 million, a record high for the State.

Coal available to fill short-term or new contracts commanded a sharp increase in value from both electric utilities and other industrial and domestic users. The reported average value per ton was \$5.68, compared with \$4.14 per ton in 1969.

Bituminous coal was produced at 1,721 mines in 38 counties, compared with 1,341 mines in 35 counties in 1969. Muhlenberg and Pike Counties produced 26 and 21 million tons of coal, respectively. Muhlenberg County led in strip mine production in western Kentucky.

In eastern Kentucky 1,623 mines in 28 counties produced 72.5 million tons of coal compared with 1,261 mines in 28 counties that produced 62 million tons in 1969.

Underground mines produced 43.2 million tons or 60 percent of the coal mined in eastern Kentucky; auger mines, 13 percent; and strip mines 27 percent.

Equipment used at 1,072 eastern Kentucky underground mines was estimated to include 815 cutting machines which undercut 47 million tons, 1,209 hand-held and mobile coal drills, 386 rotary drills and 81 percussion rock drills.

Of the total underground production, reportedly 88 percent or 38 million tons was mechanically loaded. Of this tonnage, 70 percent was loaded by 589 mobile loaders. One hundred-nine continuous miners produced 29 percent of the mechanically loaded tonnage. Five shearer-type longwall sections mined and loaded less than 1 percent of the tonnage.

Underground mine haulage included 327 locomotives, 473 shuttle cars, 281 shuttle buggies, 806 rubber tired tractors and 248 gathering conveyors.

Of the total coal produced in the eastern Kentucky coalfield, 30 percent was

crushed, 29 percent was cleaned at 31 coal cleaning plants. Shipments were 93 percent by rail or water. Unit trains carried 13 percent of the coal produced.

In the western Kentucky coalfield, 98 mines in 10 counties produced 52.8 million tons of coal, compared with 80 mines in eight counties and 47.5 million tons in 1969. Strip mines produced 63 percent of the coal, and underground mines, 37 percent. Only five auger mines were in operation. Shipments were 79 percent by rail or water and 11 percent by truck. Ten percent used steam electric generating plants at the mouth of the mine. All coal was sold on the open market. In the 32 underground mines, equipment included 90 cutting machines, 69 mobile and 17 post or hand-held power drills, 101 mobile loading machines, and two continuous mining machines. All reported production was mechanically loaded. Equipment used at 61 strip mines included 54 power shovels with a dipper capacity of less than 5 cubic yards, 34 with a capacity of 6 to 15 cubic yards, nine with a capacity of 16 to 50 cubic yards, and four with a capacity of more than 50 cubic yards. Thirty draglines stripped overburden; 10 of these had a bucket capacity of 5 cubic yards or less, 12 with a bucket capacity of 6 to 15 cubic yards, six with a capacity of 16 to 50 cubic yards, and two with a bucket capacity of more than 50 cubic yards. Other equipment included 171 bulldozers, two carryall scrapers, and 12 horizontal and 53 vertical drills for use on overburden, and 13 coal drills. Five coal augers and six bulldozers were used to auger mine coal.

In the western Kentucky coalfield 36 percent of the coal was cleaned in 18 coal preparation plants. Fifty-five percent of the total coal produced was crushed, unit train shipments were 17 percent of the total coal produced.

**Natural Gas.**—Marketed production of natural gas decreased 4 percent in quantity, and amounted to 2 percent of the total mineral production value of the State.

In 1970, 111 new gas wells were completed. Estimated proved reserves of natural gas at yearend were 977,842 million cubic feet.<sup>5</sup>

<sup>5</sup> Oil and Gas Journal, v. 69, No. 14, Apr. 5, 1971, pp. 38, 39

**Table 5.—Kentucky: Bituminous coal production, by type of mine and counties**  
(Excludes mines producing less than 1,000 short tons annually)

County	Production						Shipments				Average value per ton <sup>4</sup>	
	Underground		Strip		Auger		Rail or water <sup>1</sup>	Truck	Mine-mouth generating plants	All other <sup>2</sup>		Total <sup>3</sup>
	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity						
<b>Kentucky:</b>												
<b>Eastern:</b>												
Bell.....	18	697	28	1,646	14	461	2,498	305	--	--	2,803	5.83
Boyd.....	1	37	3	2	1	2	40	40	--	--	40	6.00
Breathitt.....	6	23	11	2,517	5	817	3,331	25	--	--	3,356	5.01
Carter.....	2	3	2	24	--	--	27	27	--	--	27	6.25
Clay.....	23	288	9	119	5	113	241	280	--	--	521	6.63
Clinton.....	3	13	2	155	--	--	102	66	--	--	168	6.37
Floyd.....	156	4,239	12	775	8	335	4,829	520	--	--	5,349	6.09
Harlan.....	93	7,338	28	1,537	20	547	8,732	645	44	44	9,421	7.59
Jackson.....	--	--	2	11	--	--	--	11	--	--	11	5.00
Johnson.....	35	294	9	1,600	7	303	2,084	112	--	--	2,196	5.18
Knot.....	64	2,409	20	1,785	13	524	3,238	480	--	--	3,718	6.10
Knox.....	25	115	21	664	2	16	453	335	7	7	795	6.13
Laurel.....	1	4	12	160	1	13	--	176	--	--	176	5.00
Lawrence.....	--	--	7	253	3	33	--	286	--	--	286	6.00
Lee.....	2	27	--	--	--	--	9	15	2	2	26	7.38
Leslie.....	26	1,368	19	515	11	440	2,275	48	--	--	2,323	7.60
Letcher.....	114	4,309	48	2,780	27	1,030	7,884	235	--	--	8,119	6.23
McCreeary.....	5	360	3	119	--	--	306	173	--	--	479	7.15
Magoffin.....	3	8	5	407	2	304	704	10	--	--	714	5.00
Martin.....	6	1,072	3	277	4	263	1,604	8	--	--	1,612	5.05
Morgan.....	2	4	5	17	--	--	--	21	--	--	21	6.82
Perry.....	44	2,786	50	3,152	28	2,237	7,815	360	--	--	8,175	6.61
Pike.....	419	17,609	82	1,675	45	2,015	20,847	450	2	2	21,299	7.64
Pulaski.....	2	84	--	--	--	--	--	75	--	--	84	6.00
Rockcastle.....	--	--	2	10	1	4	--	14	--	--	14	5.00
Wayne.....	1	5	2	48	--	--	--	53	--	--	53	5.00
Whitley.....	23	192	15	415	5	98	609	95	--	--	704	4.42
Wolfe.....	--	--	1	10	--	--	--	10	--	--	10	5.00
<b>Total<sup>3</sup></b>	<b>1,072</b>	<b>43,243</b>	<b>349</b>	<b>19,705</b>	<b>202</b>	<b>9,554</b>	<b>67,572</b>	<b>4,875</b>	<b>55</b>	<b>55</b>	<b>72,502</b>	<b>6.73</b>

See footnotes at end of table.

**Table 5.—Kentucky: Bituminous coal production, by type of mine and counties—Continued**  
(Excludes mines producing less than 1,000 short tons annually)

County	Production						Shipments				Average value per ton <sup>4</sup>	
	Underground		Strip		Auger		Truck	Mine-mouth generating plants	All other <sup>2</sup>	Total <sup>3</sup>		
	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity						
<b>Kentucky—Continued</b>												
Western:												
Butler.....	W		4	179	--	--	228	--	--	228	4.14	
Christian.....	--		4	170	--	--	55	--	--	170	3.22	
Daviess.....	--		1	804	--	--	804	--	--	804	3.91	
Henderson.....	3	93	19	5,312	W	11,844	93	--	--	12,533	4.60	
Hopkins.....	14	7,077	18	94	W	42	689	--	--	94	3.91	
McLean.....	7	4,365	18	21,491	W	48	52	--	--	25,903	3.84	
Muhlenberg.....	W		12	5,081	W	137	3,566	5,437	28	7,269	3.71	
Ohio.....	4	4,620	--	--	--	4,620	--	--	--	4,620	5.00	
Union.....	1	1,089	--	--	--	1,089	--	--	--	1,089	5.50	
Webster.....	3	2,121	--	--	3	258	--	--	--	--	--	
Other counties <sup>5</sup> .....												
Total <sup>1</sup> .....	32	19,367	61	33,131	5	305	41,720	5,603	5,437	43	52,803	4.22
Grand total <sup>1</sup> .....	1,104	62,610	410	52,836	207	9,859	109,292	10,478	5,437	99	125,305	5.63

W Withheld to avoid disclosing individual company confidential data.

<sup>1</sup> Includes coal loaded at mine directly into railroad cars or river barges, hauled by trucks to railroad sidings, and hauled by trucks to waterways.

<sup>2</sup> Includes coal used at mine for power and heat, made into beehive coke at mine, used by mine employees, used for all other purposes at mine.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

<sup>4</sup> Value received or charged for coal l.o.b. mine. Includes a value for coal not sold but used by producers, such as mine fuel and coal coke, as estimated by producers at average prices that might have been received if such coal had been sold commercially.

<sup>5</sup> Includes counties indicated by symbol W.

**Natural Gas Liquids.**—The quantity and value of natural gasoline and cycle products decreased 25 and 26 percent, respectively. Production of liquefied petroleum (LP) gases decreased 4 percent, but value increased 9 percent.

**Petroleum.**—Crude oil production of 11.6 million barrels was 10 percent less than that of 1969. Crude oil production has decreased since 1959, the record high

year. In 1970, 275 oil wells were drilled, and 76 service wells were completed. Union County in western Kentucky was the leading producing county in the State with 1.9 million barrels of oil; Lee County led in eastern Kentucky with 1.5 million barrels. At yearend, estimated proved reserves were 61,377 thousand 42-gallon barrels.<sup>6</sup>

<sup>6</sup> Work cited in footnote 5.

**Table 6.—Kentucky: Crude petroleum production by counties**  
(Thousand 42-gallon barrels and thousand dollars)

County	Production	
	1969	1970
Adair	8	276
Allen	62	47
Barren	11	10
Bath	4	4
Bell	(1)	(1)
Boyd	--	2
Breathitt	25	22
Breckinridge	12	13
Butler	62	54
Casey	16	15
Christian	181	175
Clay	3	9
Clinton	42	29
Cumberland	28	24
Daviess	1,228	968
Edmonson	(1)	(1)
Elliott	38	35
Estill	278	231
Floyd	35	30
Green	112	71
Greenup	4	2
Hancock	76	72
Hart	17	15
Henderson	2,016	1,731
Hopkins	855	791
Jackson	(1)	--
Johnson	393	277
Knott	8	8
Knox	1	2
Laurel	3	2
Lawrence	307	236
Lee	1,558	1,486
Leslie	2	2
Letcher	258	284
Logan	1	3
McCreary	1	(1)
McLean	686	585
Magoffin	344	286
Martin	11	10
Metcalfe	94	85
Monroe	23	22
Morgan	1	1
Muhlenberg	406	346
Ohio	467	385
Owsley	(1)	1
Perry	155	199
Pike	29	29
Powell	37	33
Pulaski	3	2
Russell	1	(1)
Simpson	4	11
Taylor	(1)	(1)
Todd	(1)	--
Union	2,077	1,905
Warren	24	22
Wayne	11	8
Webster	884	687
Whitley	16	11
Wolfe	6	16
<b>Total<sup>2</sup></b>		
Quantity	12,924	11,575
Value	\$40,194	\$36,461

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

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

Table 7.—Kentucky: Oil and gas well drilling completions in 1970, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
Adair	52	--	12	9	--	34	107	165,045
Allen	9	--	6	2	--	12	29	8,400
Barren	--	--	2	--	--	3	5	2,067
Bath	1	--	1	--	--	--	2	1,310
Boyd	--	1	--	--	--	--	1	3,163
Breathitt	1	3	3	--	--	--	7	12,109
Breckinridge	--	--	--	--	--	8	8	2,896
Bullitt	--	--	--	--	--	1	1	1,520
Butler	4	--	5	--	--	--	9	3,401
Campbell	--	--	--	--	--	2	2	4,781
Carter	--	--	--	--	--	1	1	1,200
Casey	6	--	6	2	--	2	16	7,667
Christian	3	2	2	--	--	2	9	6,799
Clay	1	3	3	--	--	--	7	8,981
Clinton	3	--	1	--	--	--	4	3,625
Crittenden	--	--	--	--	--	1	1	800
Cumberland	3	--	6	--	--	2	11	6,494
Daviess	20	--	32	1	--	12	65	91,208
Edmonson	--	1	--	--	--	--	1	741
Elliott	--	--	1	--	1	--	1	11,935
Estill	2	--	2	--	--	1	5	2,588
Floyd	1	9	7	--	--	--	18	42,063
Garrard	--	--	--	--	--	1	1	4,632
Grayson	--	--	--	--	--	2	2	3,879
Green	5	--	1	--	--	1	7	3,298
Hancock	11	--	9	1	--	6	27	20,268
Hardin	--	2	--	--	--	4	6	4,953
Hart	--	--	1	--	--	1	2	1,588
Henderson	15	--	15	--	--	4	34	85,917
Hopkins	7	2	7	--	--	15	31	74,313
Johnson	2	2	2	--	--	2	8	14,796
Knott	--	3	1	--	--	--	4	8,517
Knox	1	3	3	1	--	1	9	15,955
Laurel	--	1	1	--	--	--	2	2,481
Lawrence	5	5	--	--	--	1	11	26,508
Lee	24	--	3	--	--	--	27	30,107
Leslie	1	--	--	--	--	--	1	3,575
Letcher	1	16	--	--	1	2	20	72,082
Lincoln	--	--	--	--	--	1	1	5,782
Logan	--	--	--	1	--	9	10	9,123
McCreary	--	--	--	--	--	5	5	1,701
McLean	3	1	8	--	--	--	17	25,425
Magoffin	2	1	--	--	--	--	3	3,109
Martin	--	11	--	--	--	--	11	28,328
Metcalfe	5	--	14	--	--	--	24	10,192
Monroe	4	--	5	--	--	10	19	9,520
Morgan	--	1	--	--	--	--	1	1,905
Muhlenberg	11	1	--	2	2	7	29	30,484
Ohio	17	--	21	--	1	3	42	28,607
Owen	--	--	--	--	--	1	1	1,300
Owsley	--	--	--	--	1	--	2	3,234
Perry	1	18	4	--	1	1	25	88,210
Pike	1	13	1	--	2	--	17	59,383
Powell	--	--	--	--	1	--	1	318
Pulaski	--	--	--	--	--	1	1	320
Rowan	--	--	1	--	--	--	1	315
Russell	--	--	2	--	--	--	3	2,250
Simpson	1	1	6	--	--	5	13	8,746
Spencer	--	--	--	--	--	2	2	3,130
Todd	--	--	--	--	--	3	3	2,621
Union	13	--	17	1	--	4	35	74,351
Warren	7	--	3	1	--	6	17	12,459
Wayne	--	--	--	--	--	1	1	1,100
Webster	7	--	4	--	--	3	14	29,556
Whitley	1	--	1	--	--	5	7	13,134
Wolfe	3	1	--	--	--	--	4	3,755
Total	254	101	226	21	10	197	809	1,219,520

Source: American Association of Petroleum Geologists.

## NONMETALS

Nonmetals provided 8 percent of the total value of mineral production in Kentucky in 1970.

**Cement.**—Kosmos Portland Cement Co. in Jefferson County operated Kentucky's only cement plant. Quantity of portland cement shipped decreased 3 percent, but value increased 4 percent.

Most of the cement was shipped by truck to ready-mix plants in Kentucky. Shipments and value of masonry cement each decreased 15 percent. Raw materials used in portland cement manufacture were limestone (75 percent) miscellaneous clay (21 percent), gypsum (3 percent), and iron ore (1 percent).

**Clays.**—Three companies mined ball clay from six open pits in Graves County. One company mined ball clay and manufactured garden pottery. The larger companies mined, processed, packaged, or shipped bulk ball clay to manufacturers of wall tile, sanitary ware, insulation products, pottery, and dinner ware.

Fire clay production decreased 19 percent and decreased in value 13 percent. Fifteen companies produced 160,000 tons of fire clay valued at \$0.9 million, from 26 open pit mines in Carter, Greenup, Hancock, Rowan, and Morgan Counties. Most of the clay was used to manufacture firebrick and other refractories.

About 860,000 tons of common clay and shale, valued at approximately \$0.9 million, was mined by 15 companies from 17 open pit mines in 10 counties. Production decreased 17 percent, and value decreased 14 percent. Most of the clay, which included shale, was used in the manufacture of lightweight aggregate and building brick.

**Fluorspar.**—Fluorspar was mined at one mine in Livingston County and three mines in Crittenden County. The Calvert City Chemical Co. acquired the Shouse mine at Joy and reopened the Babb Mine at Salem. The Kentucky Fluorspar Co. operated the Eagle Watson mine. The Minerva Oil Co. operated the Tabb No. 1 open pit mine. Most of the fluorspar was used in manufacturing hydrofluoric acid.

**Graphite, Artificial.**—Graphite was manufactured in Fulton County for use in anodes and electrodes.

**Perlite.**—Crude perlite mined in the western States was expanded at plants in Boone and Campbell Counties for use in industrial board, soil conditioning, and building plaster.

**Sand and Gravel.**—Sand and gravel was mined by 29 producers at 39 operations in 23 counties. Production increased 5 percent and value, 9 percent. Transportation of commercial production was 78 percent by truck, 16 percent by waterway, and 6 percent by rail.

Table 8.—Kentucky: Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Ballard.....	1	19	\$10	1	19	\$10
Boone.....	3	879	887	3	578	621
Breckinridge.....	1	W	W	1	48	47
Calloway.....	2	W	W	2	51	61
Carlisle.....	1	35	18	1	35	18
Daviess.....	2	756	W	2	W	W
Graves.....	2	W	W	1	75	38
Jefferson.....	4	2,236	2,135	4	2,502	2,764
Lyon.....	1	10	5	1	10	5
Marshall.....	1	30	15	1	30	15
Martin.....	1	36	53	1	36	53
Mason.....	2	W	118	2	W	W
Undistributed <sup>1</sup> .....	19	4,365	6,388	19	5,376	6,844
Total <sup>2</sup> .....	40	8,364	9,628	39	8,760	10,474

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

<sup>1</sup> Includes Floyd, Fulton, Gallatin, Hart, Henderson, Hickman, Livingston, McCracken, Trimble, and Union Counties.

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



**Table 9.—Kentucky: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building .....	3,800	\$4,456	3,516	\$4,409
Fill .....	875	768	942	813
Paving .....	1,512	1,754	2,332	2,691
Other uses <sup>1</sup> .....	W	W	W	W
Total .....	W	W	W	W
Gravel:				
Building .....	980	1,244	578	806
Fill .....	121	87	39	39
Paving .....	655	903	1,032	1,454
Railroad ballast .....	30	51	30	51
Other uses <sup>2</sup> .....	W	W	W	W
Total .....	W	W	W	W
<b>Government-and-contractor operations:</b>				
Gravel:				
Fill .....	1	( <sup>3</sup> )	1	( <sup>3</sup> )
Paving .....	238	118	238	101
Total .....	239	118	239	101
Total sand and gravel <sup>4</sup> .....	8,364	9,628	8,760	10,474

W Withheld to avoid disclosing individual company confidential data; included with "Total sand and gravel."

<sup>1</sup> Includes blast, engine, foundry, railroad ballast, and other sands.

<sup>2</sup> Includes other sands.

<sup>3</sup> Less than ½ unit.

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

**Stone.**—Crushed limestone production decreased 3 percent, and the value increased 1 percent. Eighty-five producers, including one federal and three county agencies, crushed limestone at 118 quarries. Of the total stone produced, 69 percent was used for concrete and roads, 6 percent for aglime, and 25 percent for other uses. Shipments were 73 percent by truck, 5 percent by railroad, and 21 percent by waterway. The remaining 1 percent was not reported.

Crushed quartzite was produced near Smithland in Livingston County for use in manufacturing ferrosilicon.

**Vermiculite.**—Crude vermiculite from other States was exfoliated at plants in Boone and Campbell Counties. Production decreased 9 percent, and value decreased 4 percent. The product was used for loose fill insulation, soil conditioning, in light-weight concrete, and in plaster.

## METALS

The value of metallic ores was less than one-half of 1 percent of the total value of mineral production.

**Aluminum-Primary.**—The National Southwire Aluminum Co., owned by National Steel Corp. and Southwire Co., produced aluminum at a plant near Hawesville.

**Ferroalloys.**—Ferroalloy shipments decreased 2 percent, and value increased 17 percent. The alloys were used in steel manufacture.

**Pig Iron.**—Production of pig iron declined 6 percent. Armco Steel Corp. produced basic and foundry pig iron at its Ashland plant.

**Zinc.**—Zinc sulfide mined in Kentucky was shipped to Galena, Kans. for roasting. The roasted concentrates are shipped to Bartlesville, Okla. for smelting.

**Table 10.—Kentucky: Crushed limestone sold or used by producers, by counties**  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Barren.....	1	173	\$294	1	173	\$294
Bourbon.....	1	183	W	1	177	W
Carter.....	4	1,489	W	4	1,267	1,944
Christian.....	3	1,041	W	3	1,124	1,519
Franklin.....	3	W	W	3	765	795
Garrard.....	1	91	131	1	88	W
Grayson.....	1	W	W	1	228	W
Hardin.....	5	832	1,309	5	763	1,250
Harlan.....	1	152	297	1	W	W
Jackson.....	2	125	W	2	75	W
Jefferson.....	4	1,974	W	4	1,443	2,150
Logan.....	1	179	W	1	W	W
Monroe.....	1	W	258	1	W	228
Montgomery.....	1	W	108	1	W	105
Morgan.....	4	446	W	4	378	610
Oldham.....	4	974	1,236	3	544	839
Trigg.....	1	192	W	1	W	W
Warren.....	4	759	1,006	4	639	921
Wolfe.....	1	105	157	1	105	157
Undistributed <sup>1</sup> .....	76	21,443	39,848	76	21,492	34,396
Total.....	119	30,158	44,644	118	29,261	45,208

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

<sup>1</sup> Includes Adair, Allen, Anderson, Boyle, Breckinridge, Bullitt, Butler, Caldwell, Casey, Clinton, Crittenden, Cumberland, Edmonson, Estill, Fayette, Fleming, Green, Greenup, Harrison, Hart, Henry, Jessamine, Laurel, Lee, Letcher, Livingston, Madison, Marion, Meade, Menifee, Mercer, Metcalfe, Muhlenberg, Nelson, Nicholas, Ohio, Pendleton, Pike, Powell, Pulaski, Rockcastle, Rowan, Scott, Simpson, Taylor, Todd, Washington, and Wayne Counties.

**Table 11.—Kentucky: Crushed limestone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Bituminous aggregate.....	2,515	\$3,745	2,771	\$4,436
Concrete aggregate.....	2,865	4,229	2,566	3,791
Dense graded road base stone.....	14,407	21,943	12,432	19,932
Macadam aggregate.....	917	1,246	1,389	2,054
Surface treatment aggregate.....	1,546	2,376	1,064	1,707
Unspecified aggregate and roadstone.....	1,160	1,751	1,847	2,762
Agricultural limestone.....	1,844	3,095	1,883	3,303
Railroad ballast.....	501	W	404	560
Riprap and jetty stone.....	W	3,450	2,994	3,618
Other uses <sup>1</sup> .....	4,405	2,810	1,912	3,045
Total <sup>2</sup> .....	30,158	44,644	29,261	45,208

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

<sup>1</sup> Includes stone sand, cement, ferrosilicon, mine dusting, acid neutralization, building products, uses not specified; also, lime, fill, and others not listed for 1970.

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

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Aluminum, primary:</b>			
National-Southwire Aluminum Co.	P.O. Box M Hawesville, Ky. 42348	Smelter.....	Hancock.
<b>Cement, masonry and portland:</b>			
Kosmos Portland Cement Co., Div., of the Flintkote Co.	Dixie Highway Kosmosdale, Ky. 40272	Plant.....	Jefferson.
<b>Clays:</b>			
<b>Ball:</b>			
Bell City Pottery.....	Route 1 Farmingington, Ky. 42040	Open pit mines and plant.	Graves.
Kentucky-Tennessee Clay Co.	Box 77 Mayfield, Ky. 42066	3 open pit mines and plant.	Do.
Old Hickory Clay Co.	Box 271 Paducah, Ky. 42351	2 open pit mines...	Do.
<b>Fire:</b>			
Ford Burchett Clay Co.	Olive Hill, Ky. 41164.....	Open pit mine.....	Carter.
Burge & Fultz Clay Co.	Route 2 Olive Hill, Ky. 41164	.....do.....	Do.
General Refractories Co.	1520 Locust St. Philadelphia, Pa. 19102	4 open pit mines and plant.	Carter and Rowan.
M. A. McCoy & Son..	Oak Hill, Ohio 45656.....	2 open pit mines...	Greenup.
<b>Miscellaneous:</b>			
American Olean Tile Co.	Lewisport, Ky. 42351.....	Open pit mine and plant.	Hancock.
General Shale Products Co.	Johnson City, Tenn. 37601..	.....do.....	Jefferson.
Harsco Corp.....	4th & Washington St. Cannelton, Ind. 47520	2 open pit mines...	Hancock.
Kosmos Portland Cement Co.	Dixie Highway Kosmosdale, Ky. 40272	Open pit mine.....	Jefferson.
Ohio River Sand Co., Inc.	129 River Road Louisville, Ky. 40202	Open pit mine and plant.	Bullitt.
Owensboro Brick & Tile Co.	Ewing Road Owensboro, Ky. 42302	.....do.....	Hancock.
<b>Coal:</b>			
Ayrshire Coal Co.....	105 S. Meridian St. Indianapolis, Ind. 46225	1 strip mine.....	Muhlenberg.
Beth-Elkhorn Corp.....	701 East Third St. Bethlehem, Pa. 18016	3 underground mines.	Letcher and Pike.
Gibraltar Coal Co.....	150 South Meridian St. Indianapolis, Ind. 46225	Strip mine.....	Muhlenberg.
Island Creek Coal Co.....	Wheelwright, Ky. 41669.....	5 underground mines.	Floyd.
Do.....	444 South Main St. Madisonville, Ky. 42431	8 underground mines.	Hopkins, Muhlenberg, Union.
Do.....	Holden, W. Va. 25625.....	3 underground mines.	Pike.
Peabody Coal Co.....	301 North Memorial Dr. St. Louis, Mo. 63102	2 underground and 6 strip mines.	Muhlenberg and Ohio.
The Pittsburgh and Midway Coal Mining Co.	Ten Main Center Kansas City, Mo. 64105	2 underground and 2 strip mines.	Hopkins and Muhlenberg.
United States Steel Corp..	525 William Penn Place Pittsburgh, Pa. 15230	3 underground and 1 auger mine.	Harlan.
<b>Coke:</b>			
Chemical Coke Co.....	Dawson Springs, Ky. 42408..	Plant.....	Hopkins.
Hooker Chemical Co.....	Box 33 South Shore, Ky. 41175	.....do.....	Greenup.
Semet-Solvay Div. of Allied Chemical Corp.	40 Rector St. New York, N. Y. 10006	.....do.....	Boyd.
<b>Ferrous alloys:</b>			
Airco Alloys and Carbide..	Box 217 Calvert City, Ky. 42029	.....do.....	Marshall.
<b>Fluorspar:</b>			
Calvert City Chemical Co.	Box 305 Calvert City, Ky. 42029	Underground mine and mill.	Livingston.
Minerva Oil Co.....	Eldorado, Ill. 62980.....	Underground mine..	Crittenden.
Kentucky Fluorspar Co...	Marion, Ky. 42064.....	Underground mine and mill.	Do.
<b>Graphite, artificial:</b>			
Carborundum Co.....	Hickman, Ky. 42050.....	Plant.....	Fulton.
<b>Iron, pig:</b>			
Armco Steel Corp.....	Middletown, Ohio 45042...	.....do.....	Boyd.
<b>Natural gas:</b>			
<b>Processors:</b>			
Columbia Hydrocarbon Corp.	South Shore, Ky. 41175....	Processing plant....	Greenup.
Kentucky Hydrocarbon Corp.	Box 128 Langley, Ky. 41645	.....do.....	Floyd.
Kentucky-West Virginia Gas Co.	Allen, Ky. 41601.....	.....do.....	Do.
Tennessee Gas Pipeline Co.	Box 7 Greensburg, Ky. 42743	.....do.....	Green.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Natural gas—Continued			
Producers:			
Inland Gas Co.-----	340 17th St. Ashland, Ky. 41101	Natural gas wells...	Various.
Kentucky-West Virginia Gas Co.	Second National Bank Bldg. Ashland, Ky. 41101	....do.....	Do.
Petroleum Exploration Co.	Leeco Road Leeco, Ky. 41313	....do.....	Do.
Texas Gas Trans- mission Co.	Owensboro, Ky. 42301-----	....do.....	Do.
United Fuel Gas Co..	Box 1273 Charleston, W. Va. 25325	....do.....	Do.
Perlite, expanded:			
Grefco, Inc.-----	Box 35 Florence, Ky. 41042	Plant.....	Boone.
W. R. Grace & Co.-----	62 Whittemore Ave. Cambridge, Mass. 02140	....do.....	Campbell.
Petroleum:			
Producers:			
Ashland Oil Refining Co.	1409 Winchester Ave. Ashland, Ky. 41101	Crude oil wells.....	Various.
Har-Ken Oil Co.-----	Box 616 Owensboro, Ky. 42301	....do.....	Do.
Humble Oil and Refining Co.	2010 West Ohio St. Evansville, Ind. 47712	....do.....	Do.
Sinclair Oil and Gas Co.	300 Fidelity National Bank Bldg. Oklahoma City, Okla. 73102	....do.....	Do.
Sun Oil Co.-----	Box 5026, Lawnsdale Evansville, Ind. 47715	....do.....	Do.
Refineries:			
Ashland Oil and Refining Co.	1409 Winchester Ave. Ashland, Ky. 41101	Refinery.....	Boyd.
Kentucky Oil and Refining Co.	Box 325 Betsy Layne, Ky. 41605	....do.....	Floyd.
Louisville Refining Co..	1300 South Western Park- way Louisville, Ky. 40212	....do.....	Jefferson.
The Somerset Refinery, Inc.	520 Monticello St. Somerset, Ky. 42501	....do.....	Pulaski.
Sand and gravel:			
Evansville Materials, Inc..	624 NW. Riverside Dr. Evansville, Ind. 47708	Dredge.....	Henderson.
Ingram Materials, Inc. ....	Box 1049 4304 Harding Road Nashville, Tenn.	....do.....	Livingston.
Nugent Sand Co.-----	Box 6072 Louisville, Ky. 40206	....do.....	Jefferson.
Ohio River Sand Co., Inc..	129 River Road Louisville, Ky. 40206	....do.....	Do.
Standard Materials Corp..	11 North Penn St. Indianapolis, Ind. 46204	Open pit mine and plant.	Trimble.
Stone:			
Limestone, crushed:			
Ken-mor Stone, Inc....	Box 482 Georgetown, Ky. 40324	5 quarries.....	Carter, Morgan, Rowan.
Kentucky Stone Co....	400 Sherburn Lane Louisville, Ky. 40207	5 underground mines and 7 quarries.	Various.
Reed Crushed Stone Co., Inc.	Box 35 Gilbertsville, Ky. 42044	1 quarry.....	Livingston.
Three Rivers Rock Co.	Box 218 Smithland, Ky. 42081	....do.....	Do.
Vulcan Materials Co..	Box 7 Knoxville, Tenn. 37901	3 quarries.....	Fayette, Jefferson.
Quartzite:			
Industrial Minerals Co., Inc.	Salem, Ky. 42078-----	1 quarry.....	Livingston.
Vermiculite, exfoliated:			
W. R. Grace & Co.-----	62 Whittemore Ave. Cambridge, Mass. 02140	Plant.....	Campbell.



# The Mineral Industry of Louisiana

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

By S. O. Wood, Jr.<sup>1</sup> and Leo W. Hough<sup>2</sup>

Louisiana mineral output value in 1970 was \$5,102 million, an 8.9-percent increase from 1969. For the 13th consecutive year, Louisiana ranked second in domestic mineral production value. Production records were established for crude petroleum, natural gas, natural gas liquids, clays, lime, and secondary lead.

Mineral fuels—crude petroleum, natural gas, and natural gas liquids—provided 95.6 percent of the total value of mineral output. According to American Petroleum In-

stitute (API) estimates, proved reserves of crude oil at yearend 1970 were 5,710 million barrels, an increase of 21 million barrels from yearend 1969. Crude oil reserves added from the revisions and extensions category were 609 million barrels. New field discoveries accounted for the addition of 125 million barrels of proved reserve, and new-pool discoveries in old fields added 68 million barrels. Louisiana was one of the few States that had a net increase in proved crude oil reserves.

Table 1.—Mineral production in Louisiana<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays..... thousand short tons..	1,078	\$2,943	1,080	\$1,575
Lime..... do.....	822	10,750	1,025	12,811
Natural gas..... million cubic feet..	7,227,826	1,387,743	7,788,276	1,503,137
Natural gas liquids:				
Natural gasoline and cycle products				
thousand 42-gallon barrels..	53,565	171,434	56,526	174,632
LP gases..... do.....	71,867	96,302	80,385	138,262
Petroleum (crude)..... do.....	844,603	2,791,269	906,907	3,061,558
Salt..... thousand short tons.....	12,435	61,102	13,584	64,854
Sand and gravel..... do.....	18,131	21,895	18,155	22,363
Stone (shell, 1969)..... do.....	9,237	11,892	9,056	11,660
Sulfur (Frasch process)..... thousand long tons..	3,999	108,299	3,618	89,489
Value of items that cannot be disclosed:				
Cement, gypsum, and miscellaneous stone (1969)....	XX	21,697	XX	21,980
Total.....	XX	4,685,326	XX	5,102,321
Total 1967 constant dollars.....	XX	4,424,353	XX	4,617,601

<sup>p</sup> Preliminary. XX Not applicable.

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

**Trends and Developments.**—The Louisiana Board of Commerce and Industry approved 10-year ad valorem tax exemptions for industrial investments totaling \$609.5 million, an increase of 5.3 percent over the 1969 investment value. Approved exemp-

tions included 63 new plants with an investment of \$332.5 million and 238 expansions totaling \$277.0 million. The largest project was the Gulf Oil Co. \$200 million

<sup>1</sup> Petroleum engineer, Division of Fossil Fuels.

<sup>2</sup> State geologist, Louisiana Geological Survey, Baton Rouge, La.

Table 2.—Value of mineral production in Louisiana, by parishes  
(Thousands)

Parish	1969	1970	Minerals produced in 1970 in order of value
Acadia	\$109,633	\$106,904	Natural gas, petroleum, natural gas liquids.
Allen	7,341	6,764	Petroleum, natural gas, natural gas liquids, sand and gravel.
Ascension	11,178	43,501	Natural gas liquids, petroleum, salt, natural gas.
Assumption	28,800	29,651	Natural gas, petroleum, natural gas liquids.
Avoyelles	5,732	4,420	Petroleum, natural gas liquids, natural gas, sand and gravel.
Beauregard	9,261	8,554	Petroleum, sand and gravel, natural gas, natural gas liquids.
Bienville	9,079	12,393	Natural gas, petroleum, sand and gravel, clays.
Bossier	22,972	19,502	Natural gas, petroleum, natural gas liquids, sand and gravel.
Caddo	26,246	24,222	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Calcasieu	61,156	66,168	Petroleum, natural gas, natural gas liquids, lime, salt, sand and gravel, Frasch sulfur.
Caldwell	2,516	3,088	Natural gas, petroleum.
Cameron	270,883	239,105	Natural gas, petroleum, natural gas liquids, salt, shell.
Catahoula	9,526	10,949	Petroleum, sand and gravel, natural gas.
Claiborne	31,525	25,011	Petroleum, natural gas, natural gas liquids, sand and gravel.
Concordia	29,216	23,894	Petroleum, natural gas, natural gas liquids.
De Soto	7,493	8,516	Natural gas, petroleum, sand and gravel.
East Baton Rouge	16,320	16,074	Cement, lime, petroleum, sand and gravel, natural gas, clays.
East Carroll	28	7	Sand and gravel.
East Feliciana	W	W	Do.
Evangeline	10,460	9,829	Petroleum, natural gas, natural gas liquids, sand and gravel.
Franklin	2,185	2,108	Petroleum, natural gas.
Grant	2,875	845	Sand and gravel, petroleum, natural gas.
Iberia	235,463	216,385	Petroleum, natural gas, salt, natural gas liquids.
Iberville	60,166	61,881	Petroleum, salt, natural gas, natural gas liquids, sand and gravel.
Jackson	2,350	1,815	Natural gas, petroleum, sand and gravel.
Jefferson	303,743	231,773	Petroleum, Frasch sulfur, natural gas, natural gas liquids, sand and gravel, salt.
Jefferson Davis	55,846	53,796	Natural gas, petroleum, natural gas liquids, sand and gravel.
Lafayette	18,297	20,887	Do.
Lafourche	474,939	515,299	Petroleum, natural gas, Frasch sulfur, natural gas liquids.
La Salle	21,970	25,075	Petroleum, natural gas, sand and gravel.
Lincoln	31,862	19,659	Natural gas liquids, natural gas, petroleum, sand and gravel, clays.
Livingston	512	512	Sand and gravel.
Madison	912	1,205	Petroleum, sand and gravel, natural gas.
Morehouse	11,202	1,907	Natural gas, petroleum.
Natchitoches	29,248	27,814	Petroleum, natural gas liquids, natural gas, sand and gravel, clays.
Orleans	17,128	18,188	Cement, lime, shell, petroleum, natural gas, sand and gravel.
Ouachita	20,961	6,461	Natural gas, natural gas liquids, sand and gravel, petroleum.
Plaquemines	1,059,429	1,244,997	Petroleum, natural gas, Frasch sulfur, natural gas liquids, salt, sand and gravel.
Pointe Coupee	30,378	31,162	Petroleum, natural gas, natural gas liquids, clays.
Rapides	7,643	7,003	Petroleum, sand and gravel, natural gas, clays.
Red River	473	3,498	Petroleum, sand and gravel, natural gas.
Richland	16,819	18,484	Petroleum, natural gas, natural gas liquids.
Sabine	2,021	1,356	Petroleum, sand and gravel, natural gas.
St. Bernard	27,659	30,270	Petroleum, natural gas liquids, natural gas, sand and gravel, clays.
St. Charles	84,852	90,370	Petroleum, natural gas, natural gas liquids.
St. Helena	1,932	W	Sand and gravel, clays.
St. James	10,360	9,345	Petroleum, natural gas, natural gas liquids.
St. John the Baptist	4,928	6,930	Petroleum, natural gas.
St. Landry	50,956	48,283	Natural gas, petroleum, natural gas liquids.
St. Martin	89,122	88,187	Petroleum, natural gas, natural gas liquids, salt, sand and gravel, clays.
St. Mary	390,233	473,513	Petroleum, natural gas, natural gas liquids, salt, shell, lime, sand and gravel.
St. Tammany	6,875	6,468	Shell, sand and gravel, natural gas, petroleum, clays.
Tangipahoa	2,006	2,276	Sand and gravel, petroleum, clays.
Tensas	7,554	8,463	Petroleum, natural gas, natural gas liquids.
Terrebonne	626,619	756,968	Petroleum, natural gas, natural gas liquids, Frasch sulfur, salt.
Union	1,873	8,583	Natural gas, petroleum, sand and gravel.
Vermilion	259,542	311,444	Natural gas, petroleum, natural gas liquids, sand and gravel.

See footnote at end of table.

Table 2.—Value of mineral production in Louisiana, by parishes—Continued  
(Thousands)

Parish	1969	1970	Minerals produced in 1970 in order of value
Vernon.....	\$348	\$308	Sand and gravel.
Washington.....	1,477	1,365	Do.
Webster.....	32,079	30,138	Natural gas, natural gas liquids, petroleum, sand and gravel.
West Baton Rouge.....	4,382	2,603	Petroleum, natural gas, clays, sand and gravel.
West Carroll.....	25	40	Natural gas.
West Feliciana.....	W	W	Sand and gravel.
Winn.....	5,050	3,156	Petroleum, stone, gypsum, natural gas, sand and gravel.
Undistributed.....	1,667	2,949	
Total.....	4,685,326	5,102,321	

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

refinery in Plaquemines Parish, about 20 miles south of New Orleans.

Petroleum refining and chemical facilities dominated industrial investment and accounted for \$465.9 million, 76 percent of the total. In addition to the Gulf Oil Co. refinery, some of the larger projects approved by the Board in this category were a new \$10.5 million plastics facility near

Donaldsonville by Melamine Chemicals, Inc., a \$43.6 million chemical complex expansion by Hercules, Inc., at Lake Charles, additions by Cities Service Co. to its Lake Charles chemical facilities totaling \$34.5 million, and a \$25 million expansion of alumina and caustic operations by Kaiser Aluminum and Chemical Corp., near Gramercy.

Table 3.—Indicators of Louisiana business activity

	1969	1970	Change, percent
Employment and labor force, annual average:			
Total labor force.....thousands..	1,362.0	1,371.9	+ .7
Unemployment.....do.....	68.5	85.1	+24.2
Employment:			
Contract construction.....do.....	78.7	73.9	-6.1
Mining.....do.....	52.0	51.0	-1.9
Manufacturing.....do.....	180.9	175.7	-2.9
Total all industries <sup>1</sup> .....do.....	729.4	745.5	+2.2
Personal income:			
Total.....millions..	\$10,413	\$11,199	+7.5
Per capita.....do.....	\$2,780	\$3,065	+10.3
Construction activity:			
Total private nonresidential building.....millions..	\$128.9	\$231.4	+79.5
Highway construction contracts awarded.....do.....	\$210.2	\$167.4	-20.4
Cement shipments to and within Louisiana thousand 376-pound barrels..	11,699	10,118	-13.5
Farm marketing receipts.....millions..	\$572	\$640	+11.9
Mineral production.....do.....	\$4,685.3	\$5,102.3	+8.9

<sup>1</sup> Transportation and public utilities; wholesale and retail trade; finance, insurance, and real estate; services; and government included.

Sources: Employment and Earnings; Survey of Current Business; Construction Review; Area Trends in Employment and Unemployment; Farm Income Situation; Louisiana Business Review; Louisiana Labor Market; Roads and Streets; Bureau of Mines.

Investment in metals production, fabrication, and machinery was \$43.7 million, 7 percent of the total. Other categories with sizable expenditures were electric power production, \$31.5 million; lumber and wood products, \$24.2 million; pulp and paper, \$18.4 million; and food processing, \$15.4 million.

The reserve natural-gas-producing capacity of Louisiana decreased substantially. In fact gas supply for some industries in the very heart of gas-producing areas was re-

stricted not only during the winter months but also during summer while storage facilities were being recharged. A fuel supply availability examination by Middle South Utilities, Inc., indicated that natural gas was not available in quantities sufficient to meet its system's present or future needs. Thus, new sources of supply are to be developed for alternative fuels—fuel oil as a standby for existing units and as primary fuel for some new units, and coal for some future plants. A portion of the corpora-



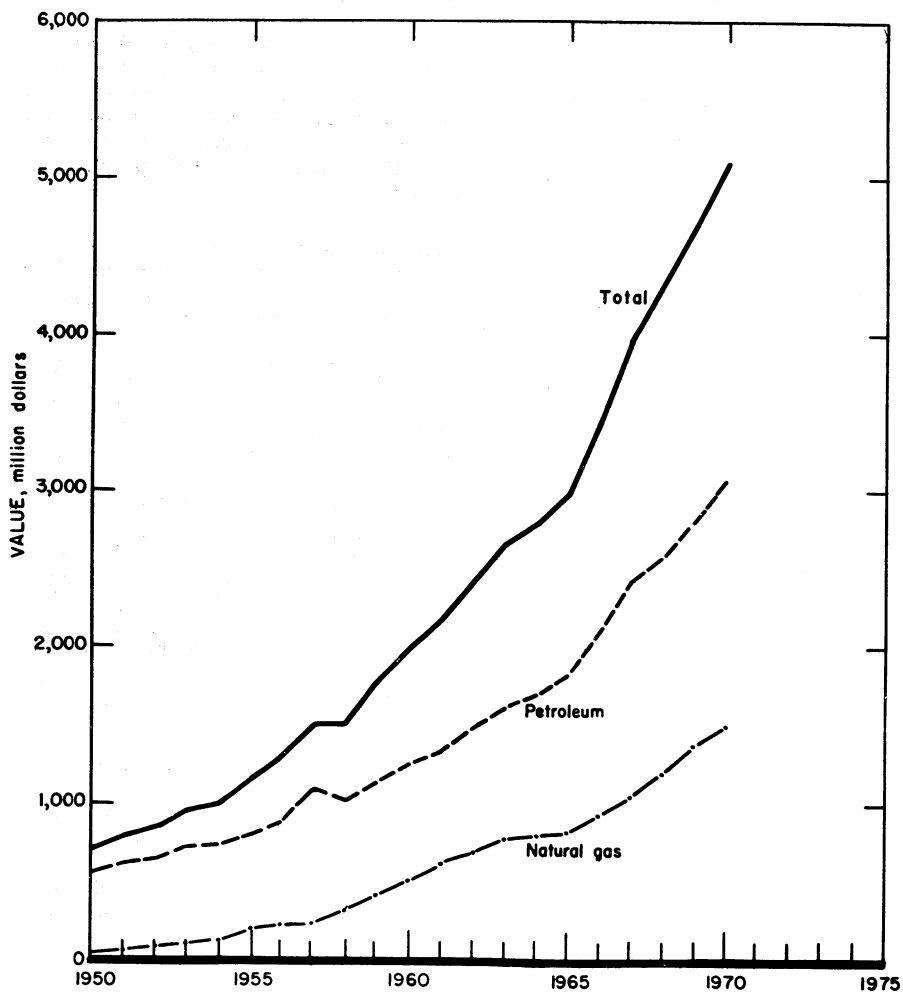


Figure 1.—Value of petroleum, natural gas, and total value of mineral production in Louisiana.

tion's future generating capability will be from nuclear-fueled units.

New Orleans continued as the Nation's second largest port in value of waterborne foreign trade. This port, the hub of a 12,000-mile waterway system, handled about 90 million tons of domestic waterborne commerce and \$2.8 billion in foreign trade during fiscal year 1970.

The U.S. Army Corps of Engineers continued deepening the Black and Ouachita Rivers to a navigable depth of 9 feet. Two of four new locks and dams in this project are in Louisiana. One lock and dam at Columbia, La., was completed, and the lock and dam at Jonesville, La., was scheduled for completion in 1971.

A fire occurred at a Chevron Oil Co. unattended offshore oil production platform about 75 miles southeast of New Orleans in the Main Pass Block 41 field on February 10, 1970. This mishap adversely affected offshore petroleum developments not only in the Gulf of Mexico but also in other coastal areas of the Nation. The Department of the Interior suspended some production and drilling operations. The Department also suspended or delayed the sale of offshore oil and gas leases on Federal lands, and sent personnel to inspect every well in the area. Several companies were fined for failure to install subsurface safety valves in conformance with Federal regulations. A subsequent fire on a Shell Oil Co. platform in December again focused critical attention on the production of oil and gas from offshore areas.

#### **Legislation and Government Programs.**

—The dispute between Louisiana and the Federal Government over the location of Louisiana's offshore boundary continued. An attorney, Walter P. Armstrong, Jr., was appointed by the U.S. Supreme Court as special master, to help draw the Federal-State boundary off the coast of Louisiana. Evidence was presented at a hearing that commenced in September; however, a decision was not expected before late 1971 or early 1972. Another boundary dispute involved the exact location of the Louisiana-Texas line in the Sabine River between Louisiana and Texas. Special Supreme Court Master Robert Van Pelt took under advisement arguments from the two States for resolving the disputed boundary. In December, the Acting Secretary of the Interior delegated to Federal

oil and gas supervisors the authority to regulate operations of oil and gas leases in the undisputed areas of the Outer Continental Shelf. In the exercise of this jurisdiction the Acting Secretary rescinded and revoked the notice of December 30, 1966, directing compliance with orders, rules, or regulations promulgated by any State or agency or subdivision thereof relating to conservation, including rates of production.

The Legislature of Louisiana enacted Act 599 to provide that the State could take in kind the portion due it as royalty of any minerals produced and saved from premises leased by the State Mineral Board. The act also stipulated that minimum royalty on all minerals except sulfur and potash would be one-eighth. Minimum royalty stipulated for sulfur was 75 cents per long ton, and minimum potash royalty was 10 cents per ton.

**Employment and Injuries.**—Employment in petroleum production, refining, and related industries averaged 80,850 persons, a decrease of 1,750 from 1969. Employment in these industries accounted for 93 percent of both total employment and total wages in the mineral industry.

There was an increase in the number of fatalities in mineral industry operations from 1969. Four men died as the result of a roof fall at the Jefferson Island mine of Diamond Crystal Salt Co. in February. An 80- by 120-foot area of roof ranging from 1 to 5 feet in thickness fell on the men. Diamond Crystal Salt Co. and other operators in the area have installed roof bolts and metal bearing plates to minimize the danger of future similar occurrences. A fire and explosion at the Wanda Petroleum Co. Belle River Terminal, on the Industrial Canal about 15 miles north of Morgan City, claimed four lives and left seven injured. An explosion in the living quarters of a Shell Oil Co. platform about 80 miles off the south Louisiana coast resulted in the death of three men and injury to six others. A ruptured glycol reboiler on a Humble Oil and Refining Co. offshore platform, about 27 miles south of Grand Isle, spilled hot liquid over a 14-man crew. Two men were fatally injured and the other 12 had varying degrees of burns and injuries.

A well undergoing remedial work by Shell Oil Co., 10 miles offshore, some 60 miles south of New Orleans, blew out and

caught fire in December. The mishap resulted in the death of three men; one man was missing and presumed dead, and 37 persons were injured, some critically. At yearend, the platform and several of the 22 wells continued to burn while relief wells were being drilled.

A natural gas explosion in the business district of Houma in January resulted in the death of three city employees investigating a leak. Twenty-five people were treated for injuries, mainly cuts from flying glass.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non-fatal	Frequency	Severity
<b>1969:</b>								
Metal.....	1,099	365	401	3,057	--	14	4.58	169
Nonmetal.....	2,103	295	621	5,062	2	118	23.71	3,759
Sand and gravel.....	1,214	243	295	2,594	2	51	20.43	5,080
Stone.....	584	325	190	1,759	--	24	13.65	331
Total.....	5,000	301	1,507	12,472	4	207	16.92	2,670
<b>1970: <sup>p</sup></b>								
Metal.....	1,235	365	451	3,609	1	17	4.99	1,908
Nonmetal.....	1,995	290	578	4,674	6	99	22.46	8,213
Sand and gravel.....	1,170	241	282	2,590	1	49	19.30	3,015
Stone.....	545	315	172	1,684	--	44	26.13	1,051
Total <sup>1</sup> .....	4,945	300	1,483	12,558	8	209	17.28	4,368

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

Table 5.—Total wage and salaried workers in petroleum production, refining, and related industries

Year	Crude petroleum and natural gas production	Petroleum refining <sup>1</sup>	Pipeline transportation (except natural gas)	Chemical and allied products <sup>2</sup>
1966.....	47,200	9,200	900	20,200
1967.....	47,100	9,800	900	21,500
1968.....	47,800	10,400	900	21,900
1969.....	47,700	10,500	900	23,500
1970 <sup>p</sup> .....	46,250	10,300	900	23,400

<sup>p</sup> Preliminary.

<sup>1</sup> Employment in chemical and petroleum refineries and petrochemicals manufactured in petroleum refineries.

<sup>2</sup> Employment in chemical and petrochemical manufacturing facilities located outside petroleum refineries.

Source: Louisiana State Department of Labor, Division of Employment Security.

## REVIEW BY MINERAL COMMODITIES

### MINERAL FUELS

New highs of production and value were established for mineral fuels. The combined value of crude petroleum, natural gas, and natural gas liquids was \$4,878 million, 95.6 percent of the entire mineral production value. The average price of petroleum (crude) increased 2.4 percent to \$3.38 per barrel and crude petroleum output accounted for 60.0 percent of the total mineral value. Natural gas and natural gas liquids contributed 29.5 and 6.1 percent respectively of the State's mineral value.

At yearend, oilfields and gasfields had a

total of 35,237 productive wells, according to the Louisiana Department of Conservation. North Louisiana had 12,990 oil and 4,522 natural gas wells, onshore south Louisiana 10,040 oil and 3,448 natural gas wells, and offshore Louisiana 3,311 oil and 926 natural gas wells. Because of the assumption of operational responsibilities in the Outer Continental Shelf by the Federal Government, approximately 1,515 oil and 745 gas wells on leases situated entirely in offshore zone 4 were not included in the yearend well count published by the Louisiana Department of Conservation.

*Leasing Activity.*—The Louisiana State Mineral Board approved leases covering 104,542 acres at monthly sales during the year. Lease bonus from these sales totaled \$8.28 million, an average of \$79 per acre.

North Louisiana leasing activity was concentrated in the northern and northeastern parishes along the general trend of Smack-over Formation oil and gas production. Lease bonuses generally ranged from \$5 to \$50 per acre.

South Louisiana leasing activity occurred in Vermilion, Jefferson Davis, Acadia, and Lafayette Parishes following discovery of gas and condensate production in deeper (Oligocene) reservoirs in the Perry Point field.

More than 1 million acres were leased in southeast Louisiana during the first half of 1970, and geophysical activity in this area increased markedly.

In compliance with the National Environmental Policy Act of 1969, a public hearing was held July 14–16, 1970, to consider the environmental aspects of a proposed Federal sale of oil and gas leases on "wildcat" acreage offshore Louisiana. The Department of the Interior concluded that the Nation's need for oil and gas outweighed the environmental objections and held its first "wildcat" lease offering in more than 2 years. Of the 127 tracts containing about 593,500 acres offered for leasing on December 15, 1970, bids were accepted on 116 tracts. High bids for the sale totaled \$851 million, an average of \$1,434 per acre. The most expensive lease per acre was the 2,500-acre East Cameron Block 270, which was sold to a group com-

posed of POGO (Pennzoil Offshore Gas Operators, Inc.), Mesa Petroleum Co., Texas Production, and Mobil Oil Corp. Their bid was \$32.2 million, or \$12,875 per acre. Trans Ocean, Inc., a subsidiary of Swift & Company, led a combine that offered the largest bid. The combine bid \$38.2 million (\$7,637 per acre) for a lease on the 5,000-acre Eugene Island Block 296.

*Exploration, Development, and Reserves.*—According to the Louisiana Geological Survey, there were 3,030 wells drilled in Louisiana, including the offshore zone 4 area, through December 4, 1970. Footage drilled was 25 million feet, an average of 8,286 feet per well. Onshore drilling accounted for 2,153 wells and 16 million feet of hole. Offshore drilling accounted for 877 wells and 9 million feet of hole, an average depth of 10,168 feet per well.

Exploratory drilling accounted for a total of 405 wells—316 onshore and 89 offshore. Of the 316 exploratory onshore wells, 11 were completed to produce oil, 11 were completed as gas producers, and 294 wells, or 93 percent, were dry. Of the 89 offshore exploratory wells, two were completed to produce oil, six were gas productive, and 81 wells, 91 percent, were dry. Proved-field well drilling accounted for 2,625 wells, of which 1,837 or 70 percent were onshore. Of the onshore proved-field wells, 766 were oil productive, 418 were gas productive, and 653, or 35 percent, were dry holes. Of the 788 proved-field wells drilled offshore, 354 were completed to produce oil, 201 were gas productive, and 233, or 30 percent, were dry holes.

Table 6.—Louisiana: Oil and gas well drilling, by parish and offshore area <sup>1</sup>

Location	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
North:								
Bienville.....	--	14	2	--	1	5	22	180,986
Bossier.....	36	2	15	--	--	4	57	80,079
Caddo.....	116	8	34	--	--	5	163	307,962
Caldwell.....	--	4	5	--	--	7	16	43,482
Catahoula.....	12	--	17	1	--	21	51	256,720
Claiborne.....	6	8	5	--	--	5	24	214,355
Concordia.....	13	--	26	--	--	23	62	391,390
De Soto.....	10	26	21	--	--	1	58	206,804
East Carroll.....	--	--	--	--	--	2	2	9,239
Franklin.....	2	--	1	--	--	1	4	15,134
Grant.....	--	--	3	--	--	3	6	20,039
Jackson.....	--	2	1	--	--	4	7	49,047
La Salle.....	34	13	59	1	--	11	118	360,792
Lincoln.....	--	1	--	--	1	--	2	20,232
Morehouse.....	--	72	5	--	--	1	78	180,421
Natchitoches.....	1	3	6	1	--	1	12	63,641
Ouachita.....	--	9	2	--	--	1	12	50,814
Red River.....	13	1	4	1	--	3	22	66,346

See footnote at end of table.

Table 6.—Louisiana: Oil and gas well drilling, by parish and offshore area<sup>1</sup>—Continued

Location	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
<b>North—Continued</b>								
Richland	2	16	12	--	--	1	31	79,260
Sabine	5	--	6	--	--	1	12	35,672
Tensas	--	1	5	--	--	2	8	63,214
Union	--	9	1	--	--	3	13	48,045
Webster	2	2	3	--	--	2	9	80,171
West Carroll	--	--	--	--	--	3	3	10,049
Winn	27	--	6	--	1	10	44	91,490
<b>Total</b>	<b>279</b>	<b>191</b>	<b>239</b>	<b>4</b>	<b>3</b>	<b>120</b>	<b>836</b>	<b>2,925,384</b>
<b>South:</b>								
Acadia	7	17	22	--	1	10	57	619,947
Allen	1	1	5	--	--	--	7	72,492
Ascension	3	3	7	--	--	2	15	128,995
Assumption	1	7	9	--	--	9	26	356,904
Avoyelles <sup>2</sup>	3	--	5	--	--	5	11	80,579
Beauregard	3	1	9	--	--	8	21	198,397
Calcasieu	19	8	27	1	--	8	63	556,285
Cameron	25	24	44	--	1	13	107	1,149,978
East Baton Rouge	2	--	--	--	--	2	4	42,497
East Feliciana	--	--	--	--	--	1	1	15,020
Evangeline	2	3	2	--	--	2	9	97,454
Iberia	22	7	24	1	--	6	60	572,180
Iberville	18	4	12	--	1	6	41	416,757
Jefferson	22	5	4	--	--	8	39	368,479
Jefferson Davis	7	16	26	--	--	3	52	551,454
Lafayette	4	4	1	--	--	2	11	120,181
Lafourche	59	18	29	--	--	11	117	1,171,982
Livingston	--	1	1	--	--	1	2	19,020
Orleans	--	2	1	1	--	1	5	49,443
Plaquemines	64	24	27	--	1	15	131	1,289,759
Pointe Coupee	4	1	3	1	--	3	12	142,330
Rapides <sup>2</sup>	6	--	14	--	--	1	21	156,798
St. Bernard	2	--	3	--	--	9	14	147,778
St. Charles	22	7	4	--	--	4	37	389,244
St. Helena	--	--	--	--	--	2	2	31,169
St. James	--	2	6	--	--	5	13	154,119
St. John the Baptist	--	--	1	--	--	3	4	43,890
St. Landry	3	3	4	--	--	4	14	151,852
St. Martin	50	7	31	2	--	6	96	694,326
St. Mary	57	17	22	--	--	3	99	1,061,614
St. Tammany	--	--	--	--	--	1	1	11,857
Terrebonne	76	32	44	--	1	12	165	1,614,944
Vermilion	4	14	23	--	3	5	49	675,463
Vernon <sup>2</sup>	--	--	--	--	--	1	1	15,723
West Baton Rouge	3	--	4	1	--	2	10	94,931
<b>Total</b>	<b>487</b>	<b>227</b>	<b>414</b>	<b>7</b>	<b>8</b>	<b>174</b>	<b>1,317</b>	<b>13,263,841</b>
<b>Offshore:<sup>3</sup></b>								
Bay Marchand	29	1	11	--	--	--	41	438,229
Breton Sound	3	2	--	--	--	11	16	131,193
Chandeleur Sound	--	--	2	--	--	8	10	87,690
East Cameron	--	11	5	--	1	3	20	247,845
Eugene Island	30	54	31	--	1	2	118	1,104,084
Grand Isle	14	13	13	--	1	3	44	549,961
Main Pass	95	14	23	--	2	13	147	1,206,601
Marsh Island	--	1	--	--	--	--	1	10,830
Ship Shoal	48	25	44	--	--	2	119	1,334,173
South Marsh Island	8	9	14	1	--	--	32	391,968
South Pass	64	2	25	--	--	13	104	943,319
South Pelto	1	1	1	--	--	--	3	40,663
South Timbalier	12	22	9	--	--	5	48	512,776
Vermilion	8	4	12	--	1	16	41	428,951
West Cameron	2	37	18	--	--	5	62	693,077
West Delta	40	5	25	1	--	--	71	796,176
<b>Total</b>	<b>354</b>	<b>201</b>	<b>233</b>	<b>2</b>	<b>6</b>	<b>81</b>	<b>877</b>	<b>8,917,536</b>
<b>Grand total</b>	<b>1,120</b>	<b>619</b>	<b>886</b>	<b>13</b>	<b>17</b>	<b>375</b>	<b>3,030</b>	<b>25,106,761</b>

<sup>1</sup> A multiple completed well is counted as 1 well.<sup>2</sup> Partly in north Louisiana.<sup>3</sup> Includes zone 4 data through December 4, 1970.

Source: Louisiana Geological Survey.

Table 7.—Louisiana: Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

Commodity	Proved reserves Dec. 31, 1969	Changes in proved reserves, due to extensions and discoveries in 1970	Proved reserves Dec. 31, 1970 (production deducted)	Change from 1969 (percent)
Crude oil.....thousand barrels..	5,689,150	476,059	5,710,320	+1.0
Natural gas liquids.....do.....	2,570,298	160,880	2,566,980	-.1
Natural gas.....million cubic feet..	85,056,639	4,563,682	82,956,688	-2.5

Source: American Petroleum Institute.

New discoveries in north Louisiana, according to the Louisiana Geological Survey, included four fields productive from Wilcox Formation reservoirs: Hudson Brake in Catahoula Parish, East Muddy Bayou in La Salle Parish, and Galbraith in Natchitoches Parish were oil productive; and Flat Creek in Winn Parish was gas productive. Cretaceous age field discoveries were Des Arc (oil) in Red River Parish, and Fryeburg (gas) in Bienville Parish. The Middlefork Field in Lincoln Parish was a Smackover Formation gas discovery.

South Louisiana oil discoveries included West Mystic Bayou and Lake Valerie in St. Martin Parish, Bayou Tommy in Point Coupee Parish, Southeast Avery Island in Iberia Parish, Southwest Manchester in Calcasieu Parish, Rebecca Bayou in West Baton Rouge Parish, and oil in the previously discovered Unknown Pass in Orleans Parish. South Louisiana gas discoveries included West Parcerperdue, North Buck Point, and Southwest Gueydan in Vermilion Parish, Lake Gero in Terrebonne Parish, Mermentau River in Acadia Parish, Big Mouth Bayou in Cameron Parish, Point Pleasant in Iberville Parish, and Crooked Bayou in Plaquemines Parish.

Offshore there were two oil and six gas discoveries. Oil discoveries were South Marsh Island Block 38 in zone 4 and West Delta Block 152 in zone 4. Gas discoveries included two discoveries not counted in pre-1970 statistics—East Cameron Block 51 in zone 3 and Vermilion Block 54 in zone 3. Other gas discoveries were Main Pass Block 127 in zone 4, Eugene Island Block 3 in zone 1, Main Pass Block 103 in zone 4, and Grand Isle Block 90 in zone 4.

Geophysical activity in north Louisiana declined about 40 percent. There was only 118 crew-weeks of seismic activity. Claiborne with 27 crew-weeks was the most active parish. Grant Parish with 24 crew-

weeks and Winn Parish with 22 crew-weeks were the other leaders. Increased activity in Winn and Grant Parishes indicates a renewal of interest in the area, possibly in Lower Cretaceous formations.

In south Louisiana onshore gravity meter crew-weeks increased from 33 to 67, according to the American Association of Petroleum Geologists. Overall geophysical activity declined, however, as seismic crew-weeks declined 33 percent to 747 crew-weeks. Offshore seismic activity also declined significantly, 47 percent. Total activity in south Louisiana offshore and onshore was 1,107 crew-weeks, a 35-percent reduction in activity from the previous year.

According to the API, proved reserves of crude oil, 5,710 million barrels at yearend 1970, reached an alltime high and continued an annual growth in reserves that has been uninterrupted for more than two decades. Natural gas reserves declined for the second year. At yearend gas reserves were slightly less than 83 trillion cubic feet. Natural gas liquids reserves also declined for the second year, to 2,567 million barrels at yearend. Louisiana's share of total U.S. reserves at yearend 1970 was crude oil, 14.6 percent; natural gas liquids, 33.3 percent; and natural gas, 28.5 percent.

**Carbon Black.**—Production was 982 million pounds, a 6.1-percent decrease from the alltime high of 1,046 million pounds in 1969. Contributing toward the lower production in 1970 was the decreased availability of heavy oil raw material. However, production was curtailed principally because of strikes in the rubber and automotive industries. About 94 percent of carbon black production was utilized in the manufacture of rubber. Nationwide, Louisiana ranked second in the production of carbon black and accounted for approximately one-third of total output. Average

unit value of 7.18 cents per pound was 6 percent higher than in 1969. During 1970 Cabot Corp. increased daily capacity of its plant in Evangeline Parish by 30,000 pounds, and Ashland Chemical Co. increased daily capacity of its Ivanhoe plant in St. Mary Parish by 50,000 pounds. All carbon black produced in Louisiana was from furnace plants. Estimated capacity of the nine plants in Louisiana was 3.5 million pounds, and production was 75 percent of capacity. There were three plants in St. Mary Parish, two in Ouachita Parish, and one each in Avoyelles, Calcasieu, Evangeline, and West Baton Rouge Parishes.

**Table 8.—Louisiana: Carbon black production and value**  
(Million pounds and million dollars)

Year	Quantity	Value
1966	899	\$60.5
1967	923	61.1
1968	1,031	70.4
1969	1,046	70.8
1970	982	70.6

Carbon black yield from 24.4 billion cubic feet of gas was 268 million pounds, an average of 11.0 pounds per 1,000 cubic feet of gas. From 150.6 million gallons of liquid hydrocarbon raw material, carbon black yield was 714 million pounds, an average of 4.7 pounds per gallon of raw material.

A tire reclamation project was jointly developed by Goodyear Tire and Rubber

Co. and Cities Service Oil Co. to utilize junked tires as a source of carbon black for use in tire manufacture. Large-scale development of reclamation of carbon black from tires could affect significantly the raw material requirements for carbon black production.

**Natural Gas.**—Marketed production was 7,788 billion cubic feet, a 7.8-percent increase from 1969. Louisiana ranked second in marketed gas production nationwide and accounted for 35.5 percent of the U.S. total.

A survey of shut-in wells in southern Louisiana was made in response to contentions made before a Senate committee and the Federal Power Commission that vast reserves of natural gas were being withheld from the market awaiting higher prices. Survey results indicated that of the 2,588 gas completions shut in as of December 31, 1969, only 128 were not committed to sales contracts. Of the uncommitted group, only 29 were considered to represent gas reserves that could economically become available to the interstate market. Contract negotiations were in progress for all of these completions.

A sharp increase in demand for natural gas resulted in the expansion of gathering and transmission pipeline systems.

Arkansas-Louisiana Gas Co. requested approval of the Federal Power Commission to construct a 35-mile, 36-inch line to its Lake Bistineau storage in Bienville, Bossier, and Webster Parishes.

**Table 9.—Louisiana: Natural gas data**  
(Million cubic feet)

Year	Withdrawals <sup>1</sup>			Marketed production <sup>2</sup>	Value at wells (thousands)	Disposition	
	From gas wells	From oil wells	Total			Repressuring	Vented and wasted <sup>3</sup>
1966	4,168,820	1,196,457	5,365,277	5,081,435	\$929,902	182,734	101,108
1967	5,070,825	1,016,600	6,087,425	5,716,857	1,057,619	208,719	161,849
1968	5,623,961	1,153,555	6,777,516	6,416,015	1,212,627	195,062	168,439
1969	6,305,897	1,255,130	7,561,027	7,227,826	1,387,743	174,349	158,852
1970	6,811,334	1,264,823	8,076,157	7,788,276	1,503,137	133,792	154,089

<sup>1</sup> Marketed production plus quantities used in repressuring, vented, and wasted.

<sup>2</sup> Comprises gas sold or consumed by producers, including losses in transmission, amounts added to storage, and increases in pipelines.

<sup>3</sup> Partly estimated. Includes direct waste on producing properties and residue blown to the air.

Columbia Gulf Transmission Co. continued to expand its system from Rayne, La., to Leach, Ky., by adding 225 miles of 36-inch line in 1970. Three loops totaling 43.7 miles are in Louisiana. Completion of the 1970 additions left less than 35 miles of line needed to complete the 850-mile

third line of the system. A 20,000-horsepower gas turbine, the most powerful in use for gas transmission service, was installed at the company's Centerville, La., compressor station.

Mississippi River Transmission Corp. added a 25-mile, 4-inch line from its new

underground gas storage project at West Unionville field to Lincoln Parish.

Sea Robin Pipeline Co. continued to expand and extend its gathering system. Construction completed during the year included a 26-mile, 20-inch line from Ship Shoal Block 222 to Ship Shoal Block 206; a 40-mile, 36-inch line from Henry, La., to the Vermilion area; a 24-mile, 24-inch line from South Marsh Island Block 33 to Eugene Island Block 206; and a 22-mile, 24-inch line from East Cameron Block 195 to East Cameron South Block 265.

Southern Natural Gas Co. added short spans of 12-inch lines to its system at Main Pass Blocks 144, 293, and 298. A 3-mile, 18-inch line was constructed to connect Main Pass Block 293 and Main Pass. The company completed a 68-mile, 30-inch line from Shadyside to White Castle and from White Castle to Franklinton. Another 30-inch line, 30 miles in length, was constructed from Lacombe, La., to Prentiss, Miss. The company received approval from the Federal Power Commission for a 29-mile, 26-inch loop line from Plaquemines Parish to Gate No. 6, 17 miles of 30-inch line from Gate No. 6 to Toca, La., and an additional 9 miles of 30-inch line from Toca, La., to Lacombe, La.

Southern Natural Gas Co. also completed a 16-mile, 30-inch line across Lake Pontchartrain near New Orleans.

Texaco, Inc., completed an 8.5-mile, 24-inch line from its Chalmette system to the Louisiana Power and Light Co. 9-mile point power generating plant near Westwego, La.

Texas Eastern Transmission Corp. installed 108 miles of 30-inch, 29 miles of 24-inch, 19 miles of 20-inch, and 22 miles of 12-inch pipelines from the offshore East Cameron area to its Gillis compressor station, about 10 miles north of Lake Charles.

Texas Gas Transmission Corp. installed 13 miles of 30-inch pipeline in Acadia and Lafayette Parishes, and Trunkline Gas Co. completed a 130-mile, 30-inch pipeline in the Ship Shoal area.

United Gas Pipeline Co. completed the installation of 51 miles of 30-inch line in Avoyelles, St. Landry, and Rapides Parishes to connect with its south to north Louisiana loop line. The company also installed 21.5 miles of 36-inch line in Lafayette and St. Landry Parishes.

Houston Natural Gas Corp. acquired Humble Gas Transmission Co., a former subsidiary of Humble Oil & Refining Co., and changed its name to Mid-Louisiana Gas Co. Included in the acquisition were 485 miles of transmission and gathering lines in eastern Louisiana and western Mississippi, more than 600 producing wells, and substantial gas reserves in the Monroe field.

**Natural Gas Liquids.**—Production again ranked second nationwide and set a new record for Louisiana. According to the annual Oil and Gas Journal survey,<sup>3</sup> there were 142 gas-processing plants in the State at yearend 1970. Total natural gas throughput capacity for these plants averaged 23,163 million cubic feet per day (MMcfd), 31 percent of the U.S. total. Plants in Louisiana processed an average of 19,343 MMcfd, equivalent to 84 percent of throughput capacity.

Natural gasoline and cycle products were recovered in 37 parishes at 136 gasoline and cycling plants and six fractionators. The refrigerated absorption process method was used in 51 percent of the plants, and the adsorption method was used in 28 percent of the plants. Production of natural gasoline and cycle products increased 5.5 percent, and unit value decreased 3.4 percent to \$3.09 per 42-gallon barrel. Production of liquefied petroleum gases increased 11.9 percent and unit value increased 28.4 percent, resulting in an increase of 43.6 percent in total value for this commodity from the previous year.

The 15.4-percent increase in plant throughput capacity, from 20,064 MMcfd to 23,163 MMcfd, resulted from the building of new plants and expansion of others.

Continental Oil Company added a 250-MMcfd ethane-recovery unit to its natural gas processing complex at Grand Chenier in Cameron Parish. The addition utilizes the gas expansion technique to achieve the low temperature needed for recovering liquids from the natural gas. Total processing capacity for the complex is about 1,000 MMcfd. Expected recovery at processing capacity is about 18,000 barrels per day of hydrocarbon liquids, principally propane, butane, and ethane.

Another increase of gas processing capability in Cameron Parish resulted from the

<sup>3</sup> Oil and Gas Journal, 1971 Survey of Gas-Processing Plants. V. 69, No. 28, July 12, 1971, p. 84.



construction of a 300-MMcfd cryogenic unit by Mobil Oil Corp.

Shell Oil Co. completed construction of its Calumet, St. Mary Parish, 1,200-MMcfd-capacity gas-processing plant. Anticipated production from this refrigeration-oil-absorber-type plant is 890,000 gallons per day of demethanized gasoline. In Terrebonne Parish, Shell Oil Co. started constructing a plant designed to process 100 MMcfd of gas and recover 130,000 gallons per day of demethanized gasoline. Plant completion is scheduled for March 1971. Shell Oil Co. added a fractionation plant adjacent to its Norco refinery. The plant processes feed stock from the Yscloskey and Toca gas processing plants. The plant was designed to produce propane, isobutane, normal butane, and debutanized gasoline. A major addition was made by Shell Oil Co. to its Yscloskey plant in St. Bernard Parish. A conventional mechanically refrigerated oil absorption plant having a gas-processing capacity of 1,200 MMcfd was added to existing facilities and increased processing capacity to 1,850 MMcfd. Another plant put into operation in St. Bernard Parish by Shell Oil Co. was designed to process 600 MMcfd of gas and produce 483,000 gallons daily of liquefied petroleum gases and gasoline.

Texaco, Inc., awarded a contract for construction of one of the largest cryogenic gas processing plants in the world 4 miles south of Morgan City. Design throughput plant capacity is 700 MMcfd, and anticipated recovery of natural gas liquids is

17,000 barrels daily. Wanda Petroleum Co. constructed a 50,000-barrel-per-day fractionating plant at Paincourtville. The plant was designed to transform raw liquefied petroleum into LP gases—propane, butane, isobutane, and gasoline.

**Petroleum.**—Crude petroleum production increased 7.4 percent to 906.9 million 42-gallon barrels. Nationwide, Louisiana ranked second in the production of crude petroleum and accounted for 25.8 percent of the U.S. total. With completion of the Coastal Production Co. No. 1 L. & N. Railroad well to produce 347 barrels of oil daily from a depth of 8,766 to 8,783 feet, Orleans became the 55th crude-petroleum-producing parish in Louisiana. Interruption of crude petroleum imports from Middle East countries resulted in higher demand for domestic production, and allowable market demand factors for 1970 were significantly higher than comparable 1969 factors. The monthly percent factors of the base depth bracket allowables for 1970 were January 46, February 47, March 48, April 48 initially and revised upward to 50, May 50, June 49, July 47, August 56, September 66, October 68, November 75, and December 75. The average monthly market demand factor in 1970 was 56.3 percent, compared with 36.8 percent in 1969.

A new world drilling-depth record was established by the drilling of State Lease 5407 well No. 1 in St. Bernard Parish to a depth of 25,600 feet by Placid Oil Co. and others. The well was drilled in 215 days by Penrod Drilling Co.

Table 10.—Louisiana: Crude petroleum production, indicated demand, and stocks in 1970, by months  
(Thousand 42-gallon barrels)

Month	Production	Indicated demand	End of month stocks originating within State
January	73,428	74,560	34,099
February	66,486	65,119	35,466
March	72,858	73,142	35,182
April	71,885	69,625	37,442
May	74,971	72,944	39,469
June	71,476	73,924	37,021
July	72,498	74,191	35,323
August	77,401	76,057	36,667
September	78,133	74,426	40,374
October	83,377	82,215	41,536
November	81,413	83,247	39,702
December	82,986	84,158	38,530
Total:			
1970	906,907	903,608	XX
1969	844,603	845,828	XX

XX Not applicable.

**Table II.—Louisiana: Number of producing oil wells and average production per well per day**

Year	Approximate number of producing wells, Dec. 31	Average production per well per day <sup>1</sup> (barrels)
1966-----	31,063	59.5
1967-----	30,670	69.2
1968-----	30,266	74.0
1969-----	29,393	78.7
1970-----	26,341	94.3

<sup>1</sup> Based upon number of wells producing Dec. 31.

<sup>2</sup> Does not include Federal leases entirely in zone 4.

The Louisiana Department of Conservation reported that production from secondary recovery projects was 225 million barrels, a 13-percent gain from the 199 million barrels in 1969. The total of 1,057 secondary-recovery projects in 177 fields accounted for 24.8 percent of the 1970 Louisiana production. During the year 147 projects were initiated, and 28 projects were abandoned, which raised the total number of abandonments to 368.

At yearend there were 12,561 "stripper" wells. Crude production from these wells was 8.47 million barrels, or a per well daily average of 1.85 barrels. Stripper wells accounted for 35.6 percent of the total number of wells, but production from these wells accounted for only 0.9 percent of the State's total.

**Refineries.**—At yearend there were 17 refineries in Louisiana. Crude oil throughput capacity increased from 1,253,150 barrels per calendar day in 1969 to 1,306,526 barrels per calendar day in 1970, according to The Oil and Gas Journal annual survey. The Bureau of Mines indicated that crude oil runs to stills in 1970 totaled 430.5 million barrels, a 1.6-percent increase from the comparable 423.8 million barrels in 1969.

Operators continued to construct and enlarge refining facilities in the State. Some notable changes in refining capability included the Canal Refining Co. addition of 1,250 barrels per day of catalytic reforming capacity to its refinery at Church Point. Cities Service Oil Co. began a \$7.5 million expansion at its refinery at Lake Charles in order to produce low-sulfur-content fuel oils and coke. A 25,000-barrel-per-day-hydrotreater to desulfurize fuel oil components was being added to supplement a previously constructed blend-oil hydrotreater. The company also started expanding the capacity of its H-oil unit from 2,500 to

6,000 barrels per day. Good Hope Refineries, Inc., increased refining capacity of its refinery at Good Hope to 10,000 barrels per calendar day. Gulf Oil Corp. continued construction of its 155,000-barrel-per-stream day refinery in Plaquemines Parish, about 20 miles south of New Orleans. Completion was scheduled for 1972. Murphy Oil Corp. increased refining capacity of its Meraux refinery to 33,500 barrels per stream day, and vacuum capacity was raised from 7,000 to 9,700 barrels per stream day. Tenneco Oil Co. expanded catalytic hydrotreating capacity of its Chalmette refinery from 6,000 to 24,000 barrels per stream day.

**Petrochemicals.**—This industry continued as one of the fastest growing segments of the State's economy. The Louisiana Board of Commerce and Industry approved applications totaling \$465.9 million for new and expanded construction of petroleum, chemical, and petrochemical facilities under Louisiana's 10-year ad valorem tax exemption plan. Some of the facilities being built or enlarged were as follows: American Cyanamid Co. was expanding its operation at Avondale with the addition of facilities to produce 70 million pounds of melamine annually. Conoco Chemicals Division of Continental Oil Co. started construction to increase output of alfol alcohol to more than 150 million pounds per year. The Lake Charles complex of Cities Service Oil Co. was being enlarged and further diversified in product output; at yearend facilities to produce 140 million pounds of methyl chloride annually were virtually completed, and construction of facilities to produce 500 million pounds of ethylene and 300 million pounds of propylene annually was well advanced. The Dow Chemical Co. completed a 400-million-ton-per-year ethylene oxide and ethylene glycol expansion at its Plaquemine plant. In the Lake Charles area, Firestone Synthetic Rubber and Latex Co. completed facilities to produce 50,000 tons per year stereo SBR. Foster Grant Co., Inc. completed a 500-million-pound-per-year styrene expansion at its Baton Rouge facilities. At yearend, Georgia Pacific Corp. was nearing completion of its Plaquemine complex; included were facilities for producing 1,000 tons per day of methanol from natural gas and 200 million pounds per year of phenol plus acetone byproduct from cumene. Goodyear Tire and Rubber Co. at yearend had vir-

Table 12.—Louisiana: Crude petroleum production by fields  
(Thousand 42-gallon barrels)

Field	1969	1970	Cumulative to Dec. 31, 1970
<b>Onshore:</b>			
Avery Island.....	2,733	3,177	66,275
Bay de Chene.....	4,230	5,391	49,721
Bay Ste Elaine.....	7,609	7,202	114,527
Bateman Lake.....	2,433	2,385	38,031
Bayou des Allemands.....	2,037	2,209	25,629
Bayou Salle.....	6,685	5,588	130,904
Black Bay East.....	3,195	3,543	19,618
Black Bay West.....	6,607	8,447	57,604
Black Lake.....	3,267	3,307	14,313
Bully Camp.....	2,408	3,548	35,288
Caddo-Fine Island.....	3,980	3,596	298,982
Caillou Island.....	29,594	32,379	411,336
Cote Blanche Bay West.....	10,533	12,770	100,103
Cote Blanche Island.....	5,941	7,622	49,127
Cut Off.....	2,903	3,208	17,801
Delhi-West Delhi.....	4,647	5,002	137,778
Delta Duck Club.....	2,990	3,125	39,945
Dog Lake.....	2,234	4,044	29,603
Duck Lake.....	2,977	2,437	50,510
Fordoche.....	3,890	3,743	24,160
Garden Island Bay.....	15,847	17,830	113,790
Golden Meadow.....	3,424	2,973	106,031
Grand Bay.....	5,886	5,823	129,525
Hackberry East.....	2,982	2,521	85,836
Hackberry West.....	4,295	3,800	104,763
Haynesville.....	2,055	2,432	140,469
Lafitte.....	10,986	11,438	178,562
Lake Barre.....	8,973	7,887	146,442
Lake Pelto.....	3,543	4,303	84,358
Lake Salvador.....	3,479	3,795	62,923
Lake Verret West.....	2,565	3,112	44,314
Lake Washington.....	10,727	11,097	175,305
Leeville.....	3,997	4,138	111,114
Paradis.....	4,393	2,820	91,260
Quarantine Bay.....	6,915	9,197	130,949
Romere Pass.....	3,740	3,654	68,721
Timbalier Bay.....	17,105	17,041	201,440
Venice.....	5,631	5,303	137,772
Vinton.....	2,049	2,110	111,257
Weeks Island.....	8,753	8,943	162,804
West Bay.....	10,328	9,856	143,360
White Castle.....	2,994	3,582	53,936
Other fields.....	158,902	228,281	5,113,888
<b>Total onshore.....</b>	<b>410,462</b>	<b>494,659</b>	<b>9,410,074</b>
<b>Offshore:</b>			
Bay Marchand Block 2.....	27,962	30,354	291,407
Breton Sound Block 20.....	2,171	2,268	19,557
Eugene Island Block 18.....	2,998	3,634	34,413
Eugene Island Block 126.....	5,659	5,404	68,743
Eugene Island Block 128.....	2,869	2,275	31,433
Eugene Island Block 188.....	3,304	3,003	22,352
Eugene Island Block 276.....	4,567	5,518	18,113
Grand Isle Block 16.....	20,719	20,866	137,158
Grand Isle Block 18.....	2,541	2,813	33,238
Grand Isle Block 41.....	4,360	5,266	14,254
Grand Isle Block 43.....	18,099	20,932	76,317
Grand Isle Block 47.....	3,520	4,212	49,117
Main Pass Block 35.....	4,181	3,956	68,484
Main Pass Block 41.....	18,757	19,682	83,734
Main Pass Block 69.....	11,041	11,639	148,417
Marsh Island South Block 6.....	2,581	3,055	12,355
Marsh Island South Block 73.....	4,179	4,179	18,423
Pelto South Block 20.....	2,140	2,359	13,327
Rabbit Island.....	4,779	6,757	18,192
Ship Shoal Block 107.....	3,495	3,580	31,966
Ship Shoal Block 113.....	3,477	4,806	14,115
Ship Shoal Block 154.....	2,898	3,793	25,005
Ship Shoal Block 207.....	4,160	7,142	12,206
Ship Shoal Block 208.....	10,444	11,185	41,790
South Pass Block 24.....	10,448	11,598	146,682
South Pass Block 27.....	20,015	21,905	196,205
South Pass Block 62.....	4,322	6,601	12,766
Timbalier Bay Block 21.....	18,514	18,692	109,384
Timbalier South Block 131.....	2,700	2,825	23,417
Timbalier South Block 135.....	17,340	17,665	87,519
Timbalier South Block 176.....	3,283	2,694	12,015
Vermilion Block 245.....	3,098	3,213	12,953

**Table 12.—Louisiana: Crude petroleum production, by fields—Continued**  
(Thousand 42-gallon barrels)

Field	1969	1970	Cumulative to Dec. 31, 1970
Offshore—Continued			
West Delta Block 30.....	23,192	24,725	215,055
West Delta Block 41.....	4,647	4,658	24,673
West Delta Block 73.....	17,838	16,238	78,967
West Delta Block 105.....	2,855	2,833	13,025
Other fields.....	134,988	89,923	469,739
Total offshore.....	434,141	412,248	2,686,516
Grand total.....	844,603	906,907	12,096,590

tually completed installation of facilities to increase polyvinyl chloride output at its Plaquemine plant to 100 million pounds per year. Gulf Oil Corp. started construction of a 500-million-pound-per-year styrene plant at its Donaldsonville complex; completion was scheduled for 1971. Hercules, Inc., was nearing completion of its Lake Charles plant expansion; polypropylene output will be increased to 180 million pounds per year. At Donaldsonville Melamine Chemicals Inc. was constructing facilities to produce 70 million pounds of melamine per year from urea and ammonia; the facilities were scheduled to come on stream in early 1971. Rubicon Chemicals Inc. continued an expansion at Geismar; installation of facilities to produce 10 million pounds yearly of toluene and diisocyanate was completed, and construction was started on facilities designed to produce 80 million pounds of methylene diisocyanate annually. Air Products and Chemicals Inc. completed an industrial gas facility at Geismar; the plant supplies oxygen and nitrogen to the nearby Wyandotte Chemicals Corp. plant for use in producing ethylene-base chemicals.

#### NONMETALS

Value of nonmetals production decreased \$14 million to \$225 million and was 4.4 percent of total value of mineral production in the State. The decrease in value was the second year of decline from the record \$289 million nonmetals production value in 1968.

**Barite.**—Crude barite was not mined in Louisiana. However, one plant in Calcasieu Parish and three plants in Orleans Parish crushed and ground barite ore. Ore mined principally in Arkansas, Georgia, Missouri, Nevada, and Tennessee as well as foreign countries including Canada, Greece, Ire-

land, and Peru was shipped to Louisiana for processing. The volume of ore processed increased 3.5 percent from that of 1969, and average unit price increased 2.2 percent. Virtually all the barite was used as a weight additive in drilling muds.

**Cement.**—Portland and masonry cement was manufactured at two plants in Orleans Parish, and one plant in East Baton Rouge Parish. Shipments of cement continued to decline for the third consecutive year. In 1970 total shipments were 9 percent less than in 1969. Average unit price of portland cement increased 12 percent, and average unit price of masonry cement increased 7 percent. Ready-mix concrete companies and concrete product manufacturers were the principal consumers of cement. However, substantial quantities were used by highway and other contractors and building material dealers.

**Clays.**—Output of common clay and undifferentiated clay and shale increased slightly to 1.08 million tons, a record high. Average unit value was \$1.46 per ton. Twelve companies operated 14 pits in 13 parishes. Principal producing parishes in descending order of production were Pointe Coupee, St. Bernard, and West Baton Rouge. Clay output was consumed in the manufacturing of lightweight aggregate, cement, and heavy building brick.

**Gypsum.**—Crude gypsum was mined in Winn Parish, and output increased 8 percent. The entire output was used as a retarder in portland cement. Unit price was 8 percent higher than in 1969. Gypsum was calcined by National Gypsum Co. at its Jefferson Parish plant and by United States Gypsum Co. at its Orleans Parish plant. Output was used in the manufacture of wallboard. Calcined gypsum production increased 8 percent, and unit value was about 4 percent higher than in 1969.

**Lime.**—Production increased 25 percent, and average unit value increased 19 percent. Olin Corp. produced hydrated lime (calcium hydroxide) at its Lake Charles plant. Allied Chemical Corp. produced quicklime (calcium oxide) at its Baton Rouge facilities. United States Gypsum Co. in Orleans Parish and Pelican State Lime Division of Radcliff Materials, Inc., in St. Mary Parish produced both quicklime and hydrated lime. Virtually all lime output was consumed in chemical applications. There is some concern as to future fuel supplies and particulate emission standards that may be promulgated for the industry.

**Perlite.**—Although not mined in Louisiana, perlite was expanded by two plants—Zonolite Division of W. R. Grace & Co. in Orleans Parish and Filter-Media Co. of Louisiana, Inc., in St. John The Baptist Parish. A substantially larger amount of perlite was expanded in 1970 than in 1969. Principal uses were for filter aids and in concrete aggregate. Other uses included horticultural aggregate, plaster aggregate, and low-temperature insulation.

**Salt.**—Louisiana ranked first in salt production (sold or used by producers) and provided 29.7 percent of domestic output. State production increased 9.2 percent to 13.58 million short tons, valued at \$64.85 million. The average unit value was \$4.77 per ton, a 2.8-percent decrease in unit value from 1969. There was a 2.5-percent decrease in evaporated salt production, rock salt production increased 6.6 percent, and brine production increased 11.7 percent. Average unit values in dollars per short ton were evaporated salt, \$29.22; rock salt, \$5.82; and brine, \$3.17. Thirteen companies mined salt at 16 operations in 10 parishes. Ten operations produced brine, three operations produced evaporated and rock salt, two operations produced rock salt, and one company produced evaporated salt only. International Salt Co.

started a modernization program at its Avery Island mine and refinery. Sinking of a new 16-foot-diameter production mine shaft to a depth of 1,010 feet started, and operation was scheduled for April 1971. Additional underground screening and graded storage areas, a new bulk-loading conveyor to a new barge-loading facility, and new truck and rail bulk-loading facilities were included in the modernization program.

Salt was consumed principally as a feedstock in the manufacture of chlorine, caustic soda (sodium hydroxide), and soda ash (sodium carbonate). There were numerous other uses including snow and ice removal, food processing, agricultural, and industrial applications.

**Sand and Gravel.**—Production was 18.2 million short tons, a slight increase from the previous year. Average unit value increased slightly to \$1.23 per short ton. There was a total of 83 operations—78 commercial and 5 Government-and-contractor. Operations were in 45 of the State's 64 parishes. Gravel was mined in 10 parishes, sand in 9 parishes, and both sand and gravel in 26 parishes. Leading parishes in descending rank of production were Washington, St. Tammany, St. Helena, East Baton Rouge, and Jefferson. These five parishes produced 38 percent of the State's output of sand and gravel. Commercial operations accounted for 98 percent of sand and gravel production.

Sand production of 7,465,000 short tons was 12.1 percent less than 1969 production. Unit value, however, increased 2.5 percent to \$1.10 per ton. Principal uses of produced sand were building, 69.5 percent; and paving, 27.8 percent. The remaining 2.7 percent was used as blast sand, glass sand, and engine sand.

Gravel production of 10,690,000 short

**Table 13.—Louisiana: Salt sold or used by producers**  
(Thousand short tons and thousand dollars)

Year	Evaporated salt		Rock salt		Brine		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1966-----	267	\$6,354	3,502	\$19,681	4,967	\$18,154	8,736	\$44,189
1967-----	301	7,619	4,183	22,131	5,101	18,733	9,585	48,483
1968-----	293	7,183	4,793	26,556	5,822	20,115	10,908	53,854
1969-----	277	7,598	5,237	29,160	6,921	24,344	12,435	61,102
1970-----	270	7,888	5,581	32,459	7,733	24,507	13,584	64,854

tons was 10.9 percent higher than in 1969. Average unit value of \$1.33 per ton was virtually unchanged. Uses for produced

gravel were building, 65.2 percent, paving, 34.7 percent, and other uses, 0.1 percent.

**Table 14.—Louisiana: Sand and gravel sold or used by producers, by classes of operations and uses**  
(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building .....	5,988	\$6,183	5,015	\$5,258
Paving .....	2,232	2,272	2,049	2,084
Other uses <sup>1</sup> .....	196	479	202	452
<b>Total</b> .....	<b>8,416</b>	<b>8,934</b>	<b>7,266</b>	<b>7,794</b>
<b>Gravel:</b>				
Building .....	6,269	8,275	6,805	8,926
Paving .....	3,024	4,059	3,667	4,796
Other uses .....	7	10	9	12
<b>Total</b> <sup>2</sup> .....	<b>9,299</b>	<b>12,345</b>	<b>10,480</b>	<b>13,733</b>
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Building .....	79	166	173	346
Paving .....	--	--	26	52
<b>Total</b> <sup>2</sup> .....	<b>79</b>	<b>166</b>	<b>199</b>	<b>399</b>
<b>Gravel:</b>				
Building .....	151	314	169	338
Paving .....	186	136	42	100
<b>Total</b> <sup>2</sup> .....	<b>337</b>	<b>450</b>	<b>210</b>	<b>438</b>
<b>Total sand and gravel</b> <sup>2</sup> .....	<b>18,131</b>	<b>21,895</b>	<b>18,155</b>	<b>22,363</b>

<sup>1</sup> Includes blast, glass, fill, and engine sand (1970).

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

**Stone.**—Production was principally oyster and clam shell along the coastal area and some crushed stone in Winn Parish. Total output of slightly more than 9 million short tons—was somewhat less than output for 1969. Average unit value increased about 1 percent to \$1.29 per ton. Most of the shell output was used on roadways, as concrete aggregate, and in general construction. Substantial amounts were also consumed in the manufacture of cement, quicklime, and hydrated lime. Smaller quantities were used in the preparation of feed for chickens and cattle and in the manufacture of glass.

**Sulfur.**—Louisiana continued its national leadership in production of sulfur by the Frasch method. The production of 3.6 million long tons of sulfur was 56.4 percent of U.S. production by the Frasch method. Average unit value of sulfur shipments was \$24.73 per long ton, an 8.7 percent decrease from 1969. The decline in unit price reflected competitive pressures on prices resulting from sulfur imports. The output of sulfur produced by the Frasch method in

Louisiana was 5.7 percent less than in 1969. During the year two operations—Union Texas Petroleum at Sulphur dome and U.S. Oil of Louisiana, Ltd., at Chacahoula dome—were closed. The six remaining operations produced at only 80 to 90 percent of capacity. Recovered sulfur was obtained from two operations, and there was a 35-percent increase in the amount of sulfur recovered. Cities Service Oil Co. awarded contracts for the construction of two 50-ton-per-day sulfur recovery units at its Lake Charles refinery.

**Table 15.—Louisiana: Sulfur produced and shipped from Frasch mines**  
(Thousand long tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value <sup>1</sup>
1966 .....	4,085	4,018	\$104,472
1967 .....	4,059	4,233	139,739
1968 .....	4,255	4,074	162,664
1969 .....	3,857	3,999	108,239
1970 .....	3,636	3,618	89,489

<sup>1</sup> F.o.b. mine plant.

**Vermiculite.**—This mineral was not mined in Louisiana; however, exfoliated vermiculite was produced by Zonolite Division of W. R. Grace & Co. in Orleans Parish. Production declined 14 percent, but average unit value was slightly higher than in 1969. The principal use of exfoliated vermiculite was as an ingredient in concrete aggregate. Other uses included loose fill insulation, soil conditioning, and plaster aggregate.

#### METALS

**Aluminum.**—Production declined 3 percent, and Louisiana dropped to fifth nationally in aluminum output. Aluminum ore (bauxite) was not mined in Louisiana. However, both alumina and aluminum were produced. Kaiser Aluminum & Chemical Corp. produced aluminum at its Chalmette electrolytic reduction plant and alumina at its Gramercy and Baton Rouge

plants. Ormet Corp. produced alumina at its Burnside plant. Kaiser Aluminum & Chemical Corp. completed installation of electrostatic precipitators at its Baton Rouge facility; the precipitators virtually eliminated all white alumina dust discharges into the atmosphere. Company personnel were working on methods to eliminate the emission of bauxite dust that occurs in dock operations.

The Gulf Coast Aluminum Corp. plant at Lake Charles was in the startup phase of producing aluminum at yearend. Of the 90 reduction cells in the plant, about half were in operation, and metallic aluminum production began on a limited basis in late 1970. Bauxite used in this operation was purchased from domestic sources.

**Lead.**—Secondary lead was recovered by Schuylkill Metals Corp. in East Baton Rouge Parish. Output was substantially higher than in 1969.

Table 16.—Principal producers and processors of minerals

Commodity and company	Address	Type of activity	Parish
<b>Aluminum:</b>			
Kaiser Aluminum & Chemical Corp.	P.O. Box 1600 Chalmette, La. 70043	Reduction plant.	St. Bernard.
Gulf Coast Aluminum Corp.	P.O. Box LL Lake Charles, La. 70601	do.	Calcasieu.
<b>Barite:</b>			
Dresser Minerals	P.O. Box 6504 Houston, Tex. 77005	Grinding plant.	Orleans and Calcasieu.
Milchem, Inc.	P.O. Box 22111 Houston, Tex. 77027	do.	Orleans.
National Lead Co.	Box 1875 Houston, Tex. 77001	do.	Do.
<b>Carbon black:</b>			
Ashland Chemical Co.	P.O. Box 1503 Houston, Tex. 77005	Furnace plant.	St. Mary.
Cabot Corp.	125 High St. Boston, Mass. 02110	do.	St. Mary and Evangeline.
Columbian Carbon Co.	380 Madison Ave. New York, N.Y. 10017	do.	Ouachita, Avoyelles, St. Mary.
Continental Carbon Co.	P.O. Box 22085 Houston, Tex. 77027	do.	Calcasieu.
Sid Richardson Carbon & Gasoline Co.	1200 Ft. Worth National Bank Bldg. Fort Worth, Tex. 76102	do.	West Baton Rouge.
Thermatomic Carbon Co.	245 Park Ave. New York, N.Y. 10017	do.	Ouachita.
<b>Cement:</b>			
Ideal Cement Co., Div. Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	Plant.	East Baton Rouge.
Lone Star Cement Corp.	P.O. Box 47327 Dallas, Tex. 75247	do.	Orleans.
Louisiana Cement Co., Div. OKC Corp.	14900 Intracoastal Dr. New Orleans, La. 70129	do.	Do.
<b>Clays:</b>			
Acme Brick Co.	Box 425 Ft. Worth, Tex. 76101	Mine and plant.	East Baton Rouge.
Athens Caddo Brick Co.	Box 70 Athens, Tex. 75751	do.	Caddo.
Big River Industries, Inc.	Box 66377 Baton Rouge, La. 70806	do.	Pointe Coupee.
Hammond Baton Rouge Brick Co.	Box 329 Hammond, La. 70401	do.	Tangipahoa.
Ideal Cement Co., Div. Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	do.	West Baton Rouge.
Kentwood Brick & Tile Manufacturing Co., Inc.	Drawer F Kentwood, La. 70444	do.	St. Helena.
Louisiana Cement Co., Div. OKE Corp.	14900 Intracoastal Dr. New Orleans, La. 71029	do.	St. Bernard.
Louisiana Lightweight Aggregate Co., Div. of Texas Industries, Inc.	8100 Carpenter Freeway Dallas, Tex. 75247	do.	Rapides.
<b>Gypsum:</b>			
National Gypsum Co.	325 Delaware Ave. Buffalo, N.Y. 14202	Calcining plant.	Jefferson.
United States Gypsum Co.	101 South Wacker Dr. Chicago, Ill. 60606	do.	Orleans.
Winn Rock, Inc.	P.O. Box 790 Winnfield, La. 71483	Quarry and plant.	Winn.
<b>Lead:</b>			
Schuykill Metals Corp.	P.O. Box 73916 Baton Rouge, La. 70807	Plant.	East Baton Rouge.
<b>Lime:</b>			
Allied Chemical Corp.	P.O. Box 70 Morristown, N.J. 07960	do.	Do.
Olin Corp.	P.O. Box 2896 Lake Charles, La. 70601	do.	Calcasieu.
Pelican State Lime Div. of Radcliff Materials, Inc.	P.O. Box 1637 Morgan City, La. 70380	do.	St. Mary.
United States Gypsum Co.	101 South Wacker Dr. Chicago, Ill. 60606	do.	Orleans.
<b>Natural gas and petroleum:<sup>1</sup></b>			
<b>Perlite:</b>			
Filter-Media Co. of La., Inc.	P.O. Box 19156 Houston, Tex. 77024	Expanding plant.	St. John the Baptist.
W. R. Grace & Co., Zonolite Div.	62 Whittemore Ave. Cambridge, Mass. 02140	do.	Orleans.
<b>Salt:</b>			
Allied Chemical Corp., Industrial Chemical Div.	Box 70 Morristown, N.J. 07960	Brine wells.	Iberville.
The Carey Salt Co.	1800 Carey Blvd. Hutchinson, Kans. 67501	Underground mine.	St. Mary.

See footnote at end of table.



Table 16.—Principal producers and processors of minerals—Continued

Commodity and company	Address	Type of activity	Parish
Salt—Continued			
Cargill, Ind.....	Cargill Building Minneapolis, Minn. 55402	Underground mine.	St. Mary.
Diamond Crystal Salt Co., Jefferson Island Div.	916 Riverside Ave. St. Clair, Mich. 48079	-----do-----	Iberia.
The Dow Chemical Co.....	Midland, Mich. 48640	Brine wells.....	Plaquemines.
Freeport Sulphur Co.....	Box 61520 New Orleans, La. 70160	-----do-----	Plaquemines, Jefferson, Terrebonne.
Gordy Salt Co., Inc.....	Box 638 New Iberia, La. 70560	-----do-----	St. Martin.
International Salt Co., Avery Mine & Refinery.	Clarks Summit, Pa. 18411	Underground mine.	Iberia.
Kaiser Aluminum & Chemical Corp.	900 17th St., N.W. Washington, D.C. 20006	Brine wells.....	Ascension.
Morton Salt Co.....	110 North Wacker Dr. Chicago, Ill. 60606	Underground mine.	Iberia.
Olin Corp.....	Box 991 Little Rock, Ark. 72203	Brine wells.....	Cameron.
PPG Industries, Inc., Industrial Chemical Div.	Box 1000 Lake Charles, La. 70604	-----do-----	Calcasieu.
Wyandotte Chemicals Corp.....	1609 Biddle Ave. Wyandotte, Mich. 48192	-----do-----	Ascension.
Sand and gravel:			
Braswell Sand & Gravel Co., Inc..	Box 798 Minden, La. 71055	Stationary.....	Webster.
Gifford-Hill & Co., Inc.....	Box 47127 Dallas, Tex. 75247	Stationary and dredge.	Jefferson Davis, Webster, Tangipahoa.
Jahncke Service, Inc.....	314 Howard Ave. New Orleans, La. 70104	Dredge.....	St. Tammany.
Louisiana Industries, Inc.....	Box 5472 Alexandria, La. 71301	-----do-----	Ouachita, Rapides, Washington.
Ouachita Gravel Co., Inc.....	Box 1241 Monroe, La. 71201	Stationary.....	Ouachita.
Rebel Sand & Gravel Co.....	Rt. 2, Box 386E Denham Springs, La. 70726	-----do-----	St. Helena.
Red Stick Gravel Co.....	Box 847 Baton Rouge, La. 70821	-----do-----	East Baton Rouge.
Standard Gravel Co., Inc.....	Rt. 4, Box 17 Franklinton, La. 70438	-----do-----	Washington.
Trinity Concrete Products.....	Box 47524 Dallas, Tex. 75247	Stationary and dredge.	Beauregard.
Shell:			
Ayers Materials Co., Inc.....	P.O. Box 382 Harvey, La. 70058	Dredge.....	St. Tammany.
W. T. Burton Industries, Inc.....	P.O. Box 100 Sulphur, La. 70663	-----do-----	Cameron.
Ideal Cement Co., Div. Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	-----do-----	St. Mary.
Jahncke Service Co., Inc.....	814 Howard Ave. New Orleans, La. 70113	-----do-----	St. Tammany.
Lake Charles Dredging & Towing Co.	Lafayette, La. 70501	-----do-----	St. Mary.
Louisiana Materials Co.....	P.O. Box 8214 New Orleans, La. 70122	-----do-----	St. Tammany.
Radcliff Materials, Inc.....	P.O. Drawer 946 Mobile, Ala. 36601	-----do-----	Orleans, St. Mary, St. Tammany.
Stone: Winn Rock, Inc.....	P.O. Box 790 Winnfield, La. 71483	Quarry and plant.	Winn.
Sulfur, native:			
Freeport Sulphur Co.....	161 East 42d St. New York, N.Y. 10017	Frasch process.	Jefferson, Plaquemines, Terrebonne.
Jefferson Lake Sulphur Co.....	Box 1185 Houston, Tex. 77001	-----do-----	Plaquemines.
Texas Gulf Sulphur Co.....	200 Park Ave. New York, N.Y. 10017	-----do-----	Lafourche.
Sulfur, recovered:			
Shell Oil Co.....	Box 60673 New Orleans, La. 71060	Secondary recovery.	St. Charles.
Stauffer Chemical Co.....	299 Park Ave. New York, N.Y. 10017	-----do-----	East Baton Rouge.
Vermiculite:			
W. R. Grace & Co., Zonolite Div..	62 Whittemore Ave. Cambridge, Mass. 02140	Exfoliating plant.	Orleans.

<sup>1</sup> Most major companies and many smaller companies operate in Louisiana. Commercial directories contain listings of operators.

# The Mineral Industry of Maine

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

By Frank B. Fulkerson <sup>1</sup>

Value of mineral production in Maine continued to increase and reached a record \$23.8 million in 1970. Increased production of zinc-copper ore, cement, and sand and gravel more than offset a decline in output of stone.

Interest in metallic mineral deposits continued in the State. Kerr American, Inc., a subsidiary of Kerr Addison, Ltd., Toronto, began a new investigation of the Black Hawk copper-zinc mine near Blue Hill, Hancock County. International Paper Co. carried out exploratory drilling of copper and silver mineralization on its land near Square Lake, Aroostook County. Knox Mining Co. continued exploration work on a nickel-copper deposit at Union, Knox County. Exploration crews representing mineral divisions of several large petro-

leum companies were active in the search for metallic mineral deposits in northern and coastal areas of Maine.

The 855,000-kw. atomic power plant under construction by Maine Yankee Atomic Power Co. at Wiscasset was more than 60 percent complete at the end of 1970. The \$200 million plant was scheduled to begin operation in mid-1972. Largest construction project in Maine history, the plant provided employment to an average of 1,000 workers during 1970.

The State Geological Survey compiled physical resource data and described several industrial site locations as part of an effort to develop an industrial complex in the lower Penobscot Bay Area.

<sup>1</sup> Industry economist, Division of Nonmetallic Minerals.

Table 1.—Mineral production in Maine <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays <sup>2</sup> .....thousand short tons..	42	\$56	41	\$55
Copper.....short tons..	W	W	2,703	3,120
Gem stones.....	NA	35	NA	35
Sand and gravel.....thousand short tons..	11,275	6,026	12,971	6,888
Silver.....thousand troy ounces..	W	W	63	112
Stone.....thousand short tons..	1,101	3,798	1,041	3,682
Zinc.....short tons..	W	W	9,114	2,792
Value of items that cannot be disclosed:				
Beryllium concentrate, cement (portland and masonry), feldspar, fire clay, peat, and value indicated by symbol W.....	XX	10,273	XX	7,096
Total.....	XX	20,188	XX	23,780
Total 1967 constant dollars.....	XX	19,064	XX	p 21,521

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

Table 2.—Value of mineral production in Maine, by counties  
(Thousand dollars)

County	1969	1970	Minerals produced in 1970 in order of value
Androscoggin	\$559	\$885	Sand and gravel, clays.
Aroostook	664	633	Sand and gravel.
Cumberland	1,747	2,472	Sand and gravel, stone, clays.
Franklin	215	W	Sand and gravel.
Hancock	W	6,345	Copper, zinc, sand and gravel, silver, peat, clays.
Kennebec	691	1,086	Sand and gravel, stone.
Knox	W	W	Cement, stone, sand and gravel.
Lincoln	140	W	Sand and gravel.
Oxford	323	223	Sand and gravel, feldspar, beryllium.
Penobscot	812	725	Sand and gravel.
Fiscataquis	W	W	Stone, sand and gravel.
Sagadahoc	W	W	Sand and gravel.
Somerset	W	W	Do.
Waldo	334	W	Do.
Washington	W	W	Sand and gravel, peat.
York	712	W	Sand and gravel.
Undistributed <sup>1</sup>	13,988	11,410	
Total <sup>2</sup>	20,188	23,780	

<sup>1</sup> W Withheld to avoid disclosing individual company confidential data.

<sup>2</sup> Includes value of gem stones and sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

<sup>3</sup> Data does not add to totals shown because of independent rounding.

Table 3.—Indicators of Maine business activity

	1969	1970	Change, percent
Employment and labor force, annual average:			
Total labor force..... thousands.....	402.6	405.6	+0.7
Unemployment..... percent of work force.....	4.6	5.6	+21.7
Employment:			
Manufacturing..... thousands.....	115.7	110.0	-4.9
Contract construction..... do.....	15.5	16.4	+5.8
Wholesale and retail trade..... do.....	64.2	65.9	+2.6
Other..... do.....	41.5	42.9	+3.4
Agricultural..... do.....	93.1	96.3	+3.4
Personal income: <sup>1</sup>			
Total..... millions.....	\$ 2,987	\$ 3,223	+7.9
Per capita.....	\$ 3,011	\$ 3,243	+7.7
Portland cement shipments to and within Maine			
thousand 376-pound barrels.....	1,069	1,094	+2.3
Mineral production value..... thousands.....	\$20,188	\$23,780	+17.8

<sup>1</sup> Survey of Current Business.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1969:								
Metal and peat.....	103	269	23	222	-----	5	22.55	433
Nonmetal.....	74	201	15	122	-----	5	40.98	172
Sand and gravel.....	625	198	124	1,105	-----	23	20.82	386
Stone.....	201	314	63	521	-----	12	23.05	311
Total <sup>1</sup> .....	1,003	229	230	1,969	-----	45	22.85	358
1970: <sup>p</sup>								
Metal and peat.....	100	255	26	206	1	15	77.52	32,189
Nonmetal.....	50	193	10	79	-----	3	38.20	739
Sand and gravel.....	690	180	124	1,121	-----	19	16.95	84
Stone.....	200	305	61	506	-----	6	11.86	79
Total <sup>1</sup> .....	1,045	212	221	1,912	1	43	23.02	3,576

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

**Employment and Injuries.**—In the mineral industries, 1,045 men worked 1,912,000 man-hours, compared with 1,003 men and 1,969,000 man-hours in 1969. Employment increased 1 percent at sand and gravel mines but decreased 3 percent at stone

quarries, 7 percent at metal and peat mines, and 35 percent at other nonmetal mines. There were 44 lost-time injuries in the mineral industries, including one fatality, compared with 45 injuries in 1969.

## REVIEW BY MINERAL COMMODITIES

## NONMETALS

**Cement.**—Dragon Cement Co. (a division of Martin Marietta Corp.), the only portland and masonry cement producer in Maine, increased total cement shipments in 1970. The cement was distributed to New England destinations. Most of the product was shipped in bulk. Consumers of portland cement were ready-mixed concrete companies, concrete product manufacturers, and building material dealers. New pressure-flow railcars were used to transport cement from the Thomaston plant to the company's Wilmington, Mass., terminal. The cars featured a new seal system to eliminate dust and to prevent contamination and waste. Capacity of the Wilmington terminal was increased to accommodate a daily capacity of 25,000 barrels of cement from the previous 9,000 capacity. The new rail cars had a carrying capacity of 100 tons of cement as compared with the 70-ton capacity of the hopper cars they replaced.

Dragon Cement Co. was constructing a new, \$18 million cement plant at the old plant site. Production at the new facility, which will have an annual capacity of 2.5 million barrels, was scheduled to begin in mid-1971, after which the present 2-million-barrel production unit was to be razed. Existing storage, packing, and shipping facilities were to be retained. The new kiln, which will replace the present two-kiln operation, will be equipped with a fiberglass baghouse for air pollution abatement by recovery of dust, which will be recycled to the raw material mix.

**Clays.**—Output of common clay for use in manufacturing building brick was virtually the same as in 1969. Production was from two pits in Androscoggin County and three pits in Cumberland County. A small quantity of stoneware clay was mined in Hancock County for use in manufacturing pottery.

**Feldspar.**—The Bell Minerals Co. quarry and grinding mill near West Paris, Oxford County, suspended operation in September 1970 owing to a declining market. Earlier in the year the grinding mill was remodeled, after a fire destroyed a portion of the facility in 1969. The area around West Paris has been associated with feldspar mining for over 50 years. Efforts were

being made at yearend to reestablish the industry.

**Gem Stones.**—Old mines, quarries, and dumps in Oxford County continued to be the chief locations for collecting gem-quality stones and mineral specimens in Maine.

**Nitrogen Compounds.**—Anhydrous ammonia used as a fertilizer component was produced by Northern Chemical Industries, Searsport, Waldo County.

**Peat.**—Sales of moss peat increased over those of 1969. Acadia Peat Corp., Penobscot, installed equipment for mechanical squeeze dewatering and air drying to produce 35-percent moisture moss. Other active peat producers were New England Peat Industries, Inc., and International Peat Moss Co., both at Jonesport.

**Sand and Gravel.**—Total output from commercial and Government-and-contractor operations was 13.0 million tons, nearly 1.7 million tons greater than the 11.3 million tons produced in 1969, but 4.3 million tons below the record high of 17.3 million in 1965. Government-and-contractor production gained 1.1 million tons. Commercial producers increased production 0.6 million tons, even though the number of operations declined from 68 in 1969 to 53 in 1970. More than one-half of the State's production was provided by commercial and Government-and-contractor operators in Androscoggin, Aroostook, Cumberland, Kennebec, and Penobscot Counties. Each of these counties produced more than 1 million tons of sand and gravel.

Of the total sand and gravel output, 5.9 million tons was processed and 7.1 million tons was bank run. All the tonnage was transported by truck. The use pattern was 10.3 million tons for paving, 0.9 million tons for building, 0.9 million tons for fill, and 0.9 million tons for miscellaneous purposes. Average value of sand and gravel production was 53 cents per ton, unchanged from 1969 figures.

The Maine State Highway Commission, the State's largest single user, reported production of paving sand and gravel in all counties; output was obtained by the Commission's own crews and by workers under contract.

**Stone.**—The quantity of stone produced declined 5 percent from that of 1969, and the value declined 3 percent. Knox County continued as the leading stone-producing

area. Dragon Cement Co. produced limestone for use at its Thomaston cement plant and for construction and miscellaneous uses. Lime Products Corp. operated its Union quarry and sold agricultural limestone, poultry grit, and mineral food. Granite for architectural uses was produced by John Swenson Granite Co., Inc., Concord, N.H., from the Vinalhaven Island quarry; activity was reduced compared with that of 1969. In Cumberland and Kennebec Counties, crushed limestone and trap rock were produced and marketed as concrete and bituminous aggregate.

Black slate, mined underground by the Portland-Monson Slate Co. near Monson, was sold for use principally as floor tile with some still being used for electrical switch plates. The slate is sawed and split to size at Monson, then trucked to the company's New York plant where the back

is ground down for smoothness and desired thickness. Plans were in preparation for a new shaft at Willimantic, about 5 miles from the operating mine.

#### METALS

Callahan Mining Co. increased production of zinc-copper ore from its new Penobscot unit at Harborside, which was opened in 1968 after an expenditure of \$4.5 million for exploration, development, and construction. Mining was by open pit and underground methods. Copper concentrates from the company flotation mill were shipped to Gaspé, Quebec, for the recovery of copper and silver, and zinc concentrates were shipped to Josephstown, Pa. Copper, silver, and zinc production in 1970 set new records for the State in output of these metals.

**Table 5.—Maine: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building .....	334	\$326	489	\$388
Fill .....	327	148	280	127
Paving .....	574	530	452	438
Other uses <sup>1</sup> .....	93	77	396	437
Total <sup>2</sup> .....	1,328	1,081	1,617	1,391
<b>Gravel:</b>				
Building .....	198	224	420	191
Fill .....	256	128	204	125
Paving .....	1,008	988	978	1,263
Other uses <sup>3</sup> .....	257	182	394	328
Total <sup>2</sup> .....	1,719	1,522	1,996	1,908
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Fill .....			200	48
Paving .....	465	198	425	155
Other uses .....	29	10	32	9
Total <sup>2</sup> .....	494	208	657	212
<b>Gravel:</b>				
Building .....			12	3
Fill .....			198	46
Paving .....	7,702	3,204	8,481	3,325
Other uses .....	33	12	10	2
Total <sup>2</sup> .....	7,735	3,215	8,702	3,376
Total sand and gravel <sup>2</sup> .....	11,275	6,026	12,971	6,888

<sup>1</sup> Includes engine and other sands.

<sup>2</sup> Due to independent rounding, data may not add to total shown.

<sup>3</sup> Includes miscellaneous, other, and railroad ballast gravel.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Dragon Cement Co., Division of Martin Marietta Corp. <sup>1</sup>	5A Joyce Kilmer Ave. New Brunswick, N. J. 08901	Plant.....	Knox.
<b>Clay:</b>			
Dennis Brick Co., Inc.....	R.F.D. No. 1 33 Old Washington Rd. Auburn, Maine 04210	Pit.....	Androscoggin.
Lachance Bros. Brick Co.....	R.F.D. No. 2 Gorham, Maine 04038	Pit.....	Cumberland.
Fred S. Liberty & Sons, Inc.....	R.F.D. No. 1, Gray, Maine 04039	Pit.....	Do.
Morin Brick Co.....	Danville, Maine 04223	Pit.....	Androscoggin.
Royal River Brick Co., Inc.....	Box 191, Grey, Maine 04039	Pit.....	Cumberland.
<b>Feldspar (crude):</b>			
Bell Minerals Co. <sup>2</sup> .....	West Paris, Maine 04289	Pit <sup>3</sup> .....	Oxford.
Frank Perham.....	West Paris, Maine 04289	Pit.....	Do.
<b>Peat:</b>			
Acadia Peat Corp.....	Penobscot, Maine 04476	Bog.....	Hancock.
International Peat Moss Co., Inc.....	430 Trapelo Rd., Belmont Mass. 02178	Bog.....	Washington.
<b>Perlite (expanded):</b>			
Chemrock Corp.....	End of Osage Street Nashville, Tenn. 37208	Plant.....	Knox.
<b>Sand and gravel:</b>			
Blue Rock Industries.....	58 Main Street Westbrook, Maine 04092	Pit.....	Androscoggin, Cumberland.
Harry C. Crooker & Sons, Inc.....	Brunswick, Maine 04011	Pit <sup>3</sup> .....	Do.
Cumberland Sand & Gravel Co., Inc.....	58 Main St. Westbrook, Maine 04092	Pit.....	Do.
Goding Ready-Mix Concrete Co.....	Lincoln, Maine 04457	Pit.....	Penobscot.
Hamlin Sand & Gravel Co., Inc.....	920 Riverside St. Portland, Maine 04103	Pit <sup>4</sup> .....	Cumberland.
Lane Construction Co.....	965 E. Main St. Meriden, Conn. 06450	Pit.....	Aroostook.
Lane Construction Co.....	do.....	Pit.....	Penobscot.
Lewiston Crushed Stone Co., Inc.....	South Ave. Lewiston, Maine 04240	Pit <sup>3</sup> .....	Androscoggin.
Harold C. MacQuinn, Inc.....	Bar Harbor, Maine 04609	Pit.....	Hancock.
C. M. Page Co., Inc.....	234 Main St. Orono, Maine 04473	Pit.....	Penobscot.
Leroy S. Prout Sand & Gravel.....	Scarborough, Maine 04074	Pit.....	Cumberland.
Maynard W. Robinson & Sons.....	R.F.D. No. 2 Cumberland Center, Maine 04021	Pit.....	Do.
Frank Rossi & Sons, Inc.....	National Bank Bldg. Gardiner, Maine 04345	Pit.....	Various.
Warren Bros. Company.....	Fairfield, Maine 04937	Pit.....	Kennebec.
<b>Stone:</b>			
<b>Granite, dimension:</b>			
Hocking Granite Industries Inc. <sup>5</sup>	Saint George, Maine 04857	Pit.....	Knox.
The John Swenson Granite Co., Inc.....	North State St. Concord, N. H. 03301	Pit <sup>6</sup> .....	York, Knox.
<b>Granite, crushed:</b>			
Cook and Co., Inc.....	150 Causeway St. Boston, Mass. 02114	Quarry.....	Cumberland.
<b>Limestone, crushed:</b>			
Blue Rock Industries.....	58 Main St. Cumberland Mills, Maine 04092	do.....	Kennebec.
Dragon Cement Co., Division of Martin Marietta Corp.....	5A Joyce Kilmer Ave. New Brunswick, N. J. 08901	do.....	Knox.
Lime Products Corp.....	P.O. Box 357 Union, Maine 04862	do.....	Do.
McKay Rock Products, Inc.....	Box 656, Reach Road Presque Isle, Maine 04769	do.....	Aroostook.
<b>Miscellaneous, crushed:</b>			
Blue Rock Industries.....	58 Main St. Cumberland Mills, Maine 04092	do.....	Cumberland.
<b>Slate, dimension:</b>			
Portland-Monson Slate Co.....	Middle Granville, N. Y. 12849	Underground ..	Piscataquis.
<b>Zinc:</b>			
Callahan Mining Corp. <sup>7</sup> .....	Harborside, Maine 04642	Pit and under- ground.	Hancock.

<sup>1</sup> Portland and masonry.<sup>2</sup> Also beryllium concentrate and scrap mica from the Bumpus mine.<sup>3</sup> 2 pits.<sup>4</sup> 3 pits.<sup>5</sup> Also crushed.<sup>6</sup> Includes 4 quarries; 3 in York (Pink, Green, and Black) and 1 in Knox (Gray).<sup>7</sup> Also copper and silver.



# The Mineral Industry of Maryland

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By Donald C. Wininger<sup>1</sup>

In 1970, Maryland's mineral production reached an alltime high of \$88.2 million. More than half, \$2.8 million, of the \$4.7 million gain over the 1969 value was due to increases in the quantity and unit value of the coal produced.

Stone remained the leading mineral commodity and accounted for 37 percent of the total value of all minerals produced. Sand and gravel represented almost one-fourth of the total value of mineral production. The continued high demand for construction materials was attributed largely to building activity in Prince Georges and Baltimore Counties and to the construction of Interstate Highway 95 between Washington, D.C. and Baltimore. Large tonnages of construction materials

were also used at the new City of Columbia (Howard County) and at Baltimore Gas and Electric Co.'s Calvert Cliffs nuclear power plant in Calvert County. Baltimore, Carroll, Frederick, Prince Georges, and Washington Counties maintained their positions as leading mineral-producing counties in the State.

The Maryland Geological Survey continued its program of geologic mapping and environmental studies in Baltimore County and southern Maryland. The Survey cooperated with the U.S. Geological Survey in the geologic mapping of Cecil County and aeromagnetic mapping of Carroll, Frederick, and Washington Counties.

<sup>1</sup> Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Mineral production in Maryland<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays <sup>2</sup> .....thousand short tons--	1,152	\$1,369	1,129	\$1,433
Coal (bituminous).....do	1,363	5,261	1,615	8,083
Gem stones.....do	NA	3	NA	3
Natural gas.....million cubic feet--	978	248	813	202
Feat.....thousand short tons--	4	78	4	47
Sand and gravel.....do	14,230	21,226	12,951	20,434
Stone.....do	15,067	30,504	16,015	32,783
Value of items that cannot be disclosed:				
Ball and fire clay, cement (portland and masonry), diatomite (1969), greensand marl, lime, potassium salts, and talc and soapstone.....do	XX	24,794	XX	25,231
Total.....do	XX	83,483	XX	88,216
Total 1967 constant dollars.....do	XX	78,833	XX	79,835

<sup>2</sup> Preliminary. 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 ball and fire clay; included with "Value of items that cannot be disclosed."



Table 2.—Value of mineral production in Maryland, by counties <sup>1</sup>  
(Thousands)

County	1969	1970	Value of minerals produced in 1970 in order of value
Allegany.....	\$2,520	W	Coal, sand and gravel, stone.
Anne Arundel.....	2,595	\$3,312	Sand and gravel.
Baltimore <sup>2</sup> .....	W	15,407	Stone, sand and gravel, clays.
Calvert.....	W	W	Greensand marl, sand and gravel.
Caroline.....	W	25	Sand and gravel.
Carroll.....	W	W	Cement, stone, clays.
Cecil.....	6,333	6,774	Stone, sand and gravel.
Charles.....	W	W	Sand and gravel.
Dorchester.....	91	91	Do.
Frederick.....	9,867	9,043	Cement, stone, clays, lime, sand and gravel.
Garrett.....	4,589	6,657	Coal, stone, natural gas, peat.
Harford.....	1,489	2,302	Stone, sand and gravel, clays, talc.
Howard.....	W	W	Stone.
Kent.....	63	W	Clays, peat.
Montgomery.....	W	W	Stone.
Prince Georges.....	8,477	8,790	Sand and gravel, clays.
St. Marys.....	W	W	Sand and gravel.
Somerset.....	W	W	Do.
Talbot.....	31	W	Do.
Washington.....	W	W	Cement, stone, clays, potash.
Wicomico.....	W	W	Sand and gravel.
Worcester.....	6	13	Do.
Undistributed <sup>3</sup> .....	47,422	35,802	
Total.....	83,483	88,216	

W Withheld to avoid disclosing individual company confidential data.

<sup>1</sup> Queen Annes County is not listed because no production was reported.

<sup>2</sup> Includes Baltimore city.

<sup>3</sup> Includes some sand and gravel that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

Table 3.—Indicators of Maryland business activity

	1969	1970	Change, percent
Employment and labor force, annual average: <sup>1</sup>			
Total labor force..... thousands.....	1,465.9	1,509.2	+3.0
Unemployment..... percent of labor force.....	3.0	3.9	+30.0
Employment:			
Manufacturing..... thousands.....	281.7	271.6	-3.6
Transportation and public utilities..... do.....	79.1	81.5	+3.0
Trade..... do.....	292.7	306.3	+4.6
Finance, insurance, and real estate..... do.....	65.9	68.7	+4.2
Mining..... do.....	1.9	1.9	-----
Contract construction..... do.....	84.7	87.7	+3.5
Services..... do.....	226.9	236.9	+4.4
Government..... do.....	243.2	249.0	+2.4
Payroll-average weekly earnings: <sup>1</sup>			
Manufacturing.....	\$131.38	\$136.34	+3.8
Personal income: <sup>2</sup>			
Total..... millions.....	\$15,336	\$16,770	+9.4
Per capita.....	\$3,965	\$4,247	+7.1
Construction activity:			
Portland cement shipments to and within Maryland thousand 376-pound barrels.....	7,230	7,712	+6.7
Mineral production..... thousands.....	\$83,483	\$88,216	+5.7

<sup>1</sup> Employment and Earnings.

<sup>2</sup> Survey of Current Business.

**Employment and Injuries.**—In the mineral industries, 2,565 men worked 5,650,000 man-hours, compared with 2,593 men and 5,650,000 man-hours in 1969. Employment increased 7 percent at coal and peat mines and 6 percent at sand and gravel mines,

but decreased 2 percent at stone quarries and 20 percent at other nonmetal mines.

There were 134 lost-time injuries in the mineral industries, including one fatality, compared with 105 lost-time injuries and one fatality in 1969.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non-fatal	Frequency	Severity
1969:								
Coal and peat....	349	197	69	552	---	6	10.88	832
Nonmetal.....	187	249	47	372	---	17	45.67	768
Sand and gravel..	775	253	196	1,750	---	30	17.14	679
Stone.....	1,282	279	358	2,976	1	52	17.81	3,046
Total <sup>1</sup> .....	2,593	258	669	5,650	1	105	18.76	1,947
1970: <sup>p</sup>								
Coal and peat....	375	196	74	591	1	6	11.84	10,931
Nonmetal.....	155	241	37	296	---	19	64.21	987
Sand and gravel..	790	258	204	1,852	---	32	17.28	2,200
Stone.....	1,245	282	350	2,911	---	76	26.11	682
Total.....	2,565	259	665	5,650	1	133	23.72	2,242

<sup>p</sup> Preliminary.<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Cement.**—Production and shipments of portland and masonry cement decreased during 1970. However, the unit value of both cements increased. Cement plants were located in Carroll, Frederick, and Washington Counties.

**Clays.**—Clays were mined in seven counties. Production declined slightly, but value increased over that of 1969. Clays classed as miscellaneous and used in the manufacture of structural clay products, aggregates, and cement accounted for most of the State's total output. United Sierra Division of Cyprus Mines Corp. mined ball clay in Baltimore County. Fire clay was mined in Harford County by Maryland Clay Co.

**Diatomite.**—No production was reported for 1970. Kaylorite Corp. has in past years produced some diatomite at Dunkirk, Calvert County, for experimental purposes.

**Gem Stones.**—A small quantity of gem stones worth a few thousand dollars was collected by dealers and amateur collectors.

**Lime.**—Lime was produced by S. W. Barrick & Sons, Inc., LeGore Lime Co., and Everett V. Moser, all operating in Frederick County. Most of the production was quicklime, which was marketed for agricultural purposes. Hydrated lime was also produced and sold, mainly for agricultural purposes. Total output decreased 17 percent from that of 1969.

**Marl, Greensand.**—Kaylorite Corp. mined

greensand marl in Calvert County. The product was sold for agricultural use.

**Perlite.**—National Gypsum Co. of Baltimore County and Atlantic Perlite Co. and Zonolite Division of W. R. Grace & Co., both of Prince Georges County, expanded perlite from western states. The product was sold for use in plaster and concrete aggregate, for insulation, and for horticultural purposes.

**Potassium Salts.**—Byproduct potassium salts, sold for agricultural purposes, were produced at Marquette Cement Manufacturing Co.'s plant in Washington County.

**Sand and Gravel.**—Production of sand and gravel was 9 percent less than that of 1969, reflecting the decline in the quantity used for fill in the State's construction activity. Commercial sand and gravel production accounted for 99 percent of total output. The average unit value of the commercial product was \$1.59 per ton, \$0.08 more than in 1969. Ninety-two percent of commercial sand and gravel went into building and highway construction; the remainder was used for fill and miscellaneous purposes. Commercial producers operated 53 stationary plants and 10 portable plants at 55 sites. Four Government-and-contractor operations utilized one stationary plant to produce noncommercial sand and gravel. Counties leading in value of sand and gravel production (in order of rank) were Prince Georges, Anne Arundel, Baltimore, Cecil, and Charles.

**Table 5.—Maryland: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operations and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building.....	5,705	\$8,014	5,202	\$7,634
Paving.....	1,403	2,285	1,549	2,461
Other uses <sup>1</sup> .....	410	834	159	321
Total <sup>2</sup> .....	7,518	11,133	6,910	10,416
Gravel:				
Building.....	3,588	6,170	3,694	7,153
Paving.....	1,240	2,295	1,337	2,120
Other uses <sup>3</sup> .....	1,640	1,542	880	726
Total <sup>2</sup> .....	6,468	10,008	5,911	9,999
<b>Government-and-contractor operations:</b>				
Sand:				
Fill.....				
Paving.....	91	32	36	5
Total <sup>2</sup> .....	91	32	36	5
Gravel:				
Fill.....	3	1		
Paving.....	150	53	94	13
Total <sup>2</sup> .....	153	54	94	13
Total sand and gravel <sup>2</sup> .....	14,230	21,226	12,951	20,434

<sup>1</sup> Includes ground and unground, fill, and other sands.

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

<sup>3</sup> Includes fill, miscellaneous, and other gravel (1969).

**Stone.**—Stone remained the leading mineral commodity in value. Total value of production increased nearly \$2.3 million, to a total \$32.8 million. Crushed and broken stone was produced at 34 quarries; eight quarries produced dimension stone. Production was reported from 10 counties. Baltimore, Frederick, Montgomery, and Howard counties accounted for about two-thirds of the State's output of stone. Of the total crushed stone production, 62 percent was limestone, 33 percent was trap rock, and the remaining 5 percent consisted of quartzite, marble, granite, oyster-shell, and miscellaneous stone. About 82 percent of the total crushed and broken stone produced was used in various aggregates, 13 percent went into the manufacture of cement, and 5 percent was used for other purposes. Dimension sandstone produced in Garrett County was sold for use as flagging, for rough construction, and as sawed architectural stone. Marble was quarried in Harford County and was used for terrazzo chips.

**Talc and Soapstone.**—Harford Talc Co. produced talc in Harford County. The

product was used in ceramics, foundry facings, and toilet preparations.

**Vermiculite (Exfoliated).**—Zonolite Division of W. R. Grace & Co. processed vermiculite at a plant in Prince Georges County and sold the product for aggregates, loosefill insulation, agriculture, and other purposes.

#### MINERAL FUELS

**Coal (Bituminous).**—Bituminous coal was mined in Allegany and Garrett Counties, where 16 underground mines, 28 strip mines, and six auger mines produced 1,615,000 tons, 18 percent more than in 1969. Strip mines produced 78 percent, underground mines 15 percent, and auger mines accounted for the remainder. The average value for coal mined from underground mines and from strip mines increased from \$3.77 and \$4.00 per ton, respectively in 1969 to \$5.25 and \$4.87 per ton, respectively.

**Coke and Coal Chemicals.**—Bethlehem Steel Corp. produced coke and coal chemicals at Sparrows Point. Coproducts and by-products included coke breeze, coke oven

gas, ammonium sulfate, soft tar pitch, crude tar, crude chemical oil, crude light oil and derivatives, and naphthalene.

**Natural Gas and Petroleum.**—Natural gas was produced in Garrett County, where 13 wells in Mountain Lake Park and Negro Mountain fields produced 813 million cubic feet with a market value of \$202,000. No crude petroleum was produced in the State, but American Oil Co. and Chevron Asphalt Co. operated refineries near Baltimore. Throughput capacities of American Oil Co. and Chevron Asphalt Co. were 11,000 and 8,000 barrels, respectively, per day.

**Peat.**—Garrett County Processing & Packaging Corp. harvested reed-sedge and humus peat from a bog in Garrett County; Maryland Peat and Humus Co. harvested peat from a bog in Kent County. The processed material was sold in both bulk and packaged form for soil improvement.

**METALS**

**Aluminum.**—Eastalco Aluminum Company, subsidiary of Howmet Corp. started up a new 85,000-ton-per-year aluminum reduction plant in Frederick County. Imported bauxite is shipped to the plant by rail from Hawkins Point, Anne Arundel County.

**Copper.**—American Smelting and Refining Company in Baltimore, and Kennecott Copper Corp. at Hawkins Point, Anne Arundel County, refined copper from anodes shipped into the State. Gold and silver were produced as byproducts.

**Iron and Steel.**—Pig iron, raw steel, and semifabricated products were produced by Bethlehem Steel Corp. at its Sparrows Point (Baltimore County) plant.

**Lead.**—Lead, lead alloys, and other alloys and products were produced at three plants in Baltimore. The plants consumed lead remelt, primary metals, and scrap.

**Table 6.—Principal producers**

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
<b>Portland:</b>			
Alpha Portland Cement Co. <sup>1</sup>	15 South Third St. Easton, Pa. 18042	Plant	Frederick.
Lehigh Portland Cement Co. <sup>2</sup>	718 Hamilton St. Allentown, Pa. 18101	do	Carroll.
Marquette Cement Mfg. Co. <sup>3</sup>	20 North Wacker Dr. Chicago, Ill. 60606	do	Washington.
<b>Masonry:</b>			
M. J. Grove Lime Co., Division of the Flintkote Co.	Lime Kiln, Md. 21763	do	Frederick.
<b>Clays:</b>			
<b>Ball:</b>			
United Sierra Division, Cyprus Mines Corp.	P.O. Box 1201 Trenton, N.J.	Pit	Baltimore.
<b>Fire:</b>			
Maryland Clay and/or William D. Bowman.	R.F.D. 2, Box 303 Aberdeen, Md. 21001	Pit	Harford.
<b>Miscellaneous clay and shale:</b>			
Baltimore Brick Co.	501 St. Paul Place Baltimore, Md. 21202	Pit	Baltimore.
Do	do	Pit	Frederick.
Chestertown Brick Co.	Chestertown, Md. 21620	Pit	Kent.
Victor Cushwa & Sons, Inc.	201 West Potomac St. Williamsport, Md. 21795	Pit	Washington.
Lehigh Portland Cement Co. <sup>4</sup>	718 Hamilton St. Allentown, Pa. 18101	2 pits	Carroll and Frederick.
Structural Components Corp.	7600 Pulaski Highway Baltimore, Md. 21237	Pit	Baltimore.
United Brick Corp.	2301 New York Ave., N.E. Washington, D.C. 20002	Pit	Prince Georges.
The Washington Brick Division, Thos. Somerville Co.	6th & Decatur, N.E. Washington, D.C. 20002	Pit	Do.
West Brothers Brick Co.	6600 Sheriff Road, N.E. Washington, D.C. 20027	Pit	Do.
<b>Coal:</b>			
Buffalo Coal Co.	P.O. Box 275 Bayard, W. Va. 26707	Strip	Allegheny.
Do	do	5 strip mines	Garrett.
Do	do	Underground	Do.
Do	do	Auger	Do.
Franklin & Polce Coal Co.	Route 1 Masontown, W. Va. 26542	do	Do.
G & S Coal Co. for W. R. Nethken & Co., Inc.	Keyser, W. Va. 26726	Strip	Do.
Moran Coal Co., Inc.	Drawer E Westernport, Md. 21562	3 strip mines	Do.

See footnotes at end of table.

Table 6.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Coal—Continued			
W. & W. Coal Co. ....	P.O. Box 221 Westernport, Md. 21562	Underground	Allegheny.
Winner Brothers Coal Co. ....	243 Upper Consol Road Frostburg, Md. 21532	Strip	Do.
Greensand marl:			
Kaylorite Corp. ....	Dunkirk, Md. 20754	Pit	Calvert.
Gypsum (calcined):			
National Gypsum Co. <sup>5</sup> .....	325 Delaware Ave. Buffalo, N.Y. 14202	Plant	Baltimore.
United States Gypsum Co. ....	101 South Wacker Dr. Chicago, Ill. 60606	do	Do.
Finished iron oxide pigments (natural and manufactured):			
Mineral Pigments Corp. ....	Washington Blvd. Muirkirk, Md. 20705	do	Prince Georges.
Lime:			
S. W. Barrick & Sons, Inc. ....	Woodsboro, Md. 21798	do	Frederick.
LeGore Lime Co. <sup>6</sup> .....	Le Gore, Md. 21761	do	Do.
Peat:			
Garrett County Processing & Packaging Corp. ....	R.F.D. 1 Accident, Md. 21520	Bog	Garrett.
Maryland Peat & Humus Co. ....	90 Cricket Ave. Ardmore, Pa. 19003	Bog	Kent.
Perlite (expanded):			
Atlantic Perlite Co. ....	7950 New Hampshire Ave. Suite 6 Langley Park, Md. 20787	Plant	Prince Georges.
Petroleum refineries:			
American Oil Co. ....	Baltimore, Md. 21200	Refinery	Baltimore.
Chevron Asphalt Co. ....	do	do	Do.
Sand and gravel:			
Annapolis Sand & Gravel Co., Inc. ....	P.O. Box 322 Waldorf, Md. 20601	Pit	Anne Arundel.
Arundel Corp. ....	501 St. Paul Place Baltimore, Md. 21202	Pit	Do.
Bob's Sand Co. ....	Severn, Md. 21144	Pit	Do.
Buffalo Sand & Gravel Co., Inc. ....	Auth Road, Camp Springs Washington, D.C. 20023	Pit	Charles.
Do. ....	do	2 pits	Prince Georges.
Do. ....	do	2 pits	Do.
Harry T. Campbell Sons' Corp. ....	Towson Baltimore, Md. 21204	2 pits	Baltimore.
Charles County Sand & Gravel Co., Inc. ....	P.O. Box 322 Waldorf, Md. 20601	Pit	Charles.
Contee Sand & Gravel Co., Inc. ....	Laurel, Md. 20810	Pit	Prince Georges.
Forestville Sand & Gravel Co., Inc. ....	R.F.D. Box 4263 Upper Marlboro, Md. 20870	Pit	Do.
Inland Materials, Inc. ....	5401 Kirby Road Clinton, Md. 20735	Pit	Do.
Nottingham Properties, Inc. ....	Regester Ave. & Overbrook Rd. Baltimore, Md. 21212	Pit	Baltimore.
Reliable Asphalt, Inc. ....	Millersville, Md. 21108	Pit	Anne Arundel.
Silver Hill Sand & Gravel Co. ....	4600 St. Barnabas Rd., S.E. Washington, D.C. 20031	Pit	Prince Georges.
A. H. Smith Co. ....	Branchville, Md. 20721	Pit	Do.
Stancill's, Inc. ....	P.O. Box 236 Aberdeen, Md. 21001	Pit	Harford.
York Building Products Co., Inc. ....	P.O. Box 1708 York, Pa. 17405	3 pits	Cecil.
Smelters:			
American Smelting & Refining Co. ....	120 Broadway New York, N.Y. 10005	Plant	Baltimore.
Kennecott Refining Corp. ....	161 East 42d St. New York, N.Y. 10017	Refinery	Anne Arundel.
Stone:			
Granite, crushed:			
Maryland Materials, Inc. ....	P.O. Box 159 Elkton, Md. 21921	Quarry	Cecil.
Limestone, crushed and broken:			
Appalachian Stone Division, Martin Marietta Corp. ....	Box 120 Mercersburg, Pa. 17236	4 Quarries	Washington.
The Arundel Corp. ....	501 St. Paul Place Baltimore, Md. 21202	Quarry	Baltimore.
Harry T. Campbell Sons' Corp., Div. of the Flintkote Co. ....	Towson Baltimore, Md. 21204	Underground mine and 2 quarries.	Do.

See footnotes at end of table.

Table 6.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Limestone, crushed and broken			
—Continued			
Cumberland Cement & Supply Co.	Rear 419 North Centre St. Cumberland, Md. 21501	Quarry	Allegany.
M. J. Grove Lime Co., Division of the Flintkote Co.	Lime Kiln, Md. 21763	do	Frederick.
Howard-Montgomery Crushed Stone Co., Div. Contee Sand & Gravel Co., Inc.	Brighton Dam Rd. Clarksville, Md. 21029	do	Howard.
Superior Concrete, Inc.	Frederick, Md. 21701	do	Do.
Teeter Stone, Division Harry T. Campbell Sons' Corp.	Towson Baltimore, Md. 21204	do	Carroll.
Marble crushed:			
The Maryland Green Marble Corp.	Box 1198 Roanoke, Va. 24006	do	Harford.
Miscellaneous (crushed and broken):			
The Arundel Corp.	501 St. Paul Place Baltimore, Md. 21202	do	Baltimore.
Miscellaneous (dimension):			
Stoneyhurst Quarries <sup>7</sup>	7501 Persimmon Tree Lane 3 Bethesda, Md. 20034	Quarries	Montgomery.
Oystershell, crushed:			
Oyster Shell Products, a division of Radcliff Materials, Inc.	607 Keyser Bldg. Baltimore, Md.	Plant	Baltimore.
Quartzite (crushed):			
Harbison Walker Refractories Co., Div. of Dresser Industries.	2 Gateway Center Pittsburgh, Pa. 15222	Quarry	Cecil.
Quartzite (dimension):			
Piccirilli Quarries	Marriottsville Rd. & Driver Rd. Marriottsville, Md. 21104	do	Howard.
The Weaver Stone Co.	Box 96 Reisterstown, Md. 21136	do	Baltimore.
Sandstone (dimension):			
M & S Stone Quarries	Grantsville, Md. 21536	do	Garrett.
Trap rock (basalt) crushed and broken:			
The Arundel Corporation	501 St. Paul Place Baltimore, Md. 21202	do	Baltimore.
Do	do	do	Howard.
Gatch Crushed Stone Co., Inc.	P.O. Box 70-A Bel Air, Md. 21014	do	Harford.
Rockville Crushed Stone, Inc.	P.O. Box 407 Rockville, Md. 20850	do	Montgomery.
D. M. Stoltzfus & Son, Inc.	Talmage, Pa. 17580	do	Cecil.
Do	do	do	Harford.
Talc:			
Harford Talc Co.	Box 527 Bel Air, Md. 21014	Pit	Do.
Vermiculite (exfoliated):			
W. R. Grace & Co., Zonolite Division. <sup>5</sup>	62 Whittemore Ave. Cambridge, Mass. 02140	Plant	Prince Georges.

<sup>1</sup> Also masonry cement, sand, and limestone.<sup>2</sup> Also limestone, sandstone, and shale.<sup>3</sup> Also masonry cement, limestone, and potassium salts.<sup>4</sup> Lightweight aggregate manufacture.<sup>5</sup> Also expanded perlite.<sup>6</sup> Also limestone.<sup>7</sup> Also crushed and broken.



# The Mineral Industry of Massachusetts

By Robert A. Clifton<sup>1</sup>

Mineral production in Massachusetts rose to a new high of \$50.3 million, a 1-percent increase over the previous high set in 1969. Sand, gravel, and stone accounted for 93 percent of mineral production value. The quantity of sand, gravel, and stone produced decreased 5 percent, but the total value increased 2 percent. The total value of lime production decreased 15 percent, and the quantity produced decreased 18 percent.

Employment in the mineral industries

dropped from 1,904 men in 1969 to 1,875 in 1970; the man-hours worked dropped from 3,820,000 to 3,769,000, a decrease of 1 percent. Stone quarry employment remained steady; there was a 2-percent decrease in sand and gravel employment and a 10-percent drop at other nonmetal and peat mines. Although the number of lost-time injuries dropped to 93 in 1970 from 102 in 1969, there was one fatality.

<sup>1</sup> Chemist, Division of Nonmetallic Minerals.

Table 1.—Mineral production in Massachusetts<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays..... thousand short tons	332	\$624	284	\$582
Gem stones.....	NA	2	NA	2
Lime..... thousand short tons	199	3,718	W	W
Sand and gravel..... do	19,456	22,950	17,925	22,244
Stone..... do	7,847	22,521	3,136	24,349
Value of items that cannot be disclosed:				
Nonmetals.....	XX	28	XX	3,183
Total.....	XX	49,843	XX	50,360
Total 1967 constant dollars.....	XX	47,067	XX	45,576

<sup>p</sup> Preliminary. NA Not available. W Withheld to avoid disclosing individual company confidential data. XX Not applicable.

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

Table 2.—Value of mineral production in Massachusetts, by counties

(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Barnstable.....	W	\$604	Sand and gravel.
Berkshire.....	\$8,321	8,211	Stone, lime, sand and gravel.
Bristol.....	3,626	3,949	Sand and gravel, stone.
Dukes.....	W	W	Sand and gravel.
Essex.....	3,802	3,981	Stone, sand and gravel.
Franklin.....	1,158	1,521	Sand and gravel, stone.
Hampden.....	4,423	5,210	Stone, sand and gravel.
Hampshire.....	608	622	Sand and gravel, stone.
Middlesex.....	13,648	13,800	Stone, sand and gravel.
Nantucket.....	4	6	Sand and gravel.
Norfolk.....	5,546	5,667	Stone, sand and gravel, clays.
Plymouth.....	994	936	Sand and gravel, clays, stone.
Suffolk.....	453	821	Stone, sand and gravel.
Worcester.....	5,716	4,023	Sand and gravel, stone, peat.
Undistributed <sup>1</sup> .....	1,546	1,011	
Total <sup>2</sup> .....	49,843	50,360	

W Withheld to avoid disclosing individual company confidential data.

<sup>1</sup> Includes gem stones, some sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

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



Table 3.—Indicators of Massachusetts business activity

	1969	1970 <sup>p</sup>	Change, percent
Employment and labor force, annual average: <sup>1</sup>			
Total labor force..... thousands..	2,537.4	2,576.5	+1.5
Unemployment..... percent of work force..	3.9	5.3	+35.9
Employment:			
Manufacturing..... thousands..	674.5	639.7	-5.2
Durable goods..... do..	345.9	327.3	-5.4
Primary metals..... do..	21.9	19.8	-9.6
Fabricated metals..... do..	42.3	41.1	-2.8
Nonelectrical machinery..... do..	74.1	71.3	-3.8
Electrical machinery..... do..	97.2	91.0	-6.4
Transportation equipment..... do..	26.8	25.2	-6.0
Instruments..... do..	31.4	31.7	+1.0
Nondurable goods..... do..	328.6	312.4	-4.9
Nonmanufacturing..... do..	1,564.9	1,603.0	+2.4
Service, miscellaneous and mining..... do..	456.2	470.9	+3.2
Contract construction..... do..	93.9	93.7	-2
Personal Income: <sup>2</sup>			
Total..... millions..	\$22,722	\$24,493	+7.8
Per capita..... do..	\$4,022	\$4,294	+6.8
Construction activity:			
Cement shipments to and within Massachusetts..... thousand 376-pound barrels..	6,962	7,442	+6.9
Mineral production value..... thousands..	\$49,843	\$50,360	+1.0

<sup>p</sup> Preliminary.<sup>1</sup> Division of Employment Security (Massachusetts).<sup>2</sup> Survey of Current Business.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours		
					Fatal	Non-Fatal	Frequency	Severity	
1969:									
Nonmetal and peat....	64	291	19	150	-----	8	53.33	927	
Sand and gravel.....	1,053	228	240	2,029	-----	45	22.17	417	
Stone.....	787	249	196	1,641	-----	49	29.87	628	
Total <sup>1</sup> .....	1,904	238	454	3,820	-----	102	26.70	528	
1970: <sup>p</sup>									
Nonmetal and peat....	55	311	17	135	-----	7	51.77	2,640	
Sand and gravel.....	1,010	231	233	1,998	-----	29	14.51	334	
Stone.....	815	247	200	1,636	-----	1	56	34.84	4,617
Total <sup>1</sup> .....	1,875	240	450	3,769	-----	1	92	24.67	2,275

<sup>p</sup> Preliminary.<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Clays.**—The value of miscellaneous clay and shale produced declined to 93 percent of that in 1969 as tonnage dropped to 86 percent of last year's. Norfolk County remained the largest producer, with Plymouth the only other county producing clays. Westfield Clay Products Co. of Hampden County stopped its more than 100 years of brickmaking in 1969 and closed its clay mine. Clay for bricks was mined in Plymouth County, and shale for lightweight aggregates was mined in Norfolk County.

**Gypsum.**—United States Gypsum Co., in Suffolk County, manufactured calcined gypsum products. There was an 11 percent decrease in volume from 1969 to 1970.

**Lime.**—During 1970 there was a decrease of 18 percent in tonnage and of 15 percent in value of lime production. The chemical industry remained the major consumer; agriculture and the building industry were also significant consumers. After the closure in 1970 of the Farnam's plant of United States Gypsum Co., the State was left with only two producers, Pfizer, Inc., and Lee

Lime Corp.—both in Berkshire County. Lime consumption in the State was 64,000 tons.

**Peat.**—Reed-sedge peat was mined by Sterling Peat Co. in Worcester County. The total value increased 7 percent over that of 1969. The peat is used mainly by nursery men, landscapers, and greenhouse owners.

**Perlite (Expanded).**—Crude perlite mined outside the State was expanded at two plants in Suffolk County, where the perlite was sold mainly for lightweight aggregate, low-temperature insulation, masonry and cavity fill insulation, and horticultural aggregate.

**Sand and Gravel.**—In spite of a nearly nine fold production increase and a five fold value increase in the sand portion of Government-and-contractor operations, total sand and gravel production in 1970 was

only 92 percent of 1969's production and 97 percent of its value. The \$22 million of sand and gravel produced accounted for 44 percent of the total mineral value in the State, making it the second leading mineral commodity produced. Gravel accounted for 57 percent of the 17.9 million tons of sand and gravel output. Nearly 85 percent of the total tonnage was mined at commercial operations; Government-and-contractor operations provided the balance.

Commercial sand and gravel was produced in all counties in the State except Suffolk, where production was all noncommercial. Building and paving markets consumed 77 percent of the production. Small quantities of sand were used for fill, molding, blast, and filtration. Besides building and paving, gravel was used for railroad ballast and fill.

**Table 5.—Massachusetts: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building.....	3,150	\$3,813	2,907	\$3,871
Fill.....	561	280	540	234
Paving.....	2,534	2,842	2,502	2,799
Blast.....	10	100	W	W
Filtration.....	7	16	W	W
Other uses <sup>1</sup> .....	922	1,522	912	1,733
Total <sup>2</sup> .....	7,185	8,573	6,860	8,636
Gravel:				
Building.....	3,149	5,115	2,840	5,121
Fill.....	1,849	1,356	1,349	854
Paving.....	3,539	4,252	3,287	3,910
Miscellaneous.....	506	513	629	690
Other uses <sup>3</sup> .....	261	370	339	562
Total <sup>2</sup> .....	9,304	11,606	8,444	11,136
<b>Government-and-contractor operations:</b>				
Sand:				
Fill.....	90	85	168	36
Paving.....	5	7	615	357
Other uses.....			68	109
Total <sup>2</sup> .....	95	92	852	502
Gravel:				
Building.....	2	2	71	176
Fill.....			2	3
Paving.....	2,863	2,676	1,626	1,650
Other uses.....	1	2	71	141
Total <sup>2</sup> .....	2,872	2,680	1,768	1,969
<b>Total sand and gravel <sup>2</sup>.....</b>	<b>19,456</b>	<b>22,950</b>	<b>17,925</b>	<b>22,244</b>

W Withheld to avoid disclosing individual company confidential data; included with other sand.  
<sup>1</sup> Includes molding and other sands.  
<sup>2</sup> Data may not add to totals shown because of independent rounding.  
<sup>3</sup> Includes railroad ballast sand.

**Stone.**—Tonnage of stone increased 4 percent, and the value increased 8 percent over that of 1969. The value of stone, which amounted to \$24.3 million, was highest among the minerals produced, and contributed 48 percent of the State's total mineral value. Middlesex County led the State in both quantity and value of stone produced.

Stone, quarried in 11 of the 14 counties, included basalt, granite, limestone, dolomite, sandstone, and miscellaneous stone. Basalt was the most important stone in both quantity and value. Crushed and broken stone accounted for 98 percent of the total stone output in 1970.

Crushed basalt was produced in seven counties. Middlesex County led in value, but Essex County led in quantity. The value of crushed basalt accounted for 39 percent of the total value of stone. The crushed stone was used mainly for construction aggregate; other uses were riprap, railroad ballast, and filter stone.

Granite, sold as crushed and dimension stone, was quarried in five counties. Middlesex County led in value of granite produced, but Norfolk led in quantity. Granite was the second most important stone produced in the State. The chief use for dimension stone was for curbing; other uses in order of decreasing output were rough blocks, construction, rubble, irregular shaped stone, paving blocks, cut stone, monumental, house stone veneer, and flagging. Crushed granite was used mainly for

construction aggregate; smaller quantities were used for riprap and manufactured fine aggregate.

Limestone and dolomite were quarried only in Berkshire County. The chief uses of crushed limestone in descending order were lime, whiting, asphalt fill, poultry grit, construction aggregate, agricultural limestone, flux stone, and other filter.

Sandstone was produced by one company in Hampden County as cut stone for architectural work.

Crushed miscellaneous stone was quarried in Bristol, Norfolk, and Worcester Counties.

**Roofing Granules.**—Output of rhyolite to make roofing granules increased slightly. The rhyolite is quarried in Norfolk County and, for statistical purposes, is classified as miscellaneous stone.

**Vermiculite.**—Sale of vermiculite increased in value over that of 1969. W. R. Grace & Co., in Hampshire County, exfoliated vermiculite mined outside the State. The material was used mainly as insulation; other uses in order of production were concrete aggregate, soil conditioning, and plaster.

## METALS

**Iron and Steel Scrap.**—The State consumed 92,000 tons of scrap iron and steel in 18 electric furnaces, 70 cupola furnaces, and four air furnaces. Fifty-two thousand tons of this scrap was generated in the State.

**Table 6.—Massachusetts: Stone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Dimension stone total				
Crushed and broken stone:	137	\$5,191	128	\$5,808
Bituminous aggregate				
Concrete aggregate	2,846	5,928	3,078	6,695
Dense graded road base stone	598	1,158	741	1,470
Macadam aggregate	641	1,226	573	1,085
Surface treatment aggregate	191	342	118	207
Unspecified aggregate and roadstone	42	101	47	133
Agricultural limestone	2,100	3,735	2,013	3,682
Undistributed <sup>1</sup>	W	617	W	W
Crushed total <sup>2</sup>	1,292	4,222	1,439	5,269
Grand total <sup>2</sup>	7,710	17,330	8,008	18,541
	7,847	22,521	8,136	24,349

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."  
<sup>1</sup> Data includes crushed and broken stone for railroad ballast, riprap, furnace flux, filter stone (1970), sandstone (1970), poultry grit (1970), lime (1970), roofing aggregates (1970), whiting (1970), asphalt fill (1970), and other uses in smaller quantities.

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

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Clays:</b>			
K-F Brick Co., Inc.	River St. Middleboro, Mass. 02346	Pit.	Plymouth.
Masslite Co.	Box 1747 Cross St., Plainville, Mass. 02762	Pit.	Norfolk.
The Stiles & Hart Brick Co.	Box J., Bridgewater, Mass. 02324	Pit.	Plymouth.
<b>Gypsum, calcined:</b>			
United States Gypsum Co.	101 South Wacker Dr. Chicago, Ill. 60606	Plant.	Suffolk.
<b>Lime:</b>			
Lee Lime Corporation	Marble St., Lee, Mass. 01238	do.	Berkshire.
Pfizer, Inc.	260 Columbia St. Adams, Mass. 01220	do.	Do.
United States Gypsum Co.	101 South Wacker Dr. Chicago, Ill. 60606	do.	Do.
<b>Peat:</b>			
Sterling Peat Co.	Sterling Junction, Mass. 01565	Bog.	Worcester.
<b>Perlite, expanded:</b>			
United States Gypsum Co.	101 South Wacker Dr. Chicago, Ill. 60606	Plant.	Suffolk.
Whittemore Products, Inc.	35 Harrison St. Roslindale, Mass. 02131	do.	Do.
<b>Roofing Granules:</b>			
Bird & Son, Inc.	East Walpole, Mass. 02032	do.	Norfolk.
<b>Sand and Gravel:</b>			
Ashland Sand & Concrete Co.	Box 347, Chestnut St. Ashland, Mass. 01721	Pit.	Middlesex.
Assonet Sand & Gravel Co., Inc.	South Main St. Assonet, Mass. 02702	Pit.	Bristol.
Burlington Sand & Gravel Co., Inc.	Blanchard Rd., Box 116 Burlington, Mass. 01803	Pit.	Middlesex.
Courtois Sand & Gravel Co.	Box 84 Central Falls, R.I. 02863	Pit.	Bristol.
J. J. Cronin Co.	P.O. Box 176 North Reading, Mass. 01864	Pit.	Middlesex.
E. L. Dauphinais, Inc.	160 Worcester Rd. North Grafton, Mass. 01536	Pit.	Middlesex and Worcester.
General Sand & Stone Corp.	444 Merrill Rd. Pittsfield, Mass. 01201	Pit.	Berkshire.
P. J. Keating Co.	P.O. Box 345 Fitchburg, Mass. 01420	Pit.	Worcester.
Merrimack Materials, Inc.	Yemma Rd. Groveland, Mass. 01830	Pit.	Essex.
Morse Sand & Gravel Co.	P.O. Box 175 Pawtucket, R.I. 02863	Pit.	Bristol.
North Wilbraham Sand & Gravel & Concrete Co., Inc.	2420 Boston Rd. North Wilbraham, Mass. 01067	Pit.	Hampden.
Northfield Washed Sand & Gravel Co., Inc.	Northfield, Mass. 01360	Pit.	Franklin.
Pomerleau Bros., Inc.	P.O. Box 236 North Chelmsford, Mass. 01863	Pit.	Middlesex.
Thomas Qunn Co., Inc.	20 Hobbs Court Arlington, Mass. 02174	Pit.	Middlesex and Worcester.
L. Romano Const. Co.	835 Taunton Ave. East Providence, R.I. 02914	Pit.	Norfolk.
Rosenfeld Washed Sand & Stone Co.	40 Cedar St. Milford, Mass. 01757	Pit.	Worcester.
San-Vel Contracting Co.	Route No. 2, Ayer Rd. Littleton, Mass. 01460	Pit.	Middlesex.
Stow Sand & Gravel Co.	Box 861, Acton, Mass. 01720	Pit.	Do.
Tresca Bros. Sand & Gravel Inc.	66 Main St. Millis, Mass. 02054	Pit.	Norfolk.
Varney Bros. Sand & Gravel, Inc.	Hartford Ave. Bellingham, Mass. 02019	Pit.	Do.
Warner Bros., Inc.	Sunderland, Mass. 01375	Pit.	Franklin.
A. A. Will Sand & Gravel Corp.	Turnpike St. Canton, Mass. 02021	Pit.	Norfolk.
Worcester Sand & Gravel Co.	182 Holden St. Shrewsbury, Mass. 01545	Pit.	Worcester.
Wrentham Sand & Gravel Co., Inc.	Riverside Rd. Wrentham, Mass. 02093	Pit.	Norfolk.
<b>Stone:</b>			
Basalt, crushed and broken: B. & M. Crushed Stone Division	Spring St., Ashland, Mass. 01721	Quarry.	Middlesex.
Bayer & Mingolla Industries, Inc.	1471 Methuen St. Dracut, Mass. 01826	do.	Do.
George Brox, Inc.			

See footnotes at end of table.

Table 7.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Basalt, crushed and broken—Continued			
Essex Bituminous Concrete Corp.	Russell St. West Peabody, Mass. 01960	Quarry	Essex.
Essex Bituminous Concrete Corp. of Dracut.	2140 Bridge St. Dracut, Mass. 01826	do	Middlesex.
Holden Trap Rock Co.	North Main St., Holden, Mass. 01520	do	Worcester.
P. J. Keating Co.	P. O. Box 345 Fitchburg, Mass. 01420	do	Do.
John S. Lane & Son, Inc.	P. O. Box 125 Westfield, Mass. 01085	do	Hampden and Hampshire.
Lynn Sand & Stone Co.	30 Danvers Rd. Swampscott, Mass. 01907	do	Essex.
Massachusetts Broken Stone Co.	Boston Post Rd. Weston, Mass. 02193	do	Middlesex.
Mario Pandolf Co., Inc.	106 Sachem Rd. Needham Heights, Mass. 02194	do	Worcester.
Rowe Contracting Co.	1500 Salem St. Malden, Mass. 02148	do	Middlesex.
Simeone Stone Corp.	P. O. Box 218 Wrentham, Mass. 02093	do	Norfolk.
Trimount Bituminous Products Co.	1840 Parkway St. Everett, Mass. 02149	do	Essex.
Warner Bros., Inc.	Sunderland, Mass. 01375	do	Franklin.
Granite, dimension:			
Bates Bros. Seam Face Granite Co. <sup>1</sup>	1372 Hancock St. Quincy, Mass. 02169	do	Norfolk.
H. E. Fletcher Co. <sup>1</sup>	West Chelmsford, Mass. 01824	do	Middlesex.
Forrest Road Granite Co., Inc.	20 Adams St. North Chelmsford, Mass. 01863	do	Do.
Guilmette Bros. Corp.	57 Ledge Rd. North Chelmsford, Mass. 01863	do	Do.
Le Masurier Granite Quarry, Inc.	P. O. Box 71, Ledge, Rd. North Chelmsford, Mass. 01863	do	Do.
Oak Hill Granite Co., Inc.	Middlesex St., Lowell, Mass. 01852	do	Do.
Plymouth Quarries, Inc. <sup>1</sup>	East Weymouth, Mass. 01402	do	Plymouth.
Granite, crushed and broken:			
Old Colony Crushed Stone Co.	P. O. Box 230 Quincy, Mass. 02169	do	Norfolk.
Simeone Stone Corp.	P. O. Box 218 Wrentham, Mass. 02093	do	Do.
West Roxbury Crushed Stone Co.	10 Grove St. West Roxbury, Mass. 02132	do	Suffolk.
Limestone and dolomite, crushed:			
John S. Lane & Son, Inc.	P. O. Box 125 Westfield, Mass. 01085	do	Berkshire.
Lee Lime Corp.	Marble St., Lee, Mass. 01238	do <sup>2</sup>	Do.
Pfizer, Inc.	260 Columbia St. Adams, Mass. 01220	do	Do.
Miscellaneous stone, crushed:			
Berlin Stone Co.	Sawyer Pill Rd. Berlin, Mass. 01503	do	Worcester.
Dedham Sand & Gravel, Inc.	Walpole, Mass. 02081	do	Norfolk.
S. M. Lorusso & Sons, Inc.	331 West St. Walpole, Mass. 02081	do	Do.
Warren Bros. Co., Division of Ash- land Oil & Refining Co.	430 Howard St. Brockton, Mass. 02402	do	Bristol.
Sandstone, dimension:			
McCormick Longmeadow Stone Co., Inc.	East Longmeadow, Mass. 01028	do <sup>3</sup>	Hampden.
Vermiculite, exfoliated:			
W. R. Grace & Co., Zonolite Div.	62 Whittemore Ave. Cambridge, Mass. 02140	Plant	Hampshire.

<sup>1</sup> Also crushed and broken granite.<sup>2</sup> 2 quarries; 1 dolomite, 1 limestone.<sup>3</sup> 2 quarries.

# The Mineral Industry of Michigan

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

By Grace N. Broderick <sup>1</sup>

In 1970 the value of mineral production in Michigan totaled \$671 million, less than a one percent gain over that of 1969. The leading commodity in terms of value continued to be iron ore, followed by cement, copper, and sand and gravel.

Nonmetals accounted for more than 55 percent of the State's total mineral value; metallic minerals accounted for 37 percent; mineral fuels made up the remainder.

**Legislation.**—In 1970 Michigan passed a Mine Reclamation Act (Act 92 of the Public Acts of 1970) to provide for recla-

mation of lands subjected to mining of metallic minerals. The Geological Survey Division of the Department of Natural Resources is undertaking a survey to determine the type of regulation needed to assure reclamation of open pit mines and upon its completion will issue appropriate regulations pertaining to surface mining operations in the State.

An environmental bill was also passed (Environmental Protection Act, State of

<sup>1</sup> Physical scientist, Division of Ferrous Metals.

Table 1.—Mineral production in Michigan <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>Cement:</b>				
Portland.....thousand 376-pound barrels..	30,373	\$98,425	29,818	\$101,019
Masonry.....thousand 280-pound barrels..	1,904	5,473	1,519	5,253
Clays.....thousand short tons..	2,667	3,037	2,480	2,887
Copper (recoverable content of ores, etc.).....short tons..	75,226	71,516	67,543	77,945
Gypsum.....thousand short tons..	1,327	5,384	1,312	5,061
Iron ore (usable).....thousand long tons, gross weight..	14,058	169,756	13,100	168,958
Lime.....thousand short tons..	1,589	20,372	1,538	21,355
Magnesium compounds.....short tons, MgO equivalent..	321,191	30,343	411,911	38,050
Natural gas.....million cubic feet..	36,163	9,294	38,851	10,373
<b>Natural gas liquids:</b>				
Natural gasoline.....thousand 42-gallon barrels..	921	2,481	599	1,611
LP gases.....do.....	1,197	2,561	1,176	2,764
Peat.....thousand short tons..	186	2,724	167	1,896
Petroleum (crude).....thousand 42-gallon barrels..	12,213	37,494	11,693	36,246
Salt.....thousand short tons..	4,819	45,961	4,899	49,963
Sand and gravel.....do.....	58,092	58,968	53,092	54,646
Silver (recoverable content of ores, etc.).....thousand troy ounces..	1,009	1,807	892	1,579
Stone.....thousand short tons..	39,186	43,572	41,687	49,501
<b>Value of items that cannot be disclosed:</b>				
Bromine, calcium-magnesium chloride, gem stones, iodine, and potassium salts.....	XX	58,818	XX	41,622
<b>Total</b> .....	XX	667,986	XX	670,729
<b>Total 1967 constant dollars</b> .....	XX	630,779	XX	607,010

Ⓟ Preliminary. Ⓡ Revised. XX Not applicable.

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

Table 2.—Value of mineral production in Michigan, by counties <sup>1</sup>

County	1969	1970	Minerals produced in 1970 in order of value
Alcona.....	\$225	W	Sand and gravel.
Alger.....	38	\$39	Do.
Allegan <sup>2</sup> .....	972	W	Sand and gravel, petroleum, peat, stone, natural gas.
Alpena.....	W	W	Cement, stone, clays, sand and gravel.
Antrim.....	475	W	Clays, sand and gravel.
Arenac.....	1,005	1,048	Petroleum, stone, sand and gravel.
Baraga.....	99	120	Sand and gravel.
Barry.....	783	W	Sand and gravel, petroleum, stone.
Bay.....	9,851	8,738	Cement, petroleum, sand and gravel, lime.
Benzie.....	9	3	Sand and gravel.
Berrien.....	2,827	2,960	Sand and gravel, stone.
Branch.....	399	355	Do.
Calhoun <sup>2</sup> .....	6,697	W	Petroleum, sand and gravel, stone, natural gas.
Cass.....	452	W	Sand and gravel, stone.
Charlevoix.....	11,761	12,389	Cement, stone, sand and gravel.
Cheboygan.....	125	138	Sand and gravel, stone.
Chippewa.....	W	4,471	Stone, sand and gravel.
Clare <sup>2</sup> .....	W	W	Petroleum, sand and gravel, natural gas.
Clinton.....	710	W	Sand and gravel, clays.
Crawford <sup>2</sup> .....	1,405	W	Petroleum, sand and gravel, natural gas.
Delta.....	205	270	Sand and gravel, stone.
Dickinson.....	26,663	26,983	Iron ore, sand and gravel, stone.
Eaton.....	887	1,033	Sand and gravel, stone, clays, peat.
Emmet.....	8,275	9,342	Cement, stone, sand and gravel.
Genesee.....	645	633	Sand and gravel, petroleum.
Gladwin.....	1,011	W	Petroleum, sand and gravel.
Gogebic.....	W	114	Sand and gravel.
Grand Traverse.....	189	W	Do.
Gratiot <sup>1</sup> .....	W	W	Salt, calcium-magnesium chloride, magnesium compounds, sand and gravel, bromine, petroleum, natural gas.
Hillsdale <sup>2</sup> .....	9,525	W	Petroleum, sand and gravel, stone, natural gas.
Houghton.....	210	119	Sand and gravel, stone.
Huron.....	970	1,105	Stone, sand and gravel, lime, petroleum.
Ingham.....	1,240	W	Sand and gravel, petroleum, peat.
Ionia.....	483	562	Sand and gravel.
Iosco.....	5,011	4,895	Gypsum, sand and gravel.
Iron.....	9,565	7,020	Iron ore, sand and gravel.
Isabella <sup>1</sup> .....	1,136	W	Petroleum, sand and gravel, natural gas.
Jackson <sup>1</sup> .....	4,190	W	Petroleum, sand and gravel, stone, natural gas.
Kalamazoo.....	1,219	1,809	Sand and gravel, stone.
Kalkaska.....	296	521	Petroleum, sand and gravel.
Kent <sup>2</sup> .....	4,945	4,478	Sand and gravel, gypsum, petroleum, peat, natural gas.
Keweenaw.....	27	21	Sand and gravel.
Lake.....	626	685	Petroleum, sand and gravel.
Lapeer <sup>2</sup> .....	1,479	1,340	Peat, sand and gravel, petroleum, calcium-magnesium chloride, natural gas.
Leelanau.....	274	222	Stone, sand and gravel.
Lenawee.....	665	766	Sand and gravel, clays, petroleum, natural gas.
Livingston.....	3,738	3,345	Sand and gravel, petroleum.
Luce.....	92	33	Sand and gravel.
Mackinac.....	W	W	Stone, sand and gravel.
Macomb <sup>2</sup> .....	2,770	2,284	Sand and gravel, petroleum, natural gas.
Manistee.....	25,790	27,573	Magnesium compounds, salt, bromine, sand and gravel.
Marquette.....	134,424	135,806	Iron ore, sand and gravel.
Mason.....	W	W	Magnesium compounds, calcium-magnesium chloride, lime, bromine, sand and gravel, petroleum.
Mecosta <sup>1</sup> .....	910	W	Petroleum, sand and gravel, peat, natural gas.
Menominee.....	W	W	Lime, sand and gravel.
Midland.....	W	W	Bromine, salt, calcium-magnesium chloride, iodine, petroleum, sand and gravel, magnesium compounds, potash.
Missaukee <sup>2</sup> .....	1,791	2,008	Petroleum, sand and gravel, natural gas.
Monroe.....	W	W	Cement, stone, clays, peat, petroleum, sand and gravel.
Montcalm <sup>2</sup> .....	636	543	Petroleum, sand and gravel, natural gas.
Montmorency.....	31	54	Sand and gravel.
Muskegon.....	2,267	2,260	Salt, sand and gravel, petroleum.
Newaygo <sup>2</sup> .....	443	493	Sand and gravel, petroleum, natural gas.
Oakland.....	12,006	W	Sand and gravel, peat, petroleum.
Oceana.....	507	507	Sand and gravel, petroleum.
Ogemaw <sup>1</sup> .....	1,412	1,736	Petroleum, sand and gravel, natural gas.
Ontonagon.....	73,412	79,618	Copper, silver, sand and gravel.
Oscoda <sup>2</sup> .....	2,384	2,261	Petroleum, sand and gravel, natural gas.
Osoda.....	20	50	Sand and gravel, petroleum.
Otsego <sup>2</sup> .....	212	911	Petroleum, sand and gravel, natural gas.

See footnotes at end of table.

Table 2.—Value of mineral production in Michigan, by counties <sup>1</sup>—Continued

(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Ottawa <sup>2</sup> .....	\$3,066	W	Sand and gravel, clays, petroleum, natural gas.
Presque Isle .....	W	W	Stone, sand and gravel, petroleum.
Roscommon <sup>2</sup> .....	772	W	Petroleum, sand and gravel, natural gas.
Saginaw .....	655	\$513	Sand and gravel, lime, clays, petroleum.
St. Clair <sup>2</sup> .....	17,773	19,293	Salt, petroleum, cement, peat, clays, sand and gravel, natural gas.
St. Joseph .....	282	266	Sand and gravel, peat, stone.
Sanilac .....	1,468	1,158	Peat, sand and gravel, lime.
Schoolcraft .....	W	W	Stone, sand and gravel.
Shiawassee .....	830	682	Sand and gravel, peat, clays, petroleum.
Tuscola .....	1,906	W	Sand and gravel, petroleum, lime.
Van Buren .....	273	174	Sand and gravel, petroleum.
Washtenaw .....	1,479	1,354	Do.
Wayne .....	56,213	57,189	Cement, salt, lime, sand and gravel, calcium-magnesium chloride, stone, clays, petroleum.
Wexford .....	114	121	Sand and gravel.
Undistributed <sup>3</sup> .....	† 202,738	238,321	
Total <sup>4</sup> .....	† 667,986	670,729	

<sup>1</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

<sup>2</sup> Values for natural gas and natural gas liquids are not available on a county basis, but are included with "Undistributed."

<sup>3</sup> Excludes value of natural gas.

<sup>4</sup> Includes values for natural gas, natural gas liquids, gem stones, some sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

<sup>5</sup> Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Michigan business activity

	1969	1970	Change, percent	
Employment and labor force, annual average:				
Total labor force .....	thousands ..	3,587.7	3,608.3	+ .4
Unemployment .....	do .....	145.0	253.7	+75.0
Employment:				
Manufacturing .....	do .....	1,192.7	1,078.1	-9.6
Contract construction .....	do .....	119.3	103.4	-13.3
Mining .....	do .....	12.2	12.2	--
Transportation and public utilities .....	do .....	149.2	147.7	-1.0
Wholesale and retail trade .....	do .....	586.4	586.2	( <sup>1</sup> )
Finance, insurance, and real estate .....	do .....	113.8	115.1	+1.1
Services .....	do .....	402.8	411.2	+2.1
Government .....	do .....	500.2	515.9	+3.1
Personal income:				
Total .....	millions ..	\$35,010	\$36,001	+2.8
Per capita .....	do .....	\$3,987	\$4,043	+1.4
Construction activity:				
Valuation of nonresidential construction .....	millions ..	\$588.2	\$473.4	-19.5
Number of private and public residential units authorized .....	do .....	55,047	53,838	-2.2
State highway department:				
Contracts awarded .....	millions ..	\$147.6	\$187.1	+26.8
Portland cement shipments to and within Michigan .....	thousand 376-pound barrels ..	16,459	14,663	-10.9
Farm marketing receipts .....	millions ..	\$863.3	\$900.2	+4.3
Mineral production .....	do .....	† \$668.0	\$670.7	+ .4

<sup>1</sup> Revised.

<sup>2</sup> Less than ½ of one percent.

Sources: U.S. Department of Labor, Survey of Current Business, Construction Review, Area Trends in Employment and Unemployment, Employment and Earnings, Farm Income Situation, U.S. Department of Commerce, and U.S. Bureau of Mines.



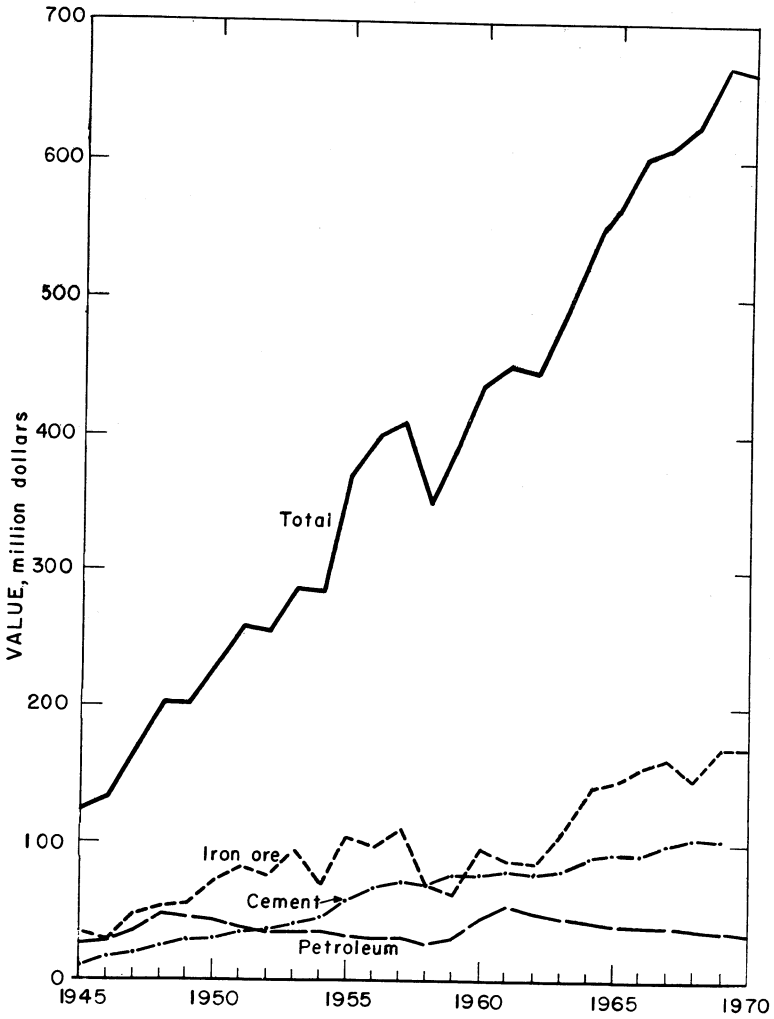


Figure 1.—Value of iron ore, petroleum, cement, and total value of all minerals produced in Michigan.

Michigan, Act 127 of the Public Acts of 1970) making Michigan the first State to permit any citizen to bring court action to protect air, water, and other natural resources; several suits have been filed under this new bill.

The Mineral Well Act (Act 315 of the Public Acts of 1969) became effective in March 1970. This act provides control of the drilling, operating, and abandoning of mineral wells to prevent surface and

underground waste. It cites several classes of mineral wells and includes holes drilled to obtain geologic or geophysical information.

**Employment.**—Preliminary data for 1970 and final data for 1969 compiled by the U.S. Bureau of Mines for employment and injuries in the mineral industries, excluding the petroleum industry, are shown in table 4.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1969:								
Peat.....	183	189	35	332	--	1	3.01	84
Metal.....	5,170	269	1,393	11,147	5	310	28.26	4,159
Nonmetal.....	1,826	275	503	4,023	--	96	23.86	475
Sand and gravel.....	2,636	219	577	4,968	3	100	20.73	4,924
Stone.....	3,435	239	993	7,941	2	59	7.68	1,980
Total <sup>1</sup> .....	13,250	264	3,501	28,412	10	566	20.27	3,114
1970: <sup>p</sup>								
Peat.....	173	195	34	311	--	5	16.10	280
Metal.....	4,635	306	1,416	11,323	3	314	27.98	2,548
Nonmetal.....	1,730	297	514	4,197	2	111	26.93	3,525
Sand and gravel.....	2,620	217	569	4,820	1	124	25.94	2,136
Stone.....	2,970	301	892	7,247	--	64	8.83	305
Total <sup>1</sup> .....	12,125	283	3,425	27,902	6	618	22.36	2,016

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Cement.**—Portland cement shipments declined about 2 percent, but value of shipments increased more than 2 percent over that of 1969 because of higher unit prices. The value per barrel increased to \$3.39 in 1970 from \$3.24 in the previous year. Masonry cement shipments declined 20 percent, while value dropped only 4 percent. Portland cement was produced at nine plants in seven counties (Alpena, Bay, Charlevoix, Emmet, Monroe, St. Clair, and Wayne); masonry cement was shipped from five of these plants. Yearend stocks of portland cement at mills were 4.0 million barrels compared with 4.3 million barrels in 1969. More than 95 percent of portland cement shipped was types I and II (general use and moderate heat); the remainder was principally type III (high-early strength). Eighty-two percent of the finished portland cement was shipped to

building material dealers, concrete products manufacturers and ready-mix concrete manufacturers.

Raw materials used in portland cement manufacture included 7.3 million tons of limestone, about 2.1 million tons of clay or shale, as well as quantities of gypsum, sand, iron ore, slag, mill scale, air-entraining compounds, and grinding aids. Over 712 million kilowatt-hours of electricity was used, of which 358 million was purchased and the remainder generated by the consumer. Shipments of portland cement to ultimate consumer were 95 percent by truck and 5 percent by rail.

American Cement Corporation, Peerless division, closed its old Jefferson Avenue plant in Detroit at yearend. A new 4 million barrel plant, scheduled for operation in 1971, is under construction.

Wyandotte Chemical Corp. shut down the kiln at its plant near Detroit early in

March and imported clinker for its finish mills.

Aetna Portland Cement Co. Division of Martin Marietta Corp. closed down four old kilns at its Essexville plant to end a dust problem. A fifth kiln, with capacity equal to the four smaller units, complies with Michigan dust standards.

**Clays.**—Miscellaneous clays and shale were mined at 16 pits in 11 counties. Output of clay and shale was about 7 percent less than in 1969, reflecting a decrease in demand for cement, the largest user of this material; in 1970, cement manufacture used 82 percent of the clay and shale output, compared with about 88 percent used for this purpose in 1969. Other uses were for lightweight aggregate, heavy clay products, pottery, and stoneware. The largest production was reported from Alpena, Wayne, Monroe, Antrim, Ottawa, St. Clair, and Saginaw Counties.

The new lightweight aggregate plant of Construction Aggregates Corp., near Grand Haven in Ottawa County, went on stream in 1970 and was producing at the rate of 300,000 tons per year. It is the first lightweight aggregate plant to have facilities for direct shipment on the Great Lakes. It is also the first local source of lightweight aggregate in western Michigan.

**Gem Stones.**—Hobbyists collected gem stones mainly along Lake Superior beaches in the Upper Peninsula. Agates, thomsonite and other semiprecious stones were found, as well as specimens of hematite and native copper. "Petoskey stone," the State's official stone, was cut and polished locally for a growing tourist and novelty industry. The Kona dolomite of upper Michigan's Kona Hills was used for ornamental objects and for jewelry.

**Gypsum.**—Gypsum output and value in 1970 were 1,312 thousand short tons and \$5.1 million, respectively; the State continued to be the leading gypsum-producer. Plant expansion as well as an air-pollution

control program was started by Grand Rapids Gypsum Co. at its Grand Rapids plant in Kent County. Plans include construction of new calcining facilities and an electrostatic dust collector.

**Lime.**—Although lime output decreased 3 percent, reflecting a decline in industrial demand, value increased 5 percent because of higher prices. Lime plants were operated in eight counties. Detroit Lime Co., a subsidiary of the Edward C. Levy Co., uses both rotary and vertical kiln calcining systems to meet a wide variety of customer requirements. The rotary kiln has a capacity of 400 tons per day; the vertical kiln is rated to operate at 600 tons per day.

**Natural Salines.**—Bromine, calcium chloride, calcium-magnesium chloride, iodine, magnesium compounds, and potash were extracted from natural well brines. In 1970, after many years as the leading producer of bromine in the United States, Michigan dropped behind Arkansas in bromine production. It continued to provide most of the output of calcium chloride and calcium-magnesium chloride and is the only domestic producer of iodine. Wells were operated in Gratiot, Lapeer, Manistee, Mason, Midland, and Wayne Counties.

**Perlite.**—Crude perlite, mined in Western States, was expanded at plants in Iosco, Kent, and Wayne Counties. The material was used for roof insulation and plaster aggregate.

**Salt.**—Salt was produced from one rock salt mine in Wayne County, the only underground salt mine in the State, and from natural and artificial brines at plants in Gratiot, Manistee, Midland, Muskegon, St. Clair, and Wayne Counties. Output was about 1.7 percent more than that in 1969, but value increased 8.7 percent.

**Sand and Gravel.**—Production of sand and gravel decreased 8.6 percent and was valued at \$55 million, a decrease of 7.3 percent from 1969. Michigan ranked

Table 5.—Michigan: Portland cement salient statistics

(Thousand 376-pound barrels and thousand dollars)

	1969	1970
Number of active plants.....	9	9
Production.....	30,565	29,655
Shipments from mills:		
Quantity.....	30,373	29,813
Value.....	\$98,425	\$101,019
Stocks at mills, Dec. 31.....	4,320	3,959

second nationally in sand and gravel output. A new plant, to replace the old one built in 1941, was constructed by American Aggregates Corp. at Brighton. Tables 6 and 7 show the production of sand and gravel, by classes of operation and uses, and by counties, respectively.

**Stone.**—Michigan, with a production of 41.7 million tons ranked seventh in the Nation's output of stone. Production, principally crushed limestone, increased 6.4 percent over the 1969 rate. Stone was quarried in 27 counties; five counties (Alpena, Chippewa, Mackinac, Monroe, and Presque Isle) with production of 1 million tons or more contributed 91 percent of the State total.

About 40 percent of all flux stone produced in the United States comes from

Michigan. Much of this material is shipped by water from upper Michigan quarries. The quantity and value of stone sold or used by producers in Michigan, by kinds and uses are shown in tables 8 and 9, respectively.

**Sulfur.**—Byproduct sulfur was recovered from crude petroleum by Leonard Refineries, Inc. (Alma), Marathon Oil Co. (Detroit), and Mobil Oil Co., Inc. (Woodhaven). Shipments decreased about 7.9 percent from those in 1969, and value declined 22 percent.

**Vermiculite.**—Crude vermiculite, mined outside the State, was exfoliated at a plant in the Detroit area. It was sold for use in loose fill insulation, plaster aggregate, concrete aggregate, and for agricultural and other uses.

**Table 6.—Michigan: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	8,179	\$7,172	6,971	\$6,181
Fill.....	4,189	2,076	3,655	1,783
Molding.....	4,468	8,734	3,188	5,994
Paving.....	5,366	4,886	4,884	4,720
Other uses <sup>1</sup> .....	941	2,448	2,131	3,765
<b>Total<sup>2</sup>.....</b>	<b>23,143</b>	<b>25,315</b>	<b>20,829</b>	<b>22,444</b>
<b>Gravel:</b>				
Building.....	7,291	11,087	6,201	10,006
Fill.....	325	247	383	229
Paving.....	19,647	17,637	17,116	16,245
Railroad ballast.....	173	260	138	186
Miscellaneous.....	--	--	213	136
Other uses.....	80	90	354	522
<b>Total<sup>2</sup>.....</b>	<b>27,518</b>	<b>29,321</b>	<b>24,405</b>	<b>27,324</b>
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Building.....	13	6	--	--
Fill.....	356	148	677	291
Paving.....	1,715	903	2,055	1,163
Other uses.....	135	63	132	77
<b>Total<sup>2</sup>.....</b>	<b>2,218</b>	<b>1,121</b>	<b>2,865</b>	<b>1,531</b>
<b>Gravel:</b>				
Building.....	11	7	38	24
Fill.....	246	111	446	201
Paving.....	4,956	3,094	4,474	3,103
Other uses.....	--	--	34	19
<b>Total<sup>2</sup>.....</b>	<b>5,213</b>	<b>3,212</b>	<b>4,992</b>	<b>3,346</b>
<b>Total sand and gravel<sup>2</sup>.....</b>	<b>58,092</b>	<b>58,968</b>	<b>53,092</b>	<b>54,646</b>

<sup>1</sup> Includes railroad ballast, abrasives, blast, enamel, engine, glass, grinding and polishing, pottery, and other sands.

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

Table 7.—Michigan: Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Alcona	2	391	\$225	2	W	W
Alger	1	64	38	2	68	\$39
Allegan	12	776	525	8	933	601
Alpena	3	112	110	3	102	W
Antrim	3	95	W	1	78	62
Arenac	2	50	41	2	W	W
Baraga	2	150	99	2	W	120
Barry	8	797	740	8	1,034	991
Benzie	1	17	9	1	8	3
Berrien	11	1,828	2,824	8	1,647	2,957
Branch	5	332	398	2	219	354
Calhoun	14	481	335	7	390	262
Cass	9	580	436	7	823	521
Charlevoix	5	113	W	6	132	68
Cheboygan	6	114	W	3	W	W
Chippewa	10	456	345	4	W	W
Clare	2	205	W	2	W	W
Clinton	12	773	W	15	801	675
Crawford	2	21	24	2	W	W
Delta	6	293	W	4	299	W
Dickinson	5	104	W	4	128	151
Eaton	12	730	589	8	919	702
Emmet	4	86	W	4	131	77
Genesee	10	805	614	17	534	548
Gladwin	2	47	33	2	W	W
Gogebic	4	163	W	3	120	114
Grand Traverse	2	253	189	1	270	W
Gratiot	4	425	395	4	428	373
Hillsdale	7	493	576	7	507	591
Houghton	5	255	W	3	153	94
Huron	6	398	W	6	319	W
Ingham	19	1,293	1,237	10	1,285	1,087
Ionia	5	575	483	8	679	562
Iosco	1	700	490	1	W	W
Iron	4	181	197	3	232	246
Isabella	5	593	449	3	W	W
Jackson	7	406	391	4	W	W
Kalamazoo	7	941	1,163	10	W	W
Kalkaska	1	19	11	1	21	11
Kent	28	2,946	3,822	24	2,723	3,439
Keweenaw	1	48	27	1	40	21
Lake	1	35	20	1	49	23
Lapeer	5	292	176	6	547	384
Leelanau	2	250	W	2	W	W
Lenawee	8	709	656	6	670	756
Livingston	9	3,435	3,736	9	2,827	3,343
Luce	4	172	92	3	52	33
Mackinac	4	196	102	4	212	104
Macomb	16	3,202	2,747	9	2,525	2,268
Marquette	10	490	W	12	325	283
Mason	8	1,145	W	3	W	W
Mecosta	5	331	W	4	279	281
Menominee	3	400	238	3	397	230
Midland	2	272	W	2	W	W
Missaukee	3	88	68	2	284	276
Montcalm	9	487	266	4	435	193
Montmorency	2	50	31	2	93	54
Muskegon	6	463	W	5	476	W
Newaygo	12	517	323	9	754	439
Oakland	28	11,779	11,944	29	9,895	10,597
Oceana	7	558	405	5	412	300
Ogemaw	7	773	567	6	808	809
Ontonagon	3	141	89	2	155	94
Osceola	4	374	316	2	695	688
Oscoda	1	29	15	1	102	46
Otsego	3	W	W	2	43	29
Ottawa	14	2,729	2,835	12	2,519	2,769
Presque Isle	4	470	W	4	W	527
Roscommon	6	331	289	5	W	W
St. Clair	8	109	55	7	W	W
St. Joseph	4	301	276	3	W	W
Saginaw	3	308	W	3	255	179
Sanilac	5	339	W	10	681	329
Schoolcraft	3	92	56	3	259	178

See footnotes at end of table.

**Table 7.—Michigan: Sand and gravel sold or used by producers, by counties—Continued**  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Shiawassee .....	12	761	\$564	11	440	\$405
Tuscola .....	14	1,525	W	13	936	1,178
Van Buren .....	8	364	245	5	194	156
Washtenaw .....	13	1,548	1,461	12	1,360	1,342
Wayne .....	11	2,696	4,978	8	2,352	3,953
Wexford .....	5	143	114	5	158	121
Undistributed <sup>1</sup> .....	7	1,083	9,484	6	6,881	7,607
<b>Total<sup>2</sup> .....</b>	<b>535</b>	<b>58,092</b>	<b>58,968</b>	<b>453</b>	<b>53,092</b>	<b>54,646</b>

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

<sup>1</sup> Includes Bay, Manistee and Monroe (1970) Counties, some sand and gravel that cannot be assigned to specific counties, and data indicated by symbol W.

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

**Table 8.—Stone sold or used by producers, by kinds**  
(Thousand short tons and thousand dollars)

Kind of stone	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Marble .....			4	\$91
Sandstone <sup>1</sup> .....	5	\$69	3	47
<b>Total<sup>2</sup> .....</b>	<b>5</b>	<b>69</b>	<b>6</b>	<b>138</b>
<b>Crushed and broken:</b>				
Limestone .....	30,659	31,385	35,390	39,768
Dolomite .....	8,407	11,983	6,124	9,356
Marl <sup>3</sup> .....	114	135	166	239
<b>Total<sup>2</sup> .....</b>	<b>39,180</b>	<b>43,503</b>	<b>41,681</b>	<b>49,363</b>
<b>Grand total<sup>2</sup> .....</b>	<b>39,186</b>	<b>43,572</b>	<b>41,687</b>	<b>49,501</b>

<sup>1</sup> To avoid disclosing company confidential data, includes limestone and dolomite.

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

<sup>3</sup> To avoid disclosing company confidential data, includes granite and traprock.

**Table 9.—Crushed and broken stone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Bituminous aggregate .....	1,268	\$1,652	W	W
Concrete aggregate .....	3,372	3,574	2,803	\$3,161
Dense graded road base stone .....	1,137	1,640	502	607
Macadam aggregate .....	266	357	W	W
Surface treatment aggregate <sup>1</sup> .....	378	513	W	W
Unspecified aggregate and roadstone .....	518	604	4,163	6,233
Agricultural limestone .....	624	768	564	666
Cement .....	9,310	8,174	8,467	7,638
Flux .....	12,351	15,591	12,973	17,121
Lime .....	7,729	8,175	7,775	8,593
Other soil conditioners .....	99	86	142	140
Railroad ballast .....	107	124	W	W
Other <sup>2</sup> .....	2,020	2,247	4,290	5,204
<b>Total<sup>3</sup> .....</b>	<b>39,180</b>	<b>43,503</b>	<b>41,681</b>	<b>49,363</b>

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

<sup>1</sup> To avoid disclosing confidential data, 1969 totals are incomplete, the portion not included being combined with "Other."

<sup>2</sup> Includes stone used for chemical uses, dead burned dolomite, paper manufacturing, poultry grit, riprap and jetty stone, stone sand, sugar refining (1970), asphalt filler and other fillers or extenders (1969), terrazzo and exposed aggregate (1969), and other uses not listed.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

## METALS

**Copper.**—Production of copper, in terms of recoverable metal, decreased 10.2 percent in 1970. The average weighted price for copper increased from 47.5 cents in 1969 to 57.7 cents per pound. The White Pine Copper Co., a subsidiary of the Copper Range Co., continued to be the only producer of primary copper in Michigan. Mining difficulties encountered in certain areas of the White Pine mine contributed to its lowered production. The Quincy Mining Co. operated its smelter at Hancock at a reduced capacity and fire-refined 9,900 tons of copper scrap.

**Iron Ore.**—Iron ore shipments in 1970 were 13.1 million long tons, a decrease of 7 percent from the 14.1 million long tons shipped in 1969. Pellets accounted for 84 percent of the total shipments. The average weighted mine value for Michigan usable iron ore shipments in 1970 was \$12.90, compared with \$12.08 in 1969.

At the end of 1970, the Cleveland-Cliffs Iron Co. closed the following facilities on

the Marquette range: the Eagle Mills pellet plant, near Negaunee, and the Humboldt mine in Humboldt Township. The Eagle Mills plant, which began operations in 1950, will remain on a standby basis pending possible future reactivation. Concentrate from the Republic mine, which has been handled at Eagle Mills, will now be pelletized at the Humboldt plant, which is being leased to the Marquette Iron Mining Co.

On the Menominee range of Michigan, the only remaining active properties were the Groveland mine operated by the Hanna Mining Co., and the Sherwood mine, an Inland Steel Co. property. The Hanna Mining Co. operated its Groveland pellet plant at near capacity, shipping 2 million tons of pellets. Shipments from stockpiles were made during 1970 from the Homer and Wauseca mines of the Hanna Mining Co.

**Pig Iron and Steel.**—Pig iron and steel were manufactured in the Detroit area. Pig iron value increased over 10 percent, but shipments decreased more than 10

Table 10.—Michigan: Mine production (recoverable) of silver and copper

	1968	1969	1970
Mines producing: Lode.....	4	1	1
Material sold or treated:			
Copper ore.....thousand short tons..	8,027	8,200	7,638
Production (recoverable): Quantity:			
Silver.....troy ounces.....	472,813	1,009,022	891,579
Copper.....short tons.....	74,805	75,226	67,543
Value:			
Silver.....thousands.....	\$1,014	\$1,807	\$1,579
Copper.....do.....	62,607	71,516	77,945
Total.....do.....	63,621	73,323	79,524

Table 11.—Michigan: Crude iron ore data, in 1970, by counties and ranges

(Thousand long tons)

County and range	Stocks Jan. 1	Production		Shipments		Stocks Dec. 31
		Under- ground	Open pit	Direct to consumers	To con- centrators	
County:						
Dickinson.....			5,347		5,347	
Iron.....	† 1,197	378		909		666
Marquette.....	† 622	2,966	20,579	603	23,079	484
Total.....	† 1,819	3,344	25,926	1,512	28,426	1,150
Range:						
Marquette.....	† 622	2,966	20,579	603	23,079	484
Menominee.....	† 1,197	378	5,347	909	5,347	666
Total.....	† 1,819	3,344	25,926	1,512	28,426	1,150

† Revised.

percent, compared with 1969. According to the American Iron & Steel Institute, Michigan produced 9.6 million short tons of steel in 1970, compared with 10.0 million short tons in 1969.

**Silver.**—Silver was recovered from copper ore mined at the White Pine mine. Concentrates from a silver-recovery circuit in the White Pine mill were shipped to an outside smelter for silver recovery. Output of silver in 1970 was 11.6 percent less than in 1969, and value was 12.6 percent less than in 1969.

#### MINERAL FUELS

**Natural Gas and Natural Gas Products.**—Natural gas was produced in 22 counties from both gas and oil wells, with about 93 percent coming from Calhoun, Hillsdale, Jackson, Macomb, and St. Clair Counties. Production of natural gas increased over that of the previous year, but output of natural gas liquids declined. Proved natural gas reserves in 1970, as estimated by the American Gas Association, Inc. (AGA),

totalled 939,671 million cubic feet for Michigan, a gain of 188,707 million cubic feet. According to AGA, gas-liquid reserves increased from 4,056 thousand barrels in 1969 to 9,903 thousand barrels in 1970, a gain of 5,847 thousand barrels.

**Peat.**—Although total production of peat in Michigan decreased from 189,447 short tons in 1969 to 156,699 short tons in 1970, a decline of over 17 percent, the State continued to be the largest producer of peat in the United States, accounting for nearly one-third of the U.S. total. Production was obtained from 11 counties; Lapeer and Sanilac Counties accounted for 71 percent of the State total. The other producing counties were Allegan, Eaton, Ingham, Kent, Mecosta, Monroe, Oakland, St. Joseph, and Shiawassee.

Sales totalled 166,950 short tons in 1970, compared with 186,278 short tons in 1969; the average value of peat produced in Michigan decreased from \$14.62 per ton in 1969 to \$11.36 per ton in 1970. Ninety-six

Table 12.—Michigan: Usable iron ore<sup>1</sup> produced (direct-shipping and all forms of concentrate), by ranges

(Thousand long tons)

Year	Marquette range	Menominee range (Michigan part)	Gogebic range (Michigan part)	Total		
				Gross weight		Iron content (percent)
				Ore	Iron content	
1854-1964	330,807	270,514	248,710	850,031	NA	NA
1965	8,973	4,595	753	14,322	8,343	58.25
1966	9,589	4,620	113	14,322	8,432	58.87
1967	10,231	3,750	49	14,030	8,453	60.25
1968	10,086	3,684	--	13,770	8,339	60.56
1969	10,048	3,369	--	13,417	8,183	60.99
1970	10,363	2,394	--	12,757	7,950	62.32
Total <sup>2</sup>	390,097	<sup>3</sup> 292,925	<sup>3</sup> 249,626	932,649	NA	NA

NA Not available.

<sup>1</sup> Exclusive, after 1905, of iron ore containing 5 percent or more manganese.

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

<sup>3</sup> Distribution by range partly estimated before 1906.

Table 13.—Michigan: Iron ore shipped from mines

(Thousand long tons)

Year	Direct-shipping ore <sup>1</sup>	Concentrates			Total usable ore <sup>2</sup>	Proportion of concentrates to total usable ore (percent)
		Agglomerates	Other	Total <sup>2</sup>		
1966	4,272	8,690	1,415	10,106	14,377	70.28
1967	3,011	10,336	783	11,119	14,130	78.69
1968	2,353	9,786	560	10,346	12,699	81.47
1969	1,972	11,657	429	12,086	14,058	85.97
1970	1,512	10,963	625	11,588	13,100	88.46

<sup>1</sup> Includes crushed, screened, and sized ore not further treated.

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



percent of the total output was used for general soil improvement, with the remainder being used as an ingredient for potting soils, mushroom beds, packing flowers, etc. Over 78 percent of the peat sold was in packaged form. Reed-sedge peat accounted for 80 percent of the total sales; humus peat, 18 percent; and moss peat, 2 percent.

**Petroleum.**—Petroleum was produced in 46 counties. The largest output was from Calhoun, Jackson, and Hillsdale Counties (Albion-Pulaski-Scipio trend). Increased

leasing and drilling activity continued in the northern part of the lower peninsula following oil and gas discoveries near Gaylord and Traverse City in October 1969. Petroleum production declined from 12,213 thousand barrels in 1969 to 11,693 thousand barrels in 1970, a loss of 4.3 percent. Reserves of crude oil, according to the American Petroleum Institute (API), were 45,615,000 barrels on December 31, 1970, a decrease of 5,902,000 barrels from the previous year.

**Table 14.—Michigan: Crude petroleum production, by counties**

(Thousand 42-gallon barrels and thousand dollars)

County	1969		1970	
	Quantity <sup>1</sup>	Value <sup>2</sup>	Quantity <sup>1</sup>	Value <sup>2</sup>
Allegan.....	141	\$432	130	\$404
Arenac.....	231	708	226	701
Barry.....	12	37	10	32
Bay.....	285	6,876	249	772
Calhoun.....	2,067	6,344	1,828	5,666
Cass.....	1	3	—	—
Clare.....	539	1,654	462	1,432
Crawford.....	450	1,381	496	1,537
Eaton.....	( <sup>3</sup> )	1	—	—
Genesee.....	10	31	27	85
Gladwin.....	319	978	299	928
Gratiot.....	12	36	11	33
Hillsdale.....	2,915	8,949	2,602	8,065
Huron.....	2	6	1	4
Ingham.....	—	—	6	20
Isabella.....	224	687	201	622
Jackson.....	1,223	3,755	1,048	3,247
Kalkaska.....	93	235	165	510
Kent.....	74	227	63	194
Lake.....	197	606	212	657
Lapeer.....	71	219	62	192
Lenawee.....	( <sup>3</sup> )	1	( <sup>3</sup> )	1
Livingston.....	1	2	1	2
Macomb.....	7	23	5	16
Mason.....	57	175	37	115
Mecosta.....	222	682	172	535
Midland.....	200	615	184	571
Missaukee.....	561	1,723	559	1,732
Monroe.....	3	10	2	7
Montcalm.....	121	370	113	350
Muskegon.....	54	167	32	99
Newaygo.....	38	115	17	54
Oakland.....	( <sup>3</sup> )	1	( <sup>3</sup> )	1
Oceana.....	33	102	67	207
Ogemaw.....	275	845	299	927
Osceola.....	673	2,068	507	1,573
Oscoda.....	2	5	1	4
Otsego.....	13	39	285	883
Ottawa.....	75	231	59	184
Presque Isle.....	1	4	1	5
Roscommon.....	157	483	167	517
Saginaw.....	22	67	21	67
St. Clair.....	721	2,214	977	3,028
Shiawassee.....	10	31	9	28
Tuscola.....	67	205	63	196
Van Buren.....	9	28	6	18
Washtenaw.....	6	18	4	12
Wayne.....	19	57	5	16
Total <sup>4</sup> .....	12,213	37,494	11,693	36,246

<sup>1</sup> Source: State of Michigan, Department of Natural Resources.

<sup>2</sup> County values calculated by using State average value per barrel; \$3.07 for 1969 and \$3.10 for 1970.

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

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

**Petroleum and Natural Gas Exploration and Development.**—Total number of well completions in Michigan declined in 1970. Of the 283 wells drilled, 49 were completed as oil wells, 19 as gas wells, and 215 as dry holes. Overall success ratio was about 24 percent; 11.5 percent of the exploratory wells were completed as oil and gas producers.

According to API, there were nine new oil discoveries and seven new gas discoveries in Michigan in 1970. The Mason field, an oil discovery in Ingham County, represents the first production from that county. Other oil discoveries include the following: A deeper pool test in the Beaver Creek field (Crawford County); Cold Springs,

Kalkaska North, and Rapid River fields (Kalkaska County); Luther North field (Lake County); Fountain field (Mason County); and Pigeon River and Johnesburg fields (Otsego County). The new gas discoveries were as follows: Kingsley and Muncie Lakes fields (Grand Traverse County); Kalkaska and Blue Lake fields (Kalkaska County); East China and Columbus Sec. 32 fields (St. Clair County); and Fostoria field (Tuscola County).

The two unsuccessful test wells in Emmet County and the unsuccessful completion in Marquette County represent the first wells ever drilled in these counties in search of oil and gas.

Table 15.—Michigan: Oil and gas well drilling completions in 1970, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
Alcona	--	--	--	--	--	1	1	6,560
Allegan	1	--	1	--	--	2	4	5,822
Antrim	--	--	--	--	--	3	3	20,296
Benzie	--	--	--	--	--	4	4	20,599
Branch	--	--	--	--	--	2	2	7,369
Calhoun	6	--	10	--	--	2	18	84,806
Cass	--	--	--	--	--	1	1	1,201
Cheboygan	--	--	--	--	--	2	2	7,954
Clare	--	--	--	--	--	1	1	3,936
Crawford	--	--	2	1	--	--	3	18,951
Eaton	--	--	1	--	--	3	4	19,432
Emmet	--	--	--	--	--	2	2	6,436
Genesee	9	--	1	--	--	--	10	21,110
Gladwin	--	--	1	--	--	--	1	3,675
Grand Traverse	--	--	1	--	2	--	5	31,256
Hillsdale	4	1	8	--	--	7	20	79,636
Ingham	--	--	--	1	--	2	3	14,520
Isabella	1	--	1	--	--	2	4	16,555
Jackson	--	--	--	--	--	3	4	19,779
Kalamazoo	--	--	--	--	--	1	1	4,023
Kalkaska	--	--	4	3	2	3	12	86,439
Lake	1	--	2	1	--	3	7	17,125
Lapeer	3	1	1	--	--	--	5	15,695
Lenawee	--	--	--	--	--	1	1	4,100
Livingston	--	4	--	--	--	2	6	27,762
Macomb	--	--	2	--	--	17	19	65,542
Marquette	--	--	--	--	--	1	1	2,235
Mason	--	--	4	1	--	3	8	15,380
Mecosta	1	--	1	--	--	3	5	18,420
Missaukee	--	--	3	--	--	1	4	13,146
Montcalm	4	--	2	--	--	7	13	42,009
Muskegon	--	2	1	--	--	3	6	17,142
Newaygo	--	--	--	--	--	2	2	11,661
Oakland	--	--	1	--	--	2	3	15,007
Oceana	2	--	8	--	--	15	25	64,771
Osceola	1	--	--	--	--	4	5	16,765
Otsego	2	1	5	2	--	1	11	66,443
Ottawa	--	--	1	--	--	1	2	4,064
Presque Isle	--	--	--	--	--	3	3	10,923
St. Clair	5	3	14	--	2	21	45	134,442
St. Joseph	--	--	--	--	--	1	1	3,130
Sanilac	--	--	--	--	--	1	1	5,475
Shiawassee	--	--	--	--	--	1	1	7,056
Tuscola	--	--	--	--	1	--	1	3,267
Wexford	--	--	--	--	--	3	3	11,850
Total	40	12	76	9	7	139	283	1,073,765

Source: American Petroleum Institute.

Table 16.—Principal producers<sup>1</sup>

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Aetna Portland Cement Co., div. of Martin Marietta Corp.	Box 8 Bay City, Mich. 48706	Portland and masonry, wet process.	Bay.
Dundee Cement Co.	Box 317 Dundee, Mich. 48131	do.	Monroe.
Huron Cement Co., div. of National Gypsum Co.	17515 West 9 Mile Rd. Honeywell Center Southfield, Mich. 48075	Portland and masonry, dry process.	Alpena.
Medusa Portland Cement Co.	Box 5668 Cleveland, Ohio 44101	Portland, wet process.	Charlevoix.
Peerless Cement Co., div. of American Cement Corp.:	900 Detroit Trade Center Detroit Mich. 48226		
Port Huron Plant.		Portland, wet process.	St. Clair.
Brennan Ave. Plant.		do.	Wayne.
Jefferson Ave. Plant.		Portland and masonry, wet process.	Do.
Penn-Dixie Cement Corp.	Box 152 Nazareth, Pa. 18064	do.	Emmet.
Wyandotte Chemicals Corp.	1609 Biddle Ave. Wyandotte, Mich. 48192	do.	Wayne.
<b>Clays and shale:</b>			
Aetna Portland Cement Co., div. of Martin Marietta Corp.	Box 8 Bay City, Mich. 48706	Pit.	Saginaw.
Dundee Cement Co.	Box 317 Dundee, Mich. 48131	Pit.	Monroe.
Huron Cement Co., div. of National Gypsum Co.	17515 West 9 Mile Rd. Honeywell Center Southfield, Mich. 48075	Pit.	Alpena.
Light Weight Aggregate Corp.	12720 Farmington Rd. Livonia, Mich. 48150	Pit and plant.	Wayne.
Medusa Portland Cement Co.	Box 5668 Cleveland, Ohio 44101	Pit.	Antrim.
Peerless Cement Co., div. of American Cement Corp.	900 Detroit Trade Ctr. Detroit Mich. 48226	Pits.	St. Clair, Wayne.
Penn-Dixie Cement Corp.	Box 152 Nazareth, Pa. 18064	Pit.	Antrim.
<b>Coke:</b>			
Industrial Chemicals Div. Allied Chemical Corp.	Box 70 Morristown, N.J. 07960	Coke ovens.	Wayne.
Ford Motor Co.	The American Rd. Dearborn, Mich. 48121	do.	Do.
National Steel Corp. (Great Lakes Steel Div.)	2800 Grant Bldg. Pittsburgh, Pa. 15219	do.	Do.
<b>Copper:</b>			
White Pine Copper Co.	Box 427 White Pine, Mich. 49971	Mine and mill.	Ontonagon.
<b>Gypsum:</b>			
Georgia-Pacific Corp. Gypsum Division.	900 SW. 5th Portland, Oreg. 97204	Underground mine, and calcining and board plant.	Kent.
Grand Rapids Gypsum Co.	Box 1674 Grand Rapids, Mich. 49501	do.	Do.
Michigan Gypsum Co.	2840 Bay Rd. Saginaw, Mich. 48601	Open pit mine.	Iosco.
National Gypsum Co.	325 Delaware Ave. Buffalo, N.Y. 14202	Open pit mine and calcining and board plant.	Do.
United States Gypsum Co.	101 South Wacker Dr. Chicago, Ill. 60606	Open pit mine. Calcining and board plant.	Do. Wayne.
<b>Iron ore:</b>			
Cleveland-Cliffs Iron Co.:	1460 Union Commerce Bldg. Cleveland, Ohio 44115		
Cliffs Shaft.		Stockpile shipments.	Marquette.
Eagle Mills pellet plant.		Pelletizes ore from the Republic mine.	Do.
Empire.		Open pit mine, concentrator, and agglomerator.	Do.
Humboldt.		do.	Do.
Mather.		Underground mine. Ore treated at the Ore Improvement Plant and Pioneer Pellet Plant.	Do.

See footnote at end of table.

Table 16.—Principal producers 1—Continued

Commodity and company	Address	Type of activity	County
<b>Iron ore—Continued</b>			
Cleveland-Cliffs Iron Co.— Continued	1460 Union Commerce Bldg. Cleveland, Ohio 44115		
Ore improvement plant.....	-----	Processes Mather ore...	Marquette.
Pioneer pellet plant.....	-----	Pelletizes ore from the Mather mine.	Do.
Republic.....	-----	Open pit mine, con- centrator, and ag- glomerator. Part of the concentrates pelletized at the Eagle Mills plant.	Do.
Tilden.....	-----	Stockpile shipments.....	Do.
The Hanna Mining Co.: Groveland.....	100 Erieview Plaza Cleveland, Ohio 44114	Open pit mine, con- centrator, and ag- glomerator.	Dickinson.
Homer.....	-----	Stockpile shipments.....	Iron.
Wauseca.....	-----	do.....	Do.
Inland Steel Co.: Sherwood.....	30 West Monroe St. Chicago, Ill. 60603	Underground mine.....	Do.
Jones & Laughlin Steel Corp.: Tracy.....	Michigan Ore Division Negaunee, Mich. 49866	do.....	Marquette.
<b>Iron and steel:</b>			
Ford Motor Co.....	The American Rd. Dearborn, Mich. 48121	Iron blast furnaces and open-hearth steel furnaces.	Wayne.
McLouth Steel Corp.....	300 South Livernois Ave. Detroit, Mich. 48217	do.....	Do.
National Steel Corp., Great Lakes Steel Div.....	2800 Grant Bldg. Pittsburgh, Pa. 15219	do.....	Do.
<b>Lime:</b>			
Detroit Lime Co., subsidiary of Edward C. Levy Co.....	8800 Dix Ave. Detroit, Mich. 48209	Quicklime, shaft and rotary kilns.	Do.
The Dow Chemical Co.....	Midland, Mich. 48640	Quicklime, 3 rotary kilns, continuous hydrator.	Mason.
Marblehead Lime Co.....	300 West Washington St. Chicago, Ill. 60606	Quicklime, 2 rotary kilns.	Wayne.
Wyandotte Chemicals Corp.....	1609 Biddle Ave. Wyandotte, Mich. 48192	Quicklime, 9 shaft kilns.	Do.
<b>Peat:</b>			
Anderson Peat Co.....	2562 Graham Rd. Imlay City, Mich. 48444	Bog, processing plant..	Lapeer.
Fletcher & Rickard.....	54001 Grand River Rd. New Hudson, Mich. 48165	do.....	Oakland.
J. M. Huber Corp.....	(Peat Department) Thornall St. Edison, N.J. 08817	do.....	Sanilac.
Michigan Peat.....	1 Decker Sq., Suite 325 Bala-Cynwyd, Pa. 19004	Bogs, processing plant..	St. Clair, Sanilac.
Scenic Lakes, Inc.....	Box 926 East Lansing, Mich. 48823	Bog, processing plant...	Shiawassee.
<b>Expanded Perlite:</b>			
Georgia-Pacific Corp., Gypsum Division.....	900 SW. 5th Portland, Ore. 97204	Processing plant.....	Kent.
National Gypsum Co.....	325 Delaware Ave. Buffalo, N.Y. 14202	do.....	Iosco.
United States Gypsum Co.....	101 South Wacker Dr. Chicago, Ill. 60606	do.....	Wayne.
<b>Petroleum refineries:</b>			
Bay Refining Division, The Dow Chemical Co.....	4868 Wilder Rd. Bay City, Mich. 48709	-----	Bay.
Crystal Refining Co.....	901 North Williams Carson City, Mich. 48811	-----	Montcalm.
Lakeside Refining Co.....	2705 East Cork Kalamazoo, Mich. 49001	-----	Kalamazoo.
Leonard Refineries, Inc.: Alma Division.....	East Superior St. Alma, Mich. 48801	-----	Gratiot.
Roosevelt Oil & Refining Division.....	Box 271 Pickard Ave. & A.A.R.R. Mount Pleasant, Mich. 48858	-----	Isabella.

See footnote at end of table.

Table 16.—Principal producers<sup>1</sup>—Continued

Commodity and company	Address	Type of activity	County
<b>Petroleum refineries—Continued</b>			
Marathon Oil Co.....	1300 South Fort St. Detroit, Mich. 48217	-----	Wayne.
Mobil Oil Co., Inc.....	Box 477 Trenton, Mich. 48183	-----	Do.
Naph-Sol Refining Co.....	1222 M-20, Box 630 Muskegon, Mich. 49443	-----	Muskegon.
Osceola Refining Co.....	Box 178 Reed City, Mich. 49677	-----	Ogemaw.
Petroleum Specialties, Inc.....	Box 448 Trenton, Mich. 48183	-----	Wayne.
<b>Salt and salines:</b>			
American Salt Corp.....	3142 Broadway Kansas City, Mo. 64111	Processing plant: Salt..	Midland.
Diamond Crystal Salt Co.....	916 South Riverside St. Clair, Mich. 48079	Brine wells and processing plant: Salt.	St. Clair.
The Dow Chemical Co.: Ludington Plant.....	Midland, Mich. 48640	Brine wells and processing plant: Bromine, calcium-magnesium compounds, magnesium compounds,	Mason.
Midland Plant.....	-----	Brine wells and processing plant: Bromine, calcium-magnesium compounds, iodine, magnesium compounds, potash, salt.	Midland.
Harbison-Walker Refractories Co.	2 Gateway Center Pittsburgh, Pa. 15222	Processing plant: Magnesium compounds.	Mason.
Hardy Salt Co.....	P.O. Drawer 449 St. Louis, Mo. 61366	Processing plant: Salt.	Manistee.
Hooker Chemical Corp.....	Box 295 Montague, Mich. 49437	Brine wells and processing plant: Salt.	Muskegon.
International Salt Co.....	Clarks Summit, Pa. 18411	Underground salt mine.	Wayne.
Kaiser Aluminum & Chemical Corp. Michigan Chemical Corp:	900 17th St., NW. Washington, D.C. 20006	Processing plant: Magnesium compounds.	Midland.
East Lake Plant.....	321 East Ohio St. Chicago, Ill. 60611	Processing plant: Bromine.	Manistee.
St. Louis Plant.....	-----	Brine wells and processing plant: Bromine, calcium-magnesium compounds, magnesium compounds, salt.	Gratiot.
Morton Chemical Co., div. of Morton-Norwich Products, Inc.	110 North Wacker Dr. Chicago, Ill. 60606	Brine wells and processing plant: Bromine, calcium-magnesium compounds, magnesium compounds.	Manistee.
Morton Salt Co., div. of Morton-Norwich Products, Inc. Manistee Plant.....	-----	Brine wells and processing plant: Salt.	Do.
St. Clair Plant.....	-----	do	St. Clair.
Pennwalt Corp.....	3 Penn Center Philadelphia, Pa. 19102	Brine wells and processing plant: Salt.	Wayne.
Standard Lime & Refractories Co., div. of Martin Marietta Corp.	2000 First National Bank Bldg. Baltimore, Md. 21203	Brine wells and processing plant: Magnesium compounds.	Manistee.
Wilkinson Chemical Corp.....	Mayville, Mich. 48744	Brine wells and processing plant: Calcium-magnesium compounds.	Lapeer.
Wyandotte Chemicals Corp.....	1609 Biddle Ave. Wyandotte, Mich. 48192	Brine wells and processing plant: Calcium-magnesium compounds and salt.	Wayne.
<b>Sand and gravel:</b>			
American Aggregates Corp.....	Garst Ave. at Ave. B Greenville, Ohio 45331	Pits and stationary plants.	Kalamazoo, Livingston, Macomb, Oakland.

See footnote at end of table.

Table 16.—Principal producers<sup>1</sup>—Continued

Commodity and company	Address	Type of activity	County
<b>Sand and gravel—Continued</b>			
J. V. Burkett Contractors Co., Inc.	St. Joseph, Mich. 49085	Pits and portable plant.	Kent, Newaygo.
Cole Brothers, Cole Brothers Contractors, Inc.	Route 3, Box 346 Battle Creek, Mich. 49017	Pits and stationary and portable plants.	Barry, Calhoun, Hillsdale, Ionia, Kalamazoo, St. Joseph.
Construction Aggregates Corp.	120 South LaSalle St. Chicago, Ill. 60603	Pit and stationary plants.	Ottawa.
R. E. Glancy, Inc.	1055 South Bay Dr. Tawas City, Mich. 48763	Pit and portable plant.	Iosco.
Grand Rapids Gravel Co.	2700 28th St., SW. Grand Rapids, Mich. 49509	Pits and stationary plants.	Kent.
Holloway Sand & Gravel Co.	29250 Wixom Rd., Box 247 Wixom, Mich. 48096	Pits and portable plants.	Genesee, Oakland, Ogemaw, Otsego.
Holly Sand & Gravel Plant, J. P. Burroughs & Sons, Inc.	16240 Tindall Rd. Davisburg, Mich. 48019	Pit and stationary	Oakland.
Lyon Sand & Gravel Co., Div. of E. C. Levy Co.	9300 Dix Dearborn, Mich. 48120	do	Do.
Manley Sand Division, Martin Marietta Corp.	Rockton, Ill. 61072	do	Berrien.
Mickelson Corp.	435 Granger Rd. Oxford, Mich. 48051	Pit, dredges, portable plant.	Oakland.
Molesworth Contracting Co.	321 Park Ave. Yale, Mich. 48097	Pits and portable plants.	Lapeer, Macomb, St. Clair, Sanilac.
Natural Aggregates Corp.	65545 Mound Rd. Romeo, Mich. 48065	Pits, dredge, portable and stationary plants.	Livingston, Macomb.
New Hudson Sand & Gravel Inc., Texas Industries, Inc.	Box H New Hudson, Mich. 48165	Pits and stationary plants.	Oakland.
Ottawa Silica Co., Michigan Division.	Box 577 Ottawa, Ill. 61350	Pit and stationary plant.	Wayne.
Oxford Mining Co.	9820 Andersonville Rd. Davisburg, Mich. 48019	do	Oakland.
Pickett & Schreur, Inc.	Box 149 Allegan, Mich. 49010	Pits and portable plants.	Allegan, Charlevoix, Clinton, Emmet, Kalamazoo, Kent, Lapeer.
Salem Gravel & Const. Plant.	5175 Oakhill Rd. Clarkston, Mich. 48016	Stationary plant.	Oakland.
Sargent Sand Co.	2840 Bay Rd. Saginaw, Mich. 48604	Pits and stationary plants.	Bay, Mason, Saginaw, Tuscola.
Thomson Sand & Gravel, Inc.	48399 W. 7 Mile Rd. Northville, Mich. 48167	Pit, portable and stationary plants.	Wayne.
West Branch Concrete Products, Inc.	2250 Rau West Branch, Mich. 48661	Pit and stationary plant.	Ogemaw.
Whittaker & Gooding Co.	5800 Cherry Hill Rd. Ypsilanti, Mich. 48197	do	Washtenaw.
John G. Yerington	Route 2, Box 34 Benton Harbor, Mich. 49022	Pits and portable plants.	Barry, Berrien, Branch, Calhoun, Cass, Lenawee, Muskegon, Newaygo, Van Buren.
<b>Silver:</b>			
White Pine Copper Co.	Box 427 White Pine, Mich. 49971	Byproduct silver	Ontonagon.
<b>Smelters:</b>			
White Pine Copper Co.		Primary copper smelter.	Do.
<b>Stone:</b>			
Granite: Caspian Construction Co.	Caspian, Mich. 49915	Quarry and stationary plant.	Dickinson.

See footnote at end of table.

Table 16.—Principal producers<sup>1</sup>—Continued

Commodity and company	Address	Type of activity	County
<b>Stone—Continued</b>			
<b>Limestone and dolomite:</b>			
Bethlehem Mines Corp., Bethlehem Steel Corp.	701 East Third St. Bethlehem, Pa. 18016	Quarry and stationary plant.	Chippewa.
Cheney Limestone Co.-----	Box 125 Bellevue, Mich. 49021	---do-----	Eaton.
Detroit Edison Co.-----	2000 South Second Ave. Detroit, Mich. 48226	Quarry and portable plant.	Monroe.
Dundee Cement Co.-----	Box 317 Dundee, Mich. 48181	Quarry and stationary plant.	Do.
The France Stone Co.-----	1800 Toledo Trust Bldg. Toledo, Ohio 43604	---do-----	Do.
Huron Cement Co., div. of National Gypsum Co.	17515 West 9 Mile Rd. Honeywell Center Southfield, Mich. 48075	---do-----	Alpena.
Inland Lime & Stone Co.---	Gulliver, Mich. 49840	Quarries and stationary plants.	Mackinac, Schoolcraft.
Medusa Portland Cement Co.	Box 5668 Cleveland, Ohio 44101	Quarry and stationary plant.	Charlevoix.
Michigan Foundation Quarry.	110 West Jefferson Ave. Trenton, Mich. 48183	---do-----	Wayne.
The Michigan Stone Co.---	Ottawa Lake, Mich. 49267	Quarries and stationary plants.	Monroe.
Peninsula Asphalt Corp.---	Box 726 Traverse City, Mich. 49684	Quarry and stationary plant.	Leelanau.
Penn-Dixie Cement Corp.---	Box 152 Nazareth, Pa. 18064	---do-----	Emmet.
Presque Isle Corp.-----	Box 426 Alpena, Mich. 49707	---do-----	Presque Isle.
United States Steel Corp. Michigan Limestone Operations.	Rogers City, Mich. 49779	Quarries and stationary plants.	Mackinac, Presque Isle.
The Wallace Stone Co., div. of J. P. Burroughs & Son, Inc.	Bay Port, Mich. 48720	Quarry and stationary plant.	Huron.
<b>Marl:</b>			
Gerald Arnsman-----	Route 1 Hopkins, Mich. 49328	Pit-----	Allegan.
Case Brothers-----	Route 2, Box 136 Union City, Mich. 49094	Pit-----	Calhoun.
Darrell L. Hamilton-----	Route 3 Nashville, Mich. 49073	Pit-----	Barry.
Hayward Dry Marl-----	Route 2 Vicksburg, Mich. 49097	Pit-----	Kalamazoo.
Poehlman & Son-----	Route 2 Cassopolis, Mich. 49031	Pit-----	Cass.
Sandstone: Ray's Stone Quarry---	303 Natasawaeppa St. Napoleon, Mich. 49261	Quarry and finishing plant.	Jackson.
<b>Recovered sulfur:</b>			
Leonard Refineries, Inc., Alma Division.	East Superior St. Alma, Mich. 48801	Byproduct sulfur recovery.	Gratiot.
Marathon Oil Co.-----	1300 South Fort St. Detroit, Mich. 48217	---do-----	Wayne.
Mobil Oil Co., Inc.-----	Box 477 Trenton, Mich. 48183	---do-----	Do.
<b>Exfoliated vermiculite:</b>			
Zonolite Division, W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 01109	Processing plant-----	Do.

<sup>1</sup> A number of oil and gas producing companies operate in Michigan and they are listed in several commercial directories.

# The Mineral Industry of Minnesota

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

By Harold J. Polta <sup>1</sup>

Minnesota's 1970 mineral output was valued at \$633 million. This was \$2.6 million below the record 1969 figure. Iron ore continued to be the principal mineral commodity, accounting for 90 percent of total output value. Production of sand and gravel, although below 1969 both in quantity and value, accounted for 6 percent of total value. Stone production value, also down from the year before, accounted for 2 percent of the State total.

Minnesota's 1970 iron ore production comprised 62 percent of the total U.S. production. It consisted of 35.3 million tons of taconite pellets and 20.7 million tons of natural ore. Pellet production capacity will be increased 6 million tons per year on completion of United States Steel Corp.'s \$100 million expansion of its Minntac plant; construction started in April. Another 4-million-ton-per-year increase could result from a taconite facility cost-study announced by Pickands Mather & Co.

Itasca and St. Louis Counties were again the State's chief mineral producers because of their large-scale mining operations. They accounted for 92 percent of State production value; St. Louis County's share was 78 percent of the State total and Itasca County's share, 14 percent.

Several changes pertinent to the mineral industry were made at the University of Minnesota. The School of Mineral and Metallurgical Engineering was discontinued and its staff and functions consolidated into the Department of Chemical Engineering and Mineral Engineering. In another change, administrative responsibility of the Mines Experiment Station was transferred to the Department of Civil Engineering and Mineral Engineering; the research center was renamed the Mineral Resources Research Center.

<sup>1</sup> Mining engineer, Division of Ferrous Metals.

Table 1.—Mineral production in Minnesota <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays..... thousand short tons.....	2 275	\$412	227	\$335
Iron ore..... thousand long tons, gross weight.....	56,957	570,446	54,791	571,488
Manganiferous ore (5 to 35 percent Mn)..... short tons, gross weight.....	381,491	W	321,436	W
Peat..... thousand short tons.....	12	249	13	335
Sand and gravel..... do.....	48,121	40,191	46,851	38,802
Stone..... do.....	5,035	14,253	4,579	12,311
Value of items that cannot be disclosed:				
Abrasive stone, cement, gem stones, lime, fire clay (1969), and values indicated by symbol W				
	XX	10,085	XX	9,735
Total.....	XX	635,636	XX	633,006
Total 1967 constant dollars.....	XX	600,231	XX	<sup>p</sup> 572,870

<sup>p</sup> Preliminary. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." 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 (1969) included with "Value of items that cannot be disclosed."



Table 2.—Value of mineral production in Minnesota, by counties

(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Aitkin		W	Sand and gravel, peat.
Anoka		\$284	Sand and gravel.
Becker	433	W	Sand and gravel.
Beltrami	304	W	Sand and gravel, peat.
Benton	355	379	Sand and gravel, stone.
Big Stone	553	W	Sand and gravel.
Blue Earth		W	Stone, sand and gravel.
Brown	1,706	1,633	Do.
Burns	439	W	Clays, sand and gravel.
Carlton	814	778	Sand and gravel, peat, clays.
Carver	673	607	Sand and gravel, lime, clays.
Cass	202	206	Sand and gravel.
Chippewa	264	191	Do.
Chisago	947	253	Do.
Clay	2,645	W	Sand and gravel, lime.
Clearwater	197	357	Sand and gravel.
Cook	W	W	Do.
Cottonwood	75	111	Do.
Crow Wing	6,518	3,772	Manganiferous ore, iron ore, sand and gravel.
Dakota	3,308	W	Sand and gravel, stone.
Dodge	W	W	Stone, sand and gravel.
Douglas	172	178	Sand and gravel.
Faribault	67	65	Do.
Fillmore	639	551	Stone, sand and gravel.
Freeborn	477	665	Sand and gravel.
Goodhue	371	382	Sand and gravel, stone.
Grant	176	W	Do.
Hennepin	4,794	W	Sand and gravel, clays.
Houston	285	W	Stone, sand and gravel.
Hubbard	103	W	Sand and gravel.
Isanti	48	W	Do.
Itasca	80,679	86,552	Iron ore, sand and gravel, peat.
Jackson	105	194	Sand and gravel.
Kanabec	70	147	Do.
Kandiyohi	1,090	979	Do.
Kittson	288	W	Do.
Koochiching	126	155	Do.
Lac qui Parle	651	W	Stone, sand and gravel.
Lake	192	W	Sand and gravel.
Lake of the Woods	40	64	Do.
Le Sueur	2,328	W	Sand and gravel, stone.
Lincoln	177	130	Sand and gravel.
Lyon	252	243	Do.
McLeod	94	61	Do.
Mahnomen	303	W	Do.
Marshall	394	410	Do.
Martin	305	297	Do.
Meeker	84	157	Do.
Mille Lacs	317	W	Stone, sand and gravel.
Morrison	W	331	Sand and gravel.
Mower	885	835	Sand and gravel, stone.
Murray	160	90	Sand and gravel.
Nicollet	769	775	Sand and gravel, stone.
Nobles	424	261	Sand and gravel.
Norman	172	119	Do.
Olmsted	1,127	W	Stone, sand and gravel.
Otter Tail	399	282	Sand and gravel.
Pennington	315	W	Do.
Pine	W	W	Sand and gravel, peat.
Pipestone	196	281	Sand and gravel.
Polk	1,470	W	Sand and gravel, lime.
Pope	87	104	Sand and gravel.
Ramsey	466	W	Sand and gravel, clays.
Red Lake	26	25	Sand and gravel.
Redwood	365	229	Sand and gravel, stone, clays.
Renville	612	W	Stone, sand and gravel.
Rice	569	W	Sand and gravel, stone.
Rock	481	695	Sand and gravel, abrasives, stone.
Roseau	418	588	Sand and gravel.
St. Louis	494,477	493,270	Iron ore, cement, sand and gravel, lime, stone, peat.
Scott	1,302	1,071	Stone, sand and gravel.
Sherburne	1,111	989	Sand and gravel.
Sibley	W	W	Do.
Stearns	6,025	W	Stone, sand and gravel.
Steele	469	W	Sand and gravel, stone.
Stevens	202	228	Sand and gravel.
Swift	114	123	Do.
Todd	316	W	Do.
Traverse	59	W	Do.

See footnotes at end of table.

Table 2.—Value of mineral production in Minnesota, by counties—Continued  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Wabasha	\$263	W	Stone, sand and gravel.
Wadena	78	\$43	Sand and gravel, stone.
Waseca	24	W	Sand and gravel.
Washington	4,628	W	Sand and gravel, stone.
Watonwan	8	W	Sand and gravel.
Wilkin	233	228	Do.
Winona	843	1,279	Stone, sand and gravel.
Wright	608	287	Sand and gravel.
Yellow Medicine	624	W	Stone, sand and gravel.
Undistributed <sup>1</sup>	1,197	31,077	
Total <sup>2</sup>	635,636	633,006	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."  
<sup>1</sup> Includes gem stones, some sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.  
<sup>2</sup> Data may not add to totals shown because of independent rounding.

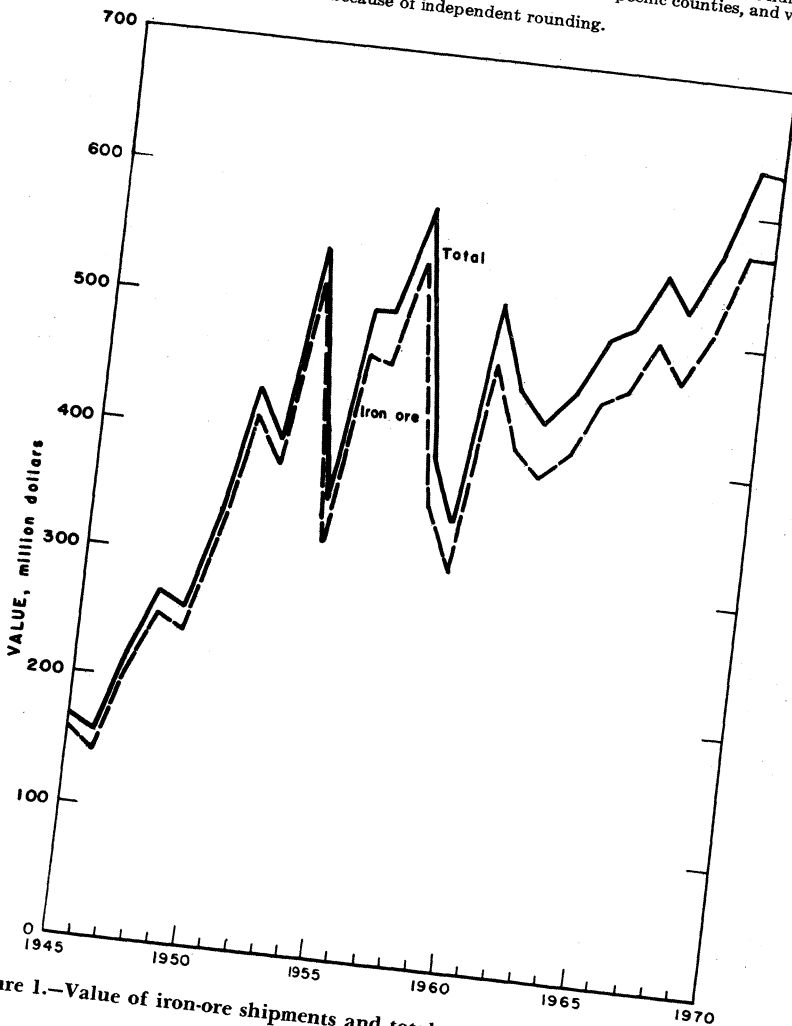


Figure 1.—Value of iron-ore shipments and total value of mineral production.

Table 3.—Indicators of Minnesota business activity

	1969	1970	Change, percent
Employment and labor force, annual average:			
Total labor force..... thousands	1,650.4	1,676.0	+1.6
Unemployment..... do	48.1	70.1	+45.7
Employment:			
Manufacturing..... do	332.0	319.7	-3.7
Construction..... do	67.6	65.3	-3.4
Mining..... do	14.5	14.3	-1.4
Transportation and public utilities..... do	87.5	87.5	+2.1
Wholesale and retail trade..... do	306.9	313.2	+2.9
Finance, insurance, and real estate..... do	62.1	63.9	+3.5
Services..... do	206.4	213.7	+3.1
Government..... do	224.1	231.0	+7.6
Personal income:			
Total..... millions	\$13,448	\$14,473	+6.0
Per capita..... do	\$3,579	\$3,793	+2.0
Construction activity:			
Valuation of authorized non-residential construction..... millions	\$243.5	\$244.1	+1.6
Number of private and public residential units authorized..... millions	30,602	24,168	-13.6
Valuation of authorized non-residential construction..... millions	\$146.0	\$126.2	-8.3
Number of private and public residential units authorized..... millions	9,150	8,391	+3.0
State highway commission contracts awarded..... million dollars	\$1,957.4	\$2,016.2	+3.0
Portland cement shipments to and within Minnesota..... million barrels	\$635.6	\$633.0	-
Portland cement shipments to and within Minnesota..... million barrels			+22.3
Farm marketing receipts..... do	\$301	\$368	+22.3
Mineral production..... do	\$574	\$566	-1.4
International trade: <sup>1</sup>			
Value of exports through Minnesota..... do			
Value of imports through Minnesota..... do			

<sup>1</sup> Includes Duluth and Minneapolis-St. Paul Customs Districts.  
 Sources: Survey of Current Business, Construction Review, Farm Income Situation, Roads and Streets, Employment and Earnings, Area Trends in Employment and Unemployment, Highlights of U.S. Export and Import Trade, U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non-fatal	Frequency	Severity
1969:								
Peat.....	32	74	2	17	--	1	57.33	229
Metal.....	8,729	317	2,763	22,102	--	92	4.16	343
Nonmetal.....	154	263	40	324	--	11	33.99	578
Sand and gravel.....	2,653	172	456	4,095	1	70	17.34	1,973
Stone.....	1,391	259	361	2,960	2	83	28.72	4,845
Total.....	12,959	230	3,622	29,498	3	257	8.81	1,023
1970: <sup>p</sup>								
Peat.....	35	83	3	20	--	1	49.52	446
Metal.....	8,535	328	2,803	22,425	8	90	4.37	2,402
Nonmetal.....	150	244	36	291	1	11	37.83	213
Sand and gravel.....	2,670	167	445	3,976	--	60	15.34	2,006
Stone.....	1,305	238	311	2,735	--	79	28.88	1,123
Total.....	12,695	283	3,598	29,448	9	241	8.49	2,207

<sup>p</sup> Preliminary.  
<sup>1</sup> Data may not add to totals shown because of independent rounding.

REVIEW BY MINERAL COMMODITIES

METALS

**Copper-Nickel.**—Exploration for copper-nickel and other base metal sulfide deposits by the mining industry continued at a high level during the year, both in the Duluth Complex and in the Precambrian greenstone belts. Exploration in the greenstone belts was still in the beginning

stages, and only a few of the many electromagnetic anomalies recorded had been drilled. In contrast, exploration had reached a more advanced stage in the Duluth Complex. Land ownerships on potentially minable properties were being consolidated, and some deposits were being, or had been, tested by close-spaced drilling

and evaluated for possible mining. Also, the gabbro was being tested at depth by drilling to at least 6,000 feet.

The State of Minnesota held its fourth sale of copper-nickel leases on June 30, 1970. The lands offered for leasing were in greenstone belts in Itasca, Koochiching, Lake of the Woods, and St. Louis Counties, adjacent to lands leased previously. In sum, 92,510 acres were leased to the following seven mining companies: International Nickel Co., Inc.; Humble Oil & Refining Co.; The Hanna Mining Co.; Bear Creek Mining Co.; W. S. Moore Co.; United States Steel Corp.; and Ridge Mining Corp., a wholly owned subsidiary of Texas Gulf Sulphur Co. This brought the total State lands under lease to over 179,000 acres—7,000 in Lake County; 67,500 in St. Louis County; 42,400 in Itasca County; 18,500 in Koochiching County; and 43,800 in Lake of the Woods County.

The Minnesota Geological Survey continued geologic mapping, gravity surveying, and research to aid in base metal exploration, and gave high priority to geologic studies in northeastern Minnesota.<sup>2</sup> It was assisted by funds and otherwise by the U.S. Geological Survey, the Minnesota Department of Iron Range Resources and Rehabilitation (IRR&R) and the Minnesota Department of Conservation.

The Bureau of Mines Twin Cities Metallurgy Research Center initiated research directed towards processing low-grade base metal ores.<sup>3</sup>

**Iron Ore.**—Minnesota iron ore production in 1970 was 56,073,000 long tons, up 1 percent from that of 1969; but the 54,791,000 tons shipped was 4 percent less than those shipped the previous year. The 56,073,000 tons produced represented 62 percent of total U.S. production and 42 percent of total U.S. consumption (domestic and foreign). Comparable 1969 percentages were 63 percent of U.S. production; and 39 percent of U.S. consumption. Total value of iron ore shipped was \$571.5 million, compared with \$570.4 million in 1969.

Demand for high-quality ore, both in grade and structure, and depletion of natural ore reserves continued. As a result, taconite pellet production increased from that of 1969, from 33,381,000 long tons to 35,345,000 long tons, and production from natural ore decreased from 21,894,000 long tons to 20,728,000 long tons.

All iron ore production was from open pits on the Mesabi Range and all manganese ore from open pits on the Cuyuna. There was no production from the Vermilion Range or from the Spring Valley district.

In April 1970, United States Steel Corp. started the announced \$100 million expansion of its Minntac taconite plant. The expansion will bring the 6-million-ton-capacity plant to a capacity of 12 million tons per year and make it the largest in Minnesota. Continued modification and improvement of the five other taconite plants together with this expansion will bring Minnesota taconite production capacity to about 40 million tons per year.

An additional increase may result from studies underway at yearend. Pickands Mather & Co., a subsidiary of Diamond Shamrock Corp., announced in October that it had awarded a contract to study the cost of building a 4-million-ton plant. Bethlehem Steel Corp. would be the participant.

Lower lake value of taconite pellets, which had been constant at 25.2 cents per iron unit since 1965, rose to 26.6 cents in 1970, and base value of Mesabi Bessemer ore, which had been \$10.70 since 1964, rose to \$10.95. Higher transportation and production costs were given as reasons that made the increases necessary. The sum of rail and vessel rates, including handling charges and other incidentals, which was \$3.89 in 1969, was raised to \$4.13 in 1970.

<sup>2</sup> Morey, G. B. and R. W. Ojakangas. Sedimentology of the Middle Precambrian Thomson Formation. Minn. Geol. Survey RI-13, 32 pp., 1970.  
Morey, G. B., J. C. Green, R. W. Ojakangas, and P. K. Sims. Stratigraphy of the Lower Precambrian Rocks in the Vermilion District, Northeastern Minnesota. Minn. Geol. Survey RI-14, 1970, 33 pp.

Davidson, D. M., Jr. Kawishiwi Lake Quadrangle, Lake and Cook Counties, Minnesota. Scale 1:24,000. Minn. Geol. Survey Map M-7, 1970.

Davidson, D. M. Jr. Perent Lake Quadrangle, Lake County, Minnesota. Scale 1:24,000. Minn. Geol. Survey Map M-8, 1970.

Ikola, R. J. Simple Bouguer Gravity Map of Minnesota Two Harbors Sheet. Scale 1:250,000. Minn. Geol. Survey Map M-9, 1970.

Craddock, C. and others. Simple Gouguer Gravity Map of Minnesota and Northwestern Wisconsin. Scale 1:1,000,000. Minn. Geol. Survey Map M-10, 1970.

Sims, P. K. Geologic Map of Minnesota. Scale 1:1,000,000. Minn. Geol. Survey Map M-14, 1970.

Wright, H. E. Jr., and others. Geologic map of Cloquet Quadrangle. Scale 1:24,000. Minn. Geol. Survey Map GM-3, 1970.

<sup>3</sup> Joyce, F. E., Jr. Extraction of Copper and Nickel from the Duluth Gabbro Complex by Selective High-Temperature Sulfatization. BuMines Rept. of Inv. 7475, 1971, 15 pp.

Almost all shipments went by rail to upper lake ports at the head of Lake Superior, and thence by vessel to lower lake ports. Efforts to maintain the competitive position of Mesabi taconites through reduced transportation costs included construction of larger vessels, research directed towards lengthening the shipping season, and a study estimating the cost of pipelining.

Bethlehem Steel Corp. had under construction a 1,000-foot-long, 52,400-gross-ton, 16-knot vessel, and the United States Steel Corp., a 805-foot-long, 45,000-ton-vessel. The use of these large vessels was made possible by the completion of the Poe Lock at Sault Ste. Marie in 1968.

Studies conducted by the Duluth, Mesabi, and Iron Range Railroad successfully demonstrated the feasibility of removing ice in harbor slips by an air bubbling system. Use of this system could extend the Great Lakes shipping season.

The Bureau of Mines made a cost estimate of pipelining concentrate fines from the Mesabi Range to the Chicago area.<sup>4</sup> The study concluded that pipelining merits consideration for augmenting present transportation capacity and suggested research directed towards using crude oil as the carrier fluid.

At the Bureau of Mines Twin Cities Metallurgy Research Center, emphasis was on making superconcentrates and metallized pellets. Research included studies directed toward improving flotation and roasting of nonmagnetic iron ores<sup>5</sup> and the production of metallized, reduced, and oxide pellets.

The Iron Range Demonstration plant near Keewatin was maintained by the State through IRR&R. Studies by Warren S. Moore Co. indicated that the plant could be used to make prerduced pellets using low-cost bituminous coal. According to the study, an investment of \$3 million would be required to complete the plant.

The Mineral Resource Research Center (former Mines Experiment Station) at the University of Minnesota reported encouraging results in experiments with "dry concentration" of taconites.

The Upper Great Lakes Regional Commission together with IRR&R authorized a \$16,000 grant to the University of Minnesota for a study to define the exact role played by the iron ore industry in the economy of the State. The study, begun in

June 1970, was scheduled for completion in June 1971.

With a \$205,000 grant from the same two agencies, Hallett Harrison Co. completed a study to determine the feasibility of a custom-pelletizing plant utilizing ores now being bypassed. The report concluded that it was technically and economically feasible to produce 20 million tons of oxide pellets from Minnesota ores but that construction of a commercial plant of this type did not appear feasible in mid-1970 because of inadequate assurance of market and profitability to justify financing at the high interest rates prevailing at that time.

The U.S. Geological Survey continued the Iron Range Water Study assisted by IRR&R-matched funds. The information from these studies is used by iron mining companies and city governments in planning for future growth.

Hearings continued in the case of Reserve Mining Co.'s tailings discharge into Lake Superior, but by yearend the controversy had not been resolved.

After the production of over 2½ billion tons of natural ore over the past 75 years, estimates of these Minnesota reserves had dwindled to less than 300 million tons by the end of 1970. Taconite reserve estimates range from less than 2 billion<sup>6</sup> to over 57 billion tons,<sup>7</sup> the quantity to a large extent, dependent on economic stripping ratio considerations, and to cost competition from other iron ore deposits.<sup>8</sup>

Eveleth Taconite Co.'s two-cargo shipment to Spain made in 1970 marked the first year in which Minnesota pellets were shipped overseas.

**Iron and Steel.**—American Steel & Wire Division of United States Steel Corp. produced pig iron and steel at Duluth. Compliance with Minnesota Pollution Control

<sup>4</sup> Polta, H. J. Mesabi Range Iron Ore Transportation. Feasibility and Estimated Cost of Pipelining. BuMines Inf. Circ. 8512, 1971, 46 pp.

<sup>5</sup> Prasky, C., R. E. Peterson, and D. L. Siebert. Reduction Roasting of Nonmagnetic Taconites with Automobile Scrap. BuMines Rept. of Inv. 7389, 1970, 19 pp.

<sup>6</sup> Gruner, John W. The Mineralogy and Geology of the Taconites and Iron Ores of the Mesabi Range, Minn. Office of the Commissioner of the Iron Range Resources and Rehabilitation, St. Paul, Minn. 1946, 122 pp.

<sup>7</sup> Emmons, William H., and Frank F. Grunt. Mineral Resources of Minn. Minn. Geol. Survey, Bull. No. 30, Univ. Minn., 1943, p. 55.

<sup>8</sup> Michelson, R. W., H. J. Polta, and Orin Peterson. Evaluating the Economic Availability of Mesabi Range Taconite Iron Ores With Computerized Models. BuMines Inf. Circ. 8480, 1970, 99 pp.

Table 5.—Crude iron ore <sup>1</sup> data, in 1970, by counties and ranges  
(Thousand long tons)

County and range	Stocks Jan. 1	Production <sup>2</sup>	Shipments		Stocks Dec. 31
			Direct to consumers	To con- centrators	
County:					
Crow Wing.....	--	--	--	--	--
Fillmore.....	--	--	--	25,431	--
Itasca.....	r 745	25,431	3,892	108,843	631
St. Louis.....	--	112,621	--	--	--
Total <sup>4</sup> .....	r 745	138,052	3,892	134,275	631
Range:					
Cuyuna.....	r 745	138,052	3,892	134,275	631
Mesabi.....	--	--	--	--	--
Spring Valley district.....	--	--	--	--	--
Total <sup>4</sup> .....	r 745	138,052	3,892	134,275	631

<sup>1</sup> Revised.

<sup>2</sup> Exclusive of ore containing 5 percent or more manganese.

<sup>3</sup> Entire production from open pit mines.

<sup>4</sup> Mostly sized ore.

<sup>5</sup> Data may not add to totals shown because of independent rounding.

Table 6.—Usable iron ore <sup>1</sup> data, in 1970, by counties and ranges

County and range	Stocks Jan. 1	Production	Iron content of production	Shipments	Stocks Dec. 31
County:					
Crow Wing.....	310	--	--	186	124
Fillmore.....	--	--	--	8,762	848
Itasca.....	r 746	8,864	5,228	45,844	4,937
St. Louis.....	r 3,571	47,209	27,723	--	--
Total <sup>2</sup> .....	r 4,627	56,073	32,951	54,791	5,909
Range:					
Cuyuna.....	310	--	--	186	124
Mesabi.....	r 4,317	56,073	32,951	54,606	5,785
Spring Valley District.....	--	--	--	--	--
Total <sup>2</sup> .....	r 4,627	56,073	32,951	54,791	5,909

<sup>1</sup> Revised.

<sup>2</sup> Exclusive of ore containing 5 percent or more manganese.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

Table 7.—Usable iron ore <sup>1</sup> produced (direct-shipment and all forms of concentrate),  
by ranges

(Thousand long tons)

Year	Cuyuna	Mesabi	Vermilion	Spring Valley district	Total <sup>2</sup>
1884-1965.....	67,035	2,513,403	102,621	7,237	2,690,295
1966.....	1,299	51,506	704	772	54,280
1967.....	1,041	48,857	202	58	50,157
1968.....	961	51,411	--	83	52,454
1969.....	--	55,275	--	--	55,275
1970.....	--	56,073	--	--	56,073
Total <sup>2</sup> .....	70,335	2,776,525	103,527	8,149	2,958,536

<sup>1</sup> Exclusive, after 1905, of iron ore containing 5 percent or more manganese.

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

Table 8.—Production of usable iron ore

(Thousand long tons)

Year	Direct shipping ore	Concentrates (other than agglomerates)	Agglomerates	Total		Iron content (percent)
				Usable ore <sup>1</sup>	Iron content	
1966-----	12,854	19,686	21,741	54,280	30,625	56.42
1967-----	11,111	14,719	24,327	50,157	28,742	57.30
1968-----	5,002	17,197	30,255	52,454	30,597	58.33
1969-----	5,461	16,493	33,381	55,275	32,555	58.90
1970-----	3,892	16,836	35,345	56,073	32,951	58.76

<sup>1</sup> Data may not add to totals shown because of independent rounding.Table 9.—Iron ore <sup>1</sup> shipped from mines

(Thousand long tons)

Year	Direct shipping ore <sup>2</sup>	Concentrates			Total usable ore <sup>3</sup>	Proportion of concentrates to total usable ore (percent)
		Agglomerates	Other	Total <sup>3</sup>		
1966-----	12,863	21,580	20,690	42,270	55,133	76.67
1967-----	11,149	23,884	14,424	38,308	49,457	77.46
1968-----	5,044	29,751	16,481	46,231	51,275	90.16
1969-----	5,461	33,693	17,802	51,496	56,957	90.41
1970-----	3,892	33,935	16,965	50,900	54,791	92.90

<sup>1</sup> Exclusive of ore containing 5 percent or more manganese.<sup>2</sup> Includes crushed, screened, and sized ore not further treated.<sup>3</sup> Data may not add to totals shown because of independent rounding.

Table 10.—Dates of first and final cargoes of iron ore at Minnesota and Wisconsin upper Great Lakes ports

Port and dock	1969		1970	
	First	Final	First	Final
Duluth, Minn.: DM&IR-----	Apr. 18	Dec. 17	Apr. 1	Dec. 18
Silver Bay, Minn.: Reserve-----	Apr. 8	Dec. 16	Apr. 7	Dec. 13
Superior, Wis.: Burlington Northern-----	Apr. 4	Dec. 19	Apr. 6	Dec. 19
Taconite Harbor, Minn.: Erie-----	Apr. 4	Dec. 18	Apr. 6	Dec. 8
Two Harbors, Minn.: DM&IR-----	Apr. 24	Jan. 10 <sup>1</sup>	Apr. 2	Jan. 27 <sup>2</sup>

<sup>1</sup> 1970.<sup>2</sup> 1971.

Source: Skillings' Mining Review.

requirements has become a major problem for the 55-year-old plant.

North Star Steel Co. doubled capacity of its plant in St. Paul with the installation of a second electric furnace. To minimize air pollution, the company had installed one bag house, and at yearend was installing another. The company's entire steel production is made from iron and steel scrap.

**Manganiferous Ore.**—The 286,996-long-ton shipment of manganiferous ore in 1970 was 16 percent below 1969 shipments. Although The Hanna Mining Co.'s Lauretta mine was the only Minnesota manganiferous ore producer in 1970, shipments included ore stockpiled at other mines in former years. The shutdown of the Laur-

etta in 1970 left the Mesabi the only remaining active iron range in Minnesota.

The U.S. Bureau of Mines studied the recovery of both iron and manganese from low-grade Cuyuna Range ores at its Twin Cities Metallurgy Research Center.<sup>9</sup>

#### NONMETALS

**Abrasive Stone.**—Grinding pebbles and tube-mill liners were made from quartzite quarried near Jasper in Rock County. Production accounted for less than 1 percent of State mineral production value.

**Cement.**—Minnesota's only cement producer was Universal Atlas Cement Division

<sup>9</sup> Leak, V. G. Autoclave and Ambient Pressure Leaching of Lake Superior Manganiferous Ores. BuMines Rept. of Inv. 7501, 1971, 18 pp.

Table 11.—Shipments of usable<sup>1</sup> manganiferous iron ore and ferruginous manganese ore from mines in the Cuyuna Range

Year	Manganiferous iron ore (5 to 10 percent Mn, natural)			Ferruginous manganese ore (10 to 35 percent Mn, natural)			Total shipments (long tons)
	Shipments (long tons)	Contents (natural)		Shipments (long tons)	Contents (natural)		
		Fe (percent)	Mn (percent)		Fe (percent)	Mn (percent)	
1966.....	4,035	33.55	8.61	242,020	33.87	14.12	246,055
1967.....	---	---	---	211,387	32.88	14.56	211,387
1968.....	1,596	39.89	6.88	169,695	33.15	14.23	171,291
1969.....	50	40.37	7.44	340,567	29.73	14.29	340,617
1970.....	---	---	---	286,996	29.96	13.97	286,996

<sup>1</sup> Direct-shipment and beneficiated ore.

of United States Steel Corp. It produced portland and masonry cement at Duluth from slag (from the nearby United States Steel blast furnace), limestone, sand, gypsum, iron dust, and air-entraining compounds. The principal market was in Minnesota, where deliveries were mostly in bulk by truck. The firm, which employs 175 workers, signed an agreement in June with the Minnesota Pollution Control Agency. With improvement of existing antipollution devices and installation of others, the plant will have a dust collection efficiency of more than 98 percent, according to an announcement by the company.

**Clays.**—Production of common clay and shale decreased 17 percent, from 275,000 tons valued at \$412,000 in 1969 to 227,000 tons valued at \$335,000 in 1970. It accounted for less than 1 percent of 1970 total Minnesota mineral production value. Most of the clay was used in the production of lightweight aggregate and brick; very small quantities were used for manufacturing floor and wall tile. The fire clay used at Red Wing to manufacture vitrified clay tile was imported from Iowa.

**Feldspar.**—National Resources, Inc., started feldspar production from a small pit near Beaver Bay. The feldspar will be used for glassmaking in Minnesota, Wisconsin, and Illinois.

**Gem Stone.**—Agates and similar semiprecious gem stones gathered by amateur collectors accounted for all State gem stone production.

**Lime.**—Minnesota quicklime and hydrated lime production declined 17 percent in quantity and 16 percent in value. The only producers were American Crystal Sugar Co. and Cutler-Magner Co. All lime production by American Crystal Sugar Co. was for its own use in sugar refining. It

operated four shaft kiln plants using coke for fuel. The Cutler-Magner Co. plant at Duluth burned Michigan limestone in a rotary kiln using coal as fuel. Its production was sold for chemical and industrial purposes, principally for papermaking and as mason's lime.

**Perlite.**—Zonolite Division, W. R. Grace & Co., produced expanded perlite at its Minneapolis plant from material mined outside the State. It was Minnesota's only expanded perlite producer. The perlite was used for plaster and concrete aggregate, insulation, and horticultural purposes.

**Sand and Gravel.**—The quantity of sand and gravel produced in Minnesota in 1970 was 46,851,000 short tons valued at \$38.8 million. Compared with 1969, both production and value were down 3 percent. Sand and gravel accounted for 6 percent of the value of mineral commodities produced in the State. It was outranked in both output and value only by iron ore. Average value was \$0.83 per ton, compared with \$0.84 per ton in 1969.

**Stone.**—Value of all stone produced in Minnesota in 1970 was \$12,311,000, down 14 percent from 1969. Stone ranked third in value of State mineral production, accounting for 2 percent of total value.

Limestone and dolomite were quarried in 15 southeastern counties. They accounted for 85 percent of total stone output, and 58 percent of total stone value. Principal production was as crushed rock. However, the 0.4 percent produced as dimension stone was worth 21 percent of total limestone and dolomite value.

Granite was quarried in eight Minnesota counties: 491,000 tons as crushed rock and 23,000 tons as dimension stone. The crushed granite was valued at \$943,000; value of dimension stone \$3,608,000.



**Table 12.—Minnesota: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building.....	5,008	\$4,503	4,627	\$4,332
Fill.....	622	328	813	707
Paving.....	3,231	2,136	2,091	1,547
Railroad ballast.....	13	W	29	W
Other uses <sup>1</sup> .....	522	1,449	809	1,731
Total <sup>2</sup> .....	9,395	8,417	8,368	8,317
Gravel:				
Building.....	3,680	6,623	3,518	5,929
Fill.....	1,428	617	1,818	499
Paving.....	27,089	20,269	23,223	17,441
Railroad ballast.....	198	139	166	191
Miscellaneous.....	--	--	131	166
Other uses.....	62	60	510	629
Total <sup>2</sup> .....	32,408	27,709	29,365	24,855
<b>Government-and-contractor operations:</b>				
Sand:				
Fill.....	42	19	123	53
Paving.....	1,235	759	2,037	1,210
Other uses.....	31	14	90	40
Total <sup>2</sup> .....	1,358	792	2,251	1,302
Gravel:				
Fill.....	159	64	517	233
Paving.....	4,772	3,198	6,351	4,095
Other uses.....	28	13	--	--
Total <sup>2</sup> .....	4,959	3,275	6,868	4,327
Total sand and gravel <sup>2</sup> .....	48,121	40,191	46,851	38,802

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

<sup>1</sup> Includes blast, engine, filler, foundry, glass, molding, oil (hydrafrac), and other sands.<sup>2</sup> Data may not add to totals shown because of independent rounding.**Table 13.—Minnesota: Sand and gravel sold or used by producers, by counties**

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Aitkin.....	4	55	\$36	3	47	\$27
Anoka.....	3	W	W	8	251	284
Becker.....	11	598	W	10	610	566
Beltrami.....	8	446	281	8	843	537
Benton.....	8	479	355	7	510	379
Big Stone.....	5	222	157	4	143	115
Blue Earth.....	11	905	760	12	748	707
Brown.....	12	496	W	10	174	117
Carlton.....	18	828	W	19	718	512
Carver.....	2	408	W	2	W	W
Cass.....	10	281	202	10	335	206
Chippewa.....	7	378	264	7	318	191
Chisago.....	9	1,394	947	7	427	253
Clay.....	12	1,397	W	12	1,596	2,535
Clearwater.....	5	251	197	7	414	357
Cook.....	4	201	W	4	W	W
Cottonwood.....	6	111	75	5	162	111
Crow Wing.....	11	266	262	9	259	258
Dakota.....	17	2,748	2,325	15	2,674	2,385
Dodge.....	3	54	41	2	W	W

See footnotes at end of table.

Table 13.—Minnesota: Sand and gravel sold or used by producers, by counties—Continued

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Douglas.....	4	226	\$172	4	253	\$178
Faribault.....	9	95	67	4	88	65
Fillmore.....	2	47	W	2	46	32
Freeborn.....	11	632	477	16	981	665
Goodhue.....	9	171	W	9	208	200
Grant.....	4	203	176	--	--	--
Hennepin.....	32	6,158	W	21	5,150	3,544
Houston.....	3	18	11	3	W	W
Hubbard.....	4	189	103	3	W	W
Isanti.....	4	74	48	4	W	W
Itasca.....	12	550	356	12	493	344
Jackson.....	7	140	105	6	254	194
Kanabec.....	5	79	70	5	223	147
Kandiyohi.....	6	955	1,090	6	864	979
Kittson.....	4	363	288	4	W	W
Koochiching.....	4	158	126	6	194	155
Lac qui Parle.....	10	422	321	10	384	245
Lake.....	10	321	192	4	W	W
Lake of the Woods.....	3	58	40	4	94	64
Le Sueur.....	12	955	1,541	8	744	1,498
Lincoln.....	5	225	177	5	178	130
Lyon.....	10	242	252	6	219	243
McLeod.....	2	108	94	3	106	61
Mahnomen.....	4	457	303	2	W	W
Marshall.....	6	444	394	4	512	410
Martin.....	7	402	305	7	373	297
Meeker.....	5	107	84	6	183	157
Mille Lacs.....	7	153	W	7	408	176
Morrison.....	5	318	W	6	397	331
Mower.....	17	926	525	15	W	W
Murray.....	6	234	160	4	157	90
Nicollet.....	6	400	W	3	W	W
Nobles.....	14	617	424	8	408	261
Norman.....	5	281	172	3	206	119
Olmsted.....	5	555	W	6	355	313
Otter Tail.....	23	668	399	19	559	282
Pennington.....	4	404	315	3	W	W
Pine.....	7	W	W	8	297	206
Pipestone.....	8	349	196	10	489	281
Polk.....	10	989	W	8	1,088	933
Pope.....	4	134	87	4	157	104
Ramsey.....	2	454	W	1	W	W
Red Lake.....	2	27	26	2	25	25
Redwood.....	8	463	W	8	245	154
Renville.....	9	408	W	8	377	235
Rice.....	13	832	537	18	1,078	675
Rock.....	8	217	W	9	227	253
Roseau.....	6	510	418	12	715	588
St. Louis.....	43	2,817	2,140	34	4,304	2,994
Scott.....	7	514	412	6	237	245
Sherburne.....	14	959	1,111	10	897	989
Stearns.....	10	1,267	1,224	13	1,224	1,136
Steele.....	8	316	W	12	360	451
Stevens.....	4	258	202	4	265	228
Swift.....	5	192	114	6	220	123
Todd.....	5	520	316	3	W	W
Traverse.....	2	84	59	1	14	W
Wabasha.....	5	81	W	5	76	76
Wadena.....	5	129	W	1	57	34
Waseca.....	3	34	24	1	6	W
Washington.....	21	4,285	W	16	3,970	3,674
Watsonwan.....	2	15	8	2	W	W
Wilkin.....	5	456	233	4	449	228
Wright.....	9	790	608	5	378	287
Yellow Medicine.....	10	461	289	9	334	204
Undistributed <sup>1</sup> .....	6	690	17,496	6	5,045	3,963
Total <sup>2</sup> .....	693	48,121	40,191	625	46,851	38,802

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

<sup>1</sup> Includes Sibley and Winona Counties, some sand and gravel that cannot be assigned to specific counties, and data indicated by symbol W.<sup>2</sup> Data may not add to totals shown because of independent rounding.

**Table 14.—Minnesota: Limestone and dolomite sold or used by producers, by uses**  
(Thousand short tons and thousand dollars unless otherwise specified)

Use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Rough architectural <sup>1</sup> .....thousand cubic feet..	32	\$108	29	\$115
Cut stone.....do.....	86	1,153	74	1,075
Sawed stone.....do.....	6	35	W	W
House stone veneer.....do.....	89	298	<sup>2</sup> 78	<sup>2</sup> 293
Flagging.....do.....	6	29	W	W
Total (approximate thousand short tons).....	18	<sup>3</sup> 1,624	14	1,483
<b>Crushed and broken:</b>				
Bituminous aggregate.....	229	350	277	418
Concrete aggregate.....	381	632	382	643
Dense graded road base stone.....	1,979	2,512	1,263	1,727
Macadam aggregate.....	343	468	950	1,210
Surface treatment aggregate.....	561	715	<sup>4</sup> 444	<sup>4</sup> 1,032
Unspecified aggregate & roadstone.....	132	163	W	W
Agricultural limestone.....	280	518	221	416
Railroad ballast.....	44	59	81	107
Riprap and jetty stone.....	72	91	74	95
Other <sup>5</sup> .....	107	278	180	W
Total <sup>3</sup> .....	4,127	5,785	3,872	5,650
Grand total <sup>3</sup> .....	4,145	7,409	3,886	7,134

<sup>1</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Other."

<sup>2</sup> Data includes irregular-shaped stone, rubble, other rough stone (1969); and flagging (1970).

<sup>3</sup> Data includes sawed stone and flagging.

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

<sup>5</sup> Data includes small amount of unspecified aggregate and value for other uses not listed.

<sup>6</sup> Data includes stone used for asphalt filler; flux; poultry grit and mineral food.

**Table 15.—Granite sold or used by producers, by uses**  
(Thousand short tons and thousand dollars unless otherwise specified)

Use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Rough architectural.....thousand cubic feet..	4	\$15	22	\$77
Rough monumental.....do.....	6	31	19	72
Dressed architectural (cut).....do.....	195	3,918	224	3,357
Dressed monumental.....do.....	60	1,323	4	102
Total..... (approximate thousand short tons).....	22	5,287	23	3,608
<b>Crushed and broken:</b>				
Aggregate and roadstone.....	216	344	171	381
Railroad ballast.....	320	547	301	424
Riprap and jetty stone.....	115	128	11	20
Other <sup>1</sup> .....	10	106	7	118
Total <sup>2</sup> .....	662	1,125	491	943
Grand total.....	684	6,412	514	4,550

<sup>1</sup> Includes granite for poultry grit; other uses not listed and unspecified.

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

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

County	1969			1970			Kind of stone produced in 1970 <sup>1</sup>
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value	
Beltrami.....	1	9	\$23	4	W	W	Granite.
Big Stone.....	2	109	396	2	W	W	Do.
Blue Earth.....	4	397	946	4	W	\$926	Limestone.
Cass.....	1	( <sup>2</sup> )	( <sup>2</sup> )	--	--	--	Marl.
Dakota.....	2	693	983	1	W	W	Limestone.
Dodge.....	3	W	W	3	W	W	Do.
Fillmore.....	8	340	537	8	316	519	Do.
Goodhue.....	9	168	195	8	156	182	Do.
Houston.....	18	236	274	10	69	63	Do.
Lac qui Parle.....	3	1	330	3	1	W	Granite.
Le Sueur.....	3	25	787	3	22	W	Limestone.
Mille Lacs.....	1	1	W	1	W	W	Granite.
Mower.....	4	241	360	4	W	W	Limestone.
Nicollet.....	1	W	W	1	W	W	Quartzite.
Olmsted.....	6	W	W	7	W	W	Limestone.
Redwood.....	3	29	59	3	W	W	Granite.
Renville.....	1	1	W	1	W	W	Do.
Rice.....	2	27	32	2	30	W	Limestone.
Rock.....	1	W	W	1	W	W	Quartzite.
St. Louis.....	1	90	W	1	62	124	Traprock.
Scott.....	4	423	890	4	368	326	Limestone.
Stearns.....	7	347	4,801	8	W	W	Granite.
Steele.....	1	W	W	1	W	W	Limestone.
Wabasha.....	4	W	W	4	W	W	Do.
Wadena.....	1	7	W	1	W	9	Marl.
Washington.....	4	475	W	4	W	W	Limestone.
Winona.....	6	70	W	4	W	W	Do.
Yellow Medicine.....	2	186	335	2	W	W	Granite.
Undistributed.....	--	1,154	3,806	--	3,555	9,662	Various.
Total <sup>3</sup> .....	103	5,035	14,253	95	4,579	12,311	

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

<sup>1</sup> "Limestone" used generally to include dolomite.

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

<sup>3</sup> Data may not add to totals shown because of independent rounding.

Minor quantities of basalt, quartzite, and marl are included in total stone statistics. Total production of these was about 179,000 tons; total value \$627,000. All basalt and most of the quartzite quarried was used as aggregate or riprap. Marl was produced for agricultural uses in Wadena County.

**Sulfur.**—Two Minnesota petroleum refineries reported production of sulfur as a byproduct. Great Northern Oil Co., near Pine Bend, used the Claus process, and Northwestern Refining Co. used the modified Claus process.

**Vermiculite.**—Three Twin Cities firms produced exfoliated vermiculite from vermiculite shipped from outside the State. The expanded material was sold for use principally as aggregate in lightweight plaster and concrete.

## MINERAL FUELS

**Peat.**—Eight companies reported peat production in Minnesota in 1970. Their output increased 11 percent from that in 1969. It consisted principally of moss and reed-sedge peats used in general soil improvement and in potting soils. Most was sold in packaged form, but some minor quantities were sold in bulk.

Minnesota has 50 percent of the Nation's known peat supply, yet only 3 percent of the market. With a grant of \$202,365 from the Federal Water Pollution Control Agency, the University of Minnesota and other private and government researchers have been studying the role peat might play in combating water pollution. The studies started in 1967 were scheduled for completion in 1971.

Table 17.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasive stone—Grinding pebbles and tube-mill liners: Jasper Stone Co.....	Box 206 Stoux City, Iowa 51102	Quarry and processing plant.	Rock.
Cement:			
Universal Atlas Cement Division United States Steel Corp.	Chatham Center, Box 2969 Pittsburgh, Pa. 15230	Portland and masonry, wet process.	St. Louis.
Clays and shale:			
North Central Lightweight Aggregate Co., Inc.	4901 W. Medicine Lake Dr. Minneapolis, Minn. 55427	Pit and plant.....	Hennepin.
Ochs Brick & Tile Co.....	Springfield, Minn. 56087...	Pits and plant.....	Brown, Redwood.
Twin City Brick Co.....	790 Joy Ave. St. Paul, Minn. 55118	Pit and plant.....	Ramsey.
Coke:			
American Steel & Wire Division United States Steel Corp.	Morgan Park Duluth, Minn. 55800	Coke ovens.....	St. Louis.
Koppers Co., Inc.....	1000 Hamline Ave. N. St. Paul, Minn. 55104	.....do.....	Ramsey.
Iron ore:			
Cleveland-Cliffs Iron Co.:	1460 Union Commerce Bldg. Cleveland, Ohio 44115		
Canisteo and Hill Trumbull.	-----	Mines and concentrators.	Itasca.
Holman-Cliffs and Sally.	-----	Stockpile shipments.	Do.
Coons Pacific Co.:	2521 First Ave. Hibbing, Minn. 55746		
Coons Pacific Plant....	-----	Concentrator.....	St. Louis.
The Hanna Mining Co.:	100 Erieview Plaza Cleveland, Ohio 44114		
Rabbit Lake.....	-----	Stockpile shipments.	Crow Wing.
Butler Taconite Project.	-----	Mine, concentrator, and agglomerator.	Itasca.
National Steel Pellet Project.	-----	.....do.....	Itasca and St. Louis.
Pierce Group.....	-----	Mine and concentrator.	St. Louis.
South Agnew Group.....	-----	Stockpile shipments.	Do.
West Hill.....	-----	Mine and concentrator.	Itasca.
Jones & Laughlin Steel Corp., Minnesota Ore Division:	Virginia, Minn. 55792.....		
Hill Annex and Lind-Greenway.	-----	Mines and concentrators.	Do.
McKinley and Schley Group.	-----	Mine and concentrator.	St. Louis.
Oglebay Norton Co.:	Hanna Bldg. Cleveland, Ohio 44115		
Thunderbird Mine....	-----	Mine; ore treated at Fairlane Plant.	Do.
Fairlane Plant.....	-----	Concentrator and agglomerator.	Do.
Pickands Mather & Co.:	2000 Union Commerce Bldg. Cleveland, Ohio 44115		
Danube.....	-----	Mine and concentrator.	Itasca.
Erie Commercial.....	-----	Mine, concentrator, and agglomerator.	St. Louis.
Mahoning.....	-----	Mine and concentrator.	Do.
Pittsburgh Pacific Co.:	2521 First Ave. Hibbing, Minn. 55746		
Dunwoody, Gilbert, and Monroe.	-----	Ore treated at Coons Pacific Plant.	Do.
Julia Plant.....	-----	Concentrator.....	Do.
Coons, Lamberton, Lamberton Annex, Lincoln, McEwen-Onondaga, South Uno Dale N.P., and Wyoming Annex.	-----	Stockpile shipments.	Do.
Reserve Mining Co.:	Silver Bay, Minn. 55614....		
Peter Mitchell.....	-----	Mine and primary crushing.	Do.
E. W. Davis Works...	-----	Concentrator and agglomerator.	Lake.

Table 17.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Iron ore—Continued</b>			
Rhude & Fryberger, Inc.:	Box 66 Hibbing, Minn. 55746		
Gross Nelson and Hull-Rust Group.	-----	Mines and con- centrators.	St. Louis.
Snyder Mining Co.:	Box 1106 Pittsburgh, Pa. 15230		
Kosmerl Lease Area, Wanless, and Whiteside.	-----	Mines-----	Do.
United States Steel Corp., Minnesota Ore Operations:	Box 417 Mountain Iron, Minn. 55768		
Plummer Group-----	-----	Mine and con- centrator.	Itasca.
Trout Lake Concen- trator.	-----	Concentrator-----	Do.
Kosmerl-----	-----	Mined by Snyder Mining Co. in conjunction with Whiteside Mine.	St. Louis.
Minntac-----	-----	Mine, concentrator, and agglomerator,	Do.
Rouchleau Group-----	-----	Ore treated at Julia Plant.	Do.
Sherman Group-----	-----	Mine and concen- trator.	Do.
Stephens Mine-----	-----	Mine; portion of ore treated at Coons Pacific Concen- trator.	Do.
<b>Iron and steel:</b>			
American Steel & Wire Division United States Steel Corp.	Morgan Park Duluth, Minn. 55800	Iron blast furnace and open-hearth steel furnaces.	Do.
North Star Steel Co.-----	1400 Red Rock Road St. Paul, Minn. 55119	Electric steel furnace.	Ramsey.
<b>Secondary lead smelters:</b>			
Gopher Smelting & Refin- ing Co.	Hwy. 49 and Hwy. 55 St. Paul, Minn. 55111	Processing plant----	Dakota.
National Lead Co.-----	3650 Hampshire Ave. So. Minneapolis, Minn. 55426	-----do-----	Hennepin.
<b>Lime:</b>			
American Crystal Sugar Co.	Boston Bldg. Denver, Colo. 80201	Quicklime, shaft kilns.	Carver, Clay, Polk.
Cutler-Magner Co.-----	12th Ave. & Waterfront Duluth, Minn. 55802	Quicklime and hydrated lime, one rotary kiln.	St. Louis.
<b>Manganiferous ore:</b>			
The Hanna Mining Co.:	100 Erieview Plaza Cleveland, Ohio 44114		
Lauretta Pittsburgh Pacific Co.:	2521 First Ave. Hibbing, Minn. 55746	Mine-----	Crow Wing.
Louise and Mangan No. 1.	-----	Stockpile shipments.	Do.
<b>Peat:</b>			
Colby Pioneer Peat Co.---	Box 8 Hanlontown, Iowa 50444	Peat bog-----	Aitkin.
Northland Products Co., Inc.	Box 16 Fergus Falls, Minn. 56537	-----do-----	Becker.
Power-O-Peat Co.-----	Gilbert, Minn. 55741-----	-----do-----	St. Louis.
Red Wing Peat Corp.-----	Box 3006 Houston, Texas 77001	-----do-----	Carlton.
<b>Expanded perlite:</b>			
Zonolite Division, W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 01109	Processing plant----	Hennepin.
<b>Sand and gravel:</b>			
Alexander Construction Co. Inc.	4641 Hiawatha Ave. Minneapolis, Minn. 55406	Pits and portable plants.	Dakota, Hennepin, Washington.
Anderson Aggregates, Inc.---	100 N. Seventh St. Minneapolis, Minn. 55403	Pit; one stationary, one portable plant.	Hennepin.
Barton Contracting Co.---	10300 89th Ave. N. Osseo, Minn. 55369	Pits and stationary plants.	Carlton, Chisago, Hennepin, St. Louis, Sherburne, Washington, Wright.

Table 17.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Sand and gravel—Continued</b>			
Duinneck Bros. & Gilchrist.	Olivia, Minn. 56277.....	Pits and portable plants.	Big Stone, Carlton, Clearwater, Kandiyohi, Kittson, Marshall, Polk, Redwood, Renville, Roseau.
Fischer Construction Co., Inc.	County Road 42 Rosemount, Minn. 55068	-----do-----	Dakota, Hennepin, Mower, Nobles, St. Louis, Washington, Wright.
W. Hodgman & Sons, Inc.	1100 Marcus St. Fairmont, Minn. 56031	-----do-----	Jackson, Martin, Roseau.
McLaughlin & Schulz, Inc.	Box 201 Marshall, Minn. 56258	-----do-----	Big Stone, Lincoln, Lyon, Pipestone, Polk, Pope, Redwood, Rock, Swift, Wilkin, Yellow Medicine.
Mark Sand & Gravel Co.	Box 396 Fergus Falls, Minn. 56537	-----do-----	Becker, Clearwater, Douglas, Mahanomen, Norman, Otter Tail, Wilkin.
Minnesota Valley Improvement Co.	Granite Falls, Minn. 56241	-----do-----	Beltrami, Benton, Blue Earth, Carlton, Chippewa, Hennepin, Lyon, Morrison, Otter Tail, Rice, Sherburne, Stevens, Wabasha, Wilkin, Wright, Yellow Medicine.
J. L. Shiely Co.....	1101 N. Snelling Ave. St. Paul, Minn. 55108	Pit and stationary plant.	Washington.
Uland Brothers, Inc.....	Box 98 Austin, Minn. 55912	Pits and portable plants.	Freeborn, Mower, Olmsted, Steele.
Do.....	Box 340 Cloquet, Minn. 55720	-----do-----	Carlton, Cook, Lake, St. Louis.
<b>Stone:</b>			
<b>Granite:</b>			
Cold Spring Granite Co.	Cold Spring, Minn. 56320..	Quarries.....	Big Stone, Lac qui Parle, Mille Lacs, Renville.
Do.....	-----do-----	Quarries and stationary plant.	Stearns.
Delano Granite, Inc..	Delano, Minn. 55328.....	Quarries.....	Big Stone, Lac qui Parle, Stearns, Yellow Medicine.
Do.....	-----do-----	Stationary plant.....	Wright.
The Green Co.....	Granite Falls, Minn. 56241.	Quarry and stationary plant.	Yellow Medicine.
Shiely-Petters Crushed Stone Co., Inc.	Box 69 St. Cloud, Minn. 56301	-----do-----	Stearns.
<b>Limestone and dolomite:</b>			
The Babcock Co.....	Kasota, Minn. 56050.....	-----do-----	Le Sueur.
Biesanz Stone Co., Inc.	116 W. 7th St. Winona, Minn. 55987	-----do-----	Winona.
Bryan Rock Products, Inc.	Box 215 Shakopee, Minn. 55379	Quarries; stationary and portable plants.	Scott, Washington.
Hector Construction Co., Inc.	Box 410 Caledonia, Minn. 55921	Quarries and portable plants.	Houston, Winona.
Edward Kraemer & Sons, Inc.	Plain, Wis. 53577.....	Quarry and stationary plant.	Dakota.
Mankato Ag Lime & Rock Co.	Route 3 Mankato, Minn. 56001	-----do-----	Blue Earth.
Mankato Stone Co....	826 N. Front St. Mankato, Minn. 56001	-----do-----	Do.
Osmundson Brothers..	Adams, Minn. 55909.....	Quarry and portable plant.	Mower.
Quarve & Anderson Co.	Route 3, Box 27 Rochester, Minn. 55901	Quarries and portable plants.	Dodge, Olmsted, Wabasha, Winona.
J. L. Shiely Co.....	1101 N. Snelling Ave. St. Paul, Minn. 55108	Quarries and stationary plants.	Scott, Washington.
Vetter Stone Co.....	Route 4 Mankato, Minn. 56001	Quarries and stationary plant.	Blue Earth, LeSueur.

Table 17.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Marl:			
Richard Nanik Marl Pit.	Star Route Staples, Minn. 56479	Pit.....	Wadena.
Quartzite:			
Jasper Stone Co.....	Box 206 Sioux City, Iowa 51102	Quarry and station- ary plant.	Rock.
New Ulm Quartzite Quarries, Inc.	New Ulm, Minn. 56073.....	.....do.....	Nicollet.
Traprock (Basalt):			
Arrowhead Blacktop Co.	14th Ave. W. & Waterfront Duluth, Minn. 55802	Pit.....	St. Louis.
Sulfur (recovered):			
Great Northern Oil Co....	Box 3596 St. Paul, Minn. 55101	Elemental sulfur recovered as a by- product of oil refining.	Dakota.
Northwestern Refining Co.	P.O. Drawer 9 St. Paul Park, Minn. 55071	.....do.....	Washington.
Exfoliated vermiculite:			
MacArthur Co.....	936 Raymond Ave. St. Paul, Minn. 55114	Processing plant....	Ramsey.
The B. F. Nelson Manu- facturing Co.	401 Main St. NE Minneapolis, Minn. 55413	.....do.....	Hennepin.
Zonolite Division, W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 01109	.....do.....	Do.





# The Mineral Industry of Mississippi

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

By S. O. Wood, Jr.<sup>1</sup> and Alvin R. Bicker, Jr.<sup>2</sup>

Value of mineral production in Mississippi increased 2.8 percent to \$250 million, a record high. Mineral fuels—petroleum, natural gas, and natural gas liquids—represented 88.1 percent of the total value. Mineral fuels accounted for a \$7.3 million increase from the 1969 value; however, value of all other mineral production decreased \$554,000.

Construction proceeded on schedule at the Mississippi Power and Light Co. 750,000-kilowatt electricity-generating unit at the Baxter Wilson steam electric station near Vicksburg. At yearend construction was 70 percent completed, and the unit was expected to become operational in 1971. The company also awarded a contract for construction of a new 750,000-kilowatt plant near Greenville. This plant is scheduled for completion in 1974. Because

the company was unable to obtain an assured supply of natural gas, fuel oil was selected to be the principal fuel.

Mississippi Power and Light Co. completed installation of a 250,000-kilowatt electricity-generating unit at its Jack Watson plant in Harrison County near Gulfport. This unit was designed to use about 3,000 tons of coal per day for fuel, and oil is the standby fuel. The company also awarded a contract for the building of foundations for a 500,000-kilowatt unit to be installed at the same plant. This unit is also to be fueled by coal. Completion is scheduled for 1973.

The State Mineral Lease Commission invited comments on environmental impact

<sup>1</sup> Petroleum engineer, Division of Fossil Fuels.

<sup>2</sup> Economic geologist, Mississippi Geological Economic, and Topographical Survey, Jackson, Miss.

Table 1.—Mineral production in Mississippi<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays..... thousand short tons..	1,703	\$8,660	1,553	\$8,062
Natural gas..... million cubic feet..	131,234	23,097	126,031	23,190
Natural gas liquids:				
Natural gasoline and cycle products				
thousand 42-gallon barrels..	565	1,572	544	1,465
LP gases..... do.....	538	799	428	964
Petroleum (crude)..... do.....	64,283	187,514	65,119	194,706
Sand and gravel..... thousand short tons..	11,484	12,263	10,859	11,950
Value of items that cannot be disclosed: Cement, lime, magnesium compounds, and stone.....	XX	9,279	XX	9,636
Total.....	XX	243,184	XX	249,973
Total 1967 constant dollars.....	XX	229,639	XX	226,226

<sup>1</sup> Preliminary. XX Not applicable.

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

Table 2.—Value of mineral production in Mississippi, by counties <sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Adams.....	\$23,765	\$23,053	Petroleum, sand and gravel, natural gas, natural gas liquids.
Alcorn.....	W	W	Clays, sand and gravel.
Amite.....	2,515	3,732	Petroleum, natural gas.
Attala.....	W	W	Clays.
Bolivar.....	W	W	Sand and gravel.
Carroll.....	904	W	Sand and gravel, clays.
Clarke.....	31,519	40,010	Petroleum, natural gas, natural gas liquids, sand and gravel.
Clay.....	563	477	Sand and gravel, stone, natural gas, petroleum.
Copiah.....	W	W	Sand and gravel.
Covington.....	937	847	Petroleum, sand and gravel, natural gas.
De Soto.....	W	W	Sand and gravel.
Forrest.....	3,883	3,649	Natural gas, sand and gravel, petroleum, clays.
Franklin.....	13,847	12,022	Petroleum, natural gas.
Greene.....	268	313	Do.
Hancock.....	247	238	Natural gas, petroleum, sand and gravel.
Harrison.....	174	174	Sand and gravel.
Hinds.....	1,857	1,555	Petroleum, clays, sand and gravel, natural gas.
Holmes.....	348	349	Sand and gravel, petroleum, natural gas.
Itawamba.....	722	W	Clays, natural gas.
Jackson.....	W	W	Magnesium compounds, lime, sand and gravel.
Jasper.....	25,875	25,880	Petroleum, natural gas liquids, natural gas, sand and gravel.
Jefferson.....	1,501	1,334	Petroleum, natural gas.
Jefferson Davis.....	6,152	5,543	Natural gas, petroleum, natural gas liquids.
Jones.....	10,821	10,870	Petroleum, natural gas, natural gas liquids, clays.
Lafayette.....	9	W	Sand and gravel.
Lamar.....	13,938	18,530	Petroleum, natural gas, sand and gravel.
Lauderdale.....	39	W	Clays, sand and gravel.
Lee.....	W	W	Do.
Leflore.....	W	W	Sand and gravel, petroleum, natural gas.
Lincoln.....	5,571	5,739	Petroleum, sand and gravel, natural gas, natural gas liquids.
Lowndes.....	W	W	Sand and gravel, clays.
Madison.....	1,715	1,751	Petroleum, natural gas.
Marion.....	7,518	W	Natural gas, petroleum, sand and gravel.
Marshall.....	381	W	Clays.
Monroe.....	3,187	W	Clays, sand and gravel, natural gas, petroleum.
Noxbee.....	631	W	Sand and gravel, clays.
Oak Grove.....	W	W	Clays, sand and gravel.
Pearl River.....	1,068	587	Natural gas, petroleum, clays.
Perry.....	196	W	Sand and gravel, petroleum.
Pike.....	4,565	3,127	Petroleum, sand and gravel, natural gas liquids, natural gas.
Pontotoc.....	W	W	Sand and gravel, clays.
Prentiss.....	12	W	Clays.
Rankin.....	6,140	5,074	Cement, petroleum, stone, sand and gravel, natural gas.
Scott.....	119	171	Petroleum, natural gas.
Simpson.....	2,569	2,048	Petroleum, natural gas, sand and gravel.
Smith.....	20,666	16,067	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Stone.....	284	W	Sand and gravel.
Sunflower.....	W	W	Clays.
Tallahatchie.....	43	W	Clays.
Tate.....	59	W	Sand and gravel.
Tippah.....	W	W	Clays.
Tishomingo.....	W	W	Sand and gravel.
Union.....	16	16	Do.
Walthall.....	4,076	5,599	Natural gas, petroleum, sand and gravel.
Warren.....	W	1,865	Cement, stone, sand and gravel.
Washington.....	823	W	Sand and gravel.
Wayne.....	15,184	17,031	Petroleum, natural gas, sand and gravel.
Wilkinson.....	8,356	7,541	Do.
Winston.....	W	W	Clays.
Yalobusha.....	W	W	Sand and gravel.
Yazoo.....	7,927	8,035	Petroleum, natural gas.
Undistributed.....	12,164	26,635	
Total.....	243,184	249,973	

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

<sup>1</sup> The following counties were not listed because no production was reported: Benton, Calhoun, Chickasaw, Choctaw, Claiborne, Coahoma, George, Grenada, Humphreys, Issaquena, Kemper, Lawrence, Leake, Montgomery, Neshoba, Newton, Oktibbeha, Quitman, Sharkey, Tunica, and Webster.

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

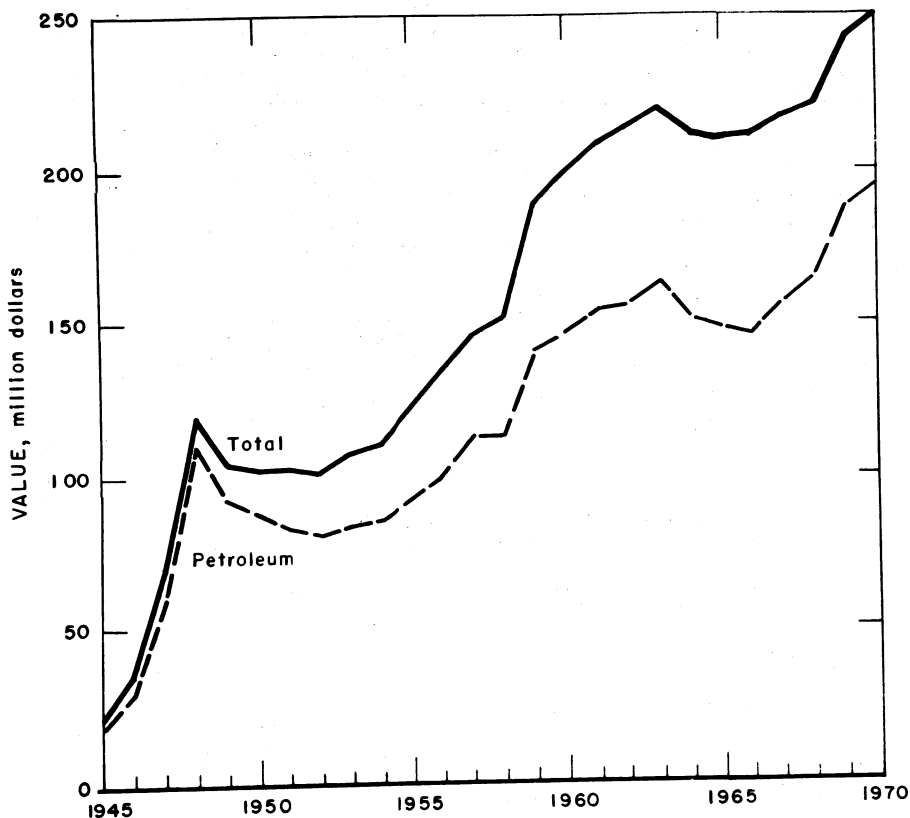


Figure 1.—Value of petroleum and total value of mineral production in Mississippi.

at a public hearing on a proposed lease sale. Proposed leases were for 98 tracts of State lands covering nearly a million acres in the Gulf of Mexico and Mississippi Sound. Subsequently, the Commission postponed the leasing of State tracts.

The acquisition of oil and gas leases on more than 2 million acres in the Black Warrior basin of northeastern Mississippi and northwestern Alabama in 1969 rekindled hopes for significant discoveries of oil and gas in the area. Near yearend 1970 there were two indicated oil and gas discoveries in Lamar County, Ala., less than 20 miles east of the Mississippi-Alabama boundary. These indicated discoveries are expected to cause increased exploratory activity in the basin. In the western portion of Mississippi, Leflore County was added to the list of oil and gas producing coun-

ties with completion of the Pan American Corp. Brodgen well 1 to produce from Upper and Lower Hosston reservoirs (Cretaceous System).

Shell Oil Co. started construction on two gas processing-sulfur recovery plants. One plant, about 20 miles northeast of Laurel, will process gas from the Goodwater field. Expected recovery is about 100,000 gallons of liquids and 25 long tons of sulfur from the processing of 15 million cubic feet of gas per day (MMcfd). A second plant, one of the largest sour-gas sulfur recovery plants in the United States, was being constructed about 25 miles southeast of Jackson. This plant was designed to process up to 100 MMcfd of sour gas and produce a maximum of 1,250 long tons of sulfur and 50 MMcfd of sweet gas. Completion is slated for 1972.

The Mississippi Geological, Economic, and Topographical Survey published three bulletins<sup>3</sup> in 1970. Bulletin 112 presents the geologic and geographic distribution of minerals that may be of economic importance in the State.

**Employment.**—According to the Mississippi Employment Security Commission, the number of wage and salaried workers in petroleum production, refining, and related industries increased 5.0 percent. Employment in the mining industry increased 8.5 percent but continued to be only 1.1 percent of total nonagricultural labor force.

**Legislation and Government Programs.**—The Mississippi Air and Water Pollution Control Commission adopted Regulations APC-S-1 and APC-S-2 on May 8, 1970.

These regulations were adopted to prevent, abate, and control air pollution caused by air contaminants being discharged into the atmosphere as particulates, smoke, fly ash, solvents, and other chemicals. Mineral extraction and processing operations that might contribute to air pollution must be in compliance with regulations of the Commission.

**Transportation.**—Collins Pipe Line Co. completed construction of its common-carrier products line from Meraux, La., to

<sup>3</sup> Bicker, Alvin R., Jr. Economic Minerals of Mississippi. Mississippi Geol., Econ., and Topographical Survey Bull. 112, 1970, 80 pp.

Huff, William J. The Jackson Eocene Ostracoda of Mississippi. Mississippi Geol., Econ., and Topographical Survey Bull. 114, 1970, 289 pp.

Shows, Thad N. Water Resources of Mississippi. Mississippi Geol., Econ., and Topographical Survey Bull. 113, 1970, 161 pp.

Table 3.—Indicators of Mississippi business activity

	1969	1970 <sup>p</sup>	Change, percent
<b>Employment and labor force, annual average:</b>			
Total work force..... thousands..	816.5	828.8	+1.5
Unemployment..... do.....	34.0	39.7	+16.8
<b>Employment:</b>			
Construction..... do.....	32.1	33.1	+3.1
Mining..... do.....	5.9	6.4	+8.5
All manufacturing..... do.....	182.1	181.5	-0.3
Other industries <sup>1</sup> ..... do.....	347.6	355.4	+2.2
<b>Personal income:</b>			
Total..... millions..	\$5,234	\$5,680	+8.5
Per capita.....	\$2,358	\$2,561	+8.6
<b>Construction activity:</b>			
Building permits, total private nonresidential..... millions..	\$63.9	\$60.7	-5.0
Cement shipments to and within Mississippi thousand 376-pound barrels..	4,427	4,328	-2.2
Farm marketing receipts..... millions..	\$807.2	\$908.9	+12.0
Mineral production..... do.....	\$243.2	\$250.0	+2.8

<sup>p</sup> Preliminary.

<sup>1</sup> Includes transportation and public utilities; wholesale and retail trade; finance, insurance, and real estate; services; and government.

Sources: Survey of Current Business, Construction Review, Farm Income Situation, Employment and Earnings and Monthly Report on the Labor Force, Area Trends in Employment and Unemployment, and U.S. Bureau of Mines.

Table 4.—Wage and salaried workers in petroleum production, refining, and related industries

Year	Crude petroleum and natural gas production	Petroleum refining <sup>1</sup>	Pipeline transportation (except natural gas)	Gas utilities	Retail filling stations	Chemicals manufactured as byproducts of petroleum or used in refining of petroleum <sup>2</sup>
1966.....	4,700	750	100	2,300	5,300	410
1967.....	4,904	827	151	2,193	5,100	373
1968.....	5,482	862	151	2,164	5,144	393
1969.....	5,515	864	158	2,141	5,084	417
1970.....	5,900	1,000	175	2,153	5,238	424

<sup>1</sup> Employment in petroleum refineries and petrochemicals manufactured in petroleum refineries.

<sup>2</sup> Employment in petrochemical manufacturing facilities located outside petroleum refineries.

Source: Mississippi Employment Security Commission.

Table 5.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non-fatal	Frequency	Severity
1969:								
Nonmetal.....	915	252	231	1,846	--	47	25.45	595
Sand and gravel.....	534	247	132	1,195	--	23	19.25	3,682
Stone.....	151	257	39	313	--	1	3.19	77
Total <sup>1</sup> .....	1,600	251	402	3,355	--	71	21.17	1,646
1970: <sup>p</sup>								
Nonmetal.....	745	244	182	1,465	--	24	16.39	307
Sand and gravel.....	545	244	133	1,249	--	28	22.41	344
Stone.....	120	204	25	200	--	--	--	--
Total <sup>1</sup> .....	1,415	241	340	2,914	--	52	17.84	302

<sup>p</sup> Preliminary.<sup>1</sup> Data may not add to totals shown because of independent rounding.

Collins, Miss. The 124-mile, 16-inch line was installed to move products from the 85,000-barrel-per-day Tenneco Oil Co. refinery at Chalmette and the 31,000-barrel-per-day Murphy Oil Corp. refinery at Meriaux to Collins, Miss., an injection point for both the Colonial and the Plantation pipeline systems.

Plantation Pipe Line Co. started looping an existing 12-inch line from Pascagoula to Collins with a 115-mile, 12-inch line. This line, like the original one, connects with the Standard Oil Co. of Kentucky refinery at Pascagoula that was being enlarged from 135,000 to 270,000 barrels per calendar day capacity.

Another products line that will connect at Collins is a 150-mile, 20-inch line from

the 155,000-barrel-per-day Gulf Oil Corp. refinery under construction at Myrtle Grove, La. The refinery and products line were scheduled to become operational in 1971.

Southern Natural Gas Co. completed 30-inch loops in their gas lines between Lacombe, La., and Prentiss, Miss., and between Prentiss, Miss., and Thomaston, Ga., and between Bay Springs, Miss., and Talbotton, Ga. The company also installed a 7-mile, 4-inch loop in Durant, Miss. Florida Gas Transmission Co., Texas Gas Transmission Corp., and Transcontinental Gas Pipe Line Corp. also increased their gas transmission capacity by looping existing pipelines.

## REVIEW BY MINERAL COMMODITIES

### MINERAL FUELS

The combined value of natural gas, natural gas liquids, and crude petroleum production increased by \$7.3 million and was 3.4 percent higher than the comparable 1969 value. The combined value of \$220.3 million was 88.1 percent of the State's total mineral production value, compared with 87.6 percent in 1969.

Mississippi ranked ninth in order of crude oil production, 10th in natural gas production, and 17th in natural gas liquids production. Leading counties in order of mineral fuels value were Clarke, Jasper, Adams, Lamar, Wayne, Smith, Franklin, and Jones.

According to the Mississippi State Oil and Gas Board, there were one gas and 18 oil new field discoveries during the year. The gas discovery and six oil discoveries were productive from formations of Jurassic age. Five oil discoveries were productive from Cretaceous age sediments, and seven discoveries produced oil from the Wilcox Formation (Tertiary age). Jurassic discoveries were East Barbara Creek (Smackover), North Shubuta (Smackover), Prairie Branch (Norphlet and Smackover), South State Line (Norphlet-gas discovery), Stafford Springs (Buckner), West Nancy (Smackover), and Tchula Lake (Smackover). Cretaceous discoveries were Dinan

(Tuscaloosa), Dollar Lake (Hosston-two reservoirs), Frances Creek (Paluxy), South Soso (Sligo), and Turnerville (Rodessa). Wilcox discoveries were East Carthage Point, Majorca, North Clear Springs, North Gardens, North Stamps, Owen Creek, and South Stamps.

According to the Mississippi State Oil and Gas Board, at yearend 401 oil pools and 61 gas pools in 385 fields were productive. There were 3,472 producible wells, a

small increase from 3,424 at yearend 1969.

**Natural Gas.**—Marketed natural gas production was 126 billion cubic feet, a decline of 4 percent from the 131 billion cubic feet marketed in 1969. The volume of gas marketed declined for the sixth consecutive year. Wellhead value in 1970 averaged 18.4 cents per thousand cubic feet (Mcf), up from 17.6 cents per Mcf in 1969. Nationwide, Mississippi ranked 10th in marketed natural gas.

Table 6.—Mississippi: Oil and gas well drilling completions, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
Adams	23	--	40	4	--	47	114	724,135
Amite	6	--	2	--	--	8	16	161,833
Bolivar	--	--	--	--	--	1	1	8,646
Claiborne	--	--	--	--	--	1	1	12,316
Clarke	46	--	20	6	--	10	82	1,030,015
Forrest	--	--	--	--	--	1	1	11,500
Franklin	9	1	4	--	--	1	6	32,204
Greene	--	--	11	2	--	40	62	385,911
Hinds	--	--	--	--	1	--	1	18,545
Holmes	--	1	--	--	--	3	4	23,561
Humphreys	--	--	--	--	1	--	3	30,700
Issaquena	--	--	1	--	--	1	2	11,413
Itawamba	--	2	--	--	--	1	1	12,008
Jasper	4	--	2	2	--	--	2	3,907
Jefferson	--	--	4	2	--	10	18	270,942
Jefferson Davis	--	2	1	--	--	10	14	75,362
Jones	13	--	2	--	--	--	3	31,049
Lamar	49	--	3	2	--	1	18	226,354
Lawrence	--	--	2	--	--	--	52	461,973
Leflore	--	--	--	--	--	2	2	20,725
Lincoln	2	--	--	2	--	--	3	24,650
Madison	2	--	3	--	--	2	7	76,219
Marion	2	--	1	--	--	1	4	24,382
Pike	8	--	--	--	--	--	8	79,505
Rankin	--	--	2	--	--	1	3	32,736
Scott	--	--	--	--	--	1	1	18,869
Sharkey	--	--	--	1	--	1	2	27,044
Simpson	--	--	--	--	--	4	4	14,966
Smith	1	--	1	--	--	1	1	14,031
Stone	--	--	--	--	--	5	7	110,544
Walthall	--	--	--	--	--	1	1	8,922
Wayne	4	4	3	1	--	4	16	192,455
Wilkinson	10	--	11	1	--	11	33	411,663
Yazoo	8	--	12	4	--	35	59	444,516
Yazoo	1	--	2	--	--	1	4	25,042
Total	186	10	125	25	2	208	556	5,058,643

Source: American Petroleum Institute.

Table 7.—Mississippi: Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

Commodity	Proved reserves Dec. 31, 1969	Changes in proved reserves due to extensions and discoveries in 1970	Proved reserves Dec. 31, 1970 (production deducted)	Change from 1969 (percent)
Crude oil.....thousand barrels	360,193	29,603	354,741	-1.5
Natural gas liquids.....do	20,045	7,040	22,651	+13.0
Natural gas.....million cubic feet	1,410,898	150,544	1,333,905	-5.5

Source: American Petroleum Institute.

Five counties supplied 78 percent of the State's natural gas production. In descending order of production they were Jefferson Davis, Marion, Walthall, Smith, and Forrest. Natural gas reserves declined for the ninth consecutive year, extending the downward trend that started in 1961. According to the American Gas Association, Inc., estimated gas reserves were 1,334 billion cubic feet at yearend 1970, 5.5 percent less than at yearend 1969. The reserve-to-production ratio declined from 16.4:1 in 1961 to 8.5:1 in 1970. One new gasfield was discovered, according to the Mississippi State Oil and Gas Board. The Shell Oil Co. Lucas et al well 1 in sec 14, T 4 N, R 5 W, Greene County, was completed to produce gas and condensate from the Norphlet Formation at depths from 18,207 to 18,227 feet. The field was named South State Line.

Underground storage of gas was at three operations: Amory field in Monroe County, Jackson Dome in Rankin and Hinds Counties, and Eminence Dome in Covington County. These operations have a total gas storage capacity of about 10 billion cubic feet.

Houston Natural Gas Corp. acquired Humble Gas Transmission Co., a former subsidiary of Humble Oil & Refining Co., and changed its name to Mid Louisiana Gas Co. Involved in the acquisition were 485 miles of gathering and transmission lines in western Mississippi and eastern Louisiana, along with substantial gas reserves and producing wells in the Monroe, La., gasfield.

**Natural Gas Liquids.**—Reserves of natural gas liquids increased 2.6 million barrels, a 13-percent increase, according to the American Gas Association, Inc. The change in reserves was the fourth consecutive year of increases. Mississippi contained 0.3 percent of domestic natural gas liquids reserves.

According to the Oil and Gas Journal annual survey of natural gas plants,<sup>4</sup> 10 plants in Mississippi at yearend 1970 had a total capacity of 230 MMcf. This capacity was 0.3 percent of the U.S. total. The survey indicated that the Mississippi plants operated at an average of 58 percent of capacity in 1970. Two gas-processing plants operated by Tonkawa Gas Processing Co. became operational during the year: Clarke County gas processing plant (Clarke

County) and Diamond gas processing plant in Wayne County.

The Brookhaven gas processing plant of Chevron Oil Co. was shut down in June. However, compression facilities needed for the gas-lift system used in oil production remained in operation.

Three companies conducted underground natural gas liquids storage operations in the Petal salt dome, Forrest County. According to the Oil and Gas Journal annual survey, storage capacity in the dome was 4.10 million barrels of propane and 650,000 barrels of butane-propane mix.

**Petroleum.**—Mississippi ranked ninth in crude petroleum production and accounted for 2 percent of U.S. output. State production of 65.1 million barrels of crude petroleum was valued at \$194.7 million, an average unit value of \$2.99 per barrel. With discovery of the Dollar Lake oilfield, Leflore became the 32d-oil-producing county in the State. Ten counties produced more than 2 million barrels of crude petroleum, and they accounted for 87 percent of the State's production. These counties, in descending order of production, were Clarke, Jefferson, Adams, Lamar, Wayne, Smith, Franklin, Jones, Yazoo, and Wilkinson. Salt water produced in association with crude petroleum production was 197 million barrels, an average of 3 barrels of water for each barrel of petroleum.

Two percent of the wells drilled for oil and gas in the United States were drilled in Mississippi. According to American Petroleum Institute (API) drilling statistics, there were 25 successful oil and two successful gas ventures from a total of 235 exploratory wells drilled—a success ratio of 11.5 percent. Of the 321 proved field wells drilled, there were 196 successes, 186 oil and 10 gas producers.

Mississippi State Oil and Gas Board monthly bulletin data indicated that 63 percent of exploratory wells were drilled to the Wilcox Formation, and 18 percent of the exploratory wells were drilled to formations of Jurassic age. Of the proved field well completions, 29 percent were drilled to the Wilcox Formation, 28 percent were to formations of Jurassic age, and virtually all the remaining 43 percent were to Cretaceous formations—principally the Tuscaloosa.

<sup>4</sup>Oil and Gas Journal, 1971 Survey of Gas Processing Plants. V. 69, No. 28, July 12, 1971, p. 84.



**Table 8.—Mississippi: Crude petroleum production, indicated demand, and stocks in 1970, by months**  
(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Mississippi
January.....	5,502	5,282	5,498
February.....	4,975	4,372	5,601
March.....	5,586	5,170	6,017
April.....	5,417	5,716	5,718
May.....	5,500	5,478	5,740
June.....	5,221	5,740	5,221
July.....	5,419	5,588	5,057
August.....	5,490	5,612	4,929
September.....	5,386	5,287	5,028
October.....	5,641	5,682	4,987
November.....	5,373	5,297	5,063
December.....	5,609	6,001	4,671
Total:			
1970..	65,119	65,726	XX
1969..	64,283	64,210	XX

XX Not applicable.

Proved crude oil reserves at yearend 1970 were 354.7 million barrels, 5.5 million barrels less than at yearend 1969, according to API estimates. Crude oil reserves-to-production ratio was 5.5:1, compared with the nationwide average of 11.7:1.

Standard Oil Co. of Kentucky was nearing completion of refinery expansions started in 1969 at Pascagoula. A two-stage crude distillation unit, a two-stage isomax unit, and steam-methane reforming equipment were scheduled to become operational in April or May 1971. Along with increasing distillation capacity to 270,000

barrels per calendar day, the company installed equipment to maintain environmental quality. Equipment installed to minimize pollution included stripping columns to recover ammonia and hydrogen sulfide vapors, electrostatic precipitators to collect catalyst dust, and water filtration and treating equipment including separators, floatation units, and aeration devices. Capacity of the crude oil line that transports crude from Louisiana to the refinery was increased to 230,000 barrels per day.

**Petrochemicals.**—The Conoco Plastics Division of Continental Oil Co. completed an expansion of its polyvinyl chloride plant at Aberdeen. Douglas and Lomason expanded its plant at Cleveland to produce some plastic components with stamped aluminum automobile trim. General Tire and Rubber Co. expanded its plant at Columbus to increase output of vinyl materials. Coastal Chemical Corp. started construction to expand its Pascagoula operations. Included in the expansion are a 1,500-ton-per-day sulfuric acid plant and a triple superphosphate plant.

#### NONMETALS

The combined value of nonmetals production was \$29.6 million, 11.9 percent of the value of mineral production. The value of nonmetals production decreased 1.8 percent from the comparable 1969 value.

**Cement.**—Portland and masonry cements

**Table 9.—Mississippi: Crude petroleum production, by fields**  
(Thousand 42-gallon barrels)

Field	1969	1970	Cumulative to Dec. 31, 1970
Baxterville.....			
Bay Springs.....	4,917	6,616	134,085
Brookhaven.....	3,288	2,858	18,297
Bryan.....	1,094	1,358	64,766
East Eucutta.....	825	1,090	19,062
Goodwater.....	1,187	1,225	34,381
East Heidelberg.....	477	1,412	1,889
West Heidelberg.....	2,361	2,286	63,515
East Nancy.....	1,387	1,243	30,960
West Nancy.....	1,481	1,498	3,324
Pachuta Creek.....		1,163	1,163
Quitman.....	4,468	4,217	8,942
Quitman Bayou.....	2,262	2,188	9,126
Soso.....	1,483	1,479	8,613
Tallahala Creek.....	1,518	1,436	48,989
East Tallahala Creek.....	2,552	1,452	6,812
Tinsley.....	1,447	1,178	3,303
Other fields.....	2,157	2,283	184,769
Total.....	31,379	30,137	625,496
Total.....	64,283	65,119	1,267,492

Source: Mississippi State Oil and Gas Board.

were produced at two plants using the wet process. Shipments of portland cement in 1970 were 14.7 percent less than 1969 shipments, and masonry cement shipments declined 12 percent. Unit values of cement increased. Portland cement average unit value was \$3.44 per 376-pound barrel, a 7.2-percent increase from the 1969 value. Masonry cement average unit value was \$2.70 per 280-pound barrel, an increase of 8.4 percent from the 1969 value. The two plants in Mississippi were fueled by natural gas. Most of the cement was consumed by ready-mix concrete companies. The second largest cement-consuming group was highway contractors.

**Clays.**—This commodity was mined at 40 pits in 21 counties and contributed 3 percent of the State's mineral production value. Clay output totaled 1.55 million tons, 9 percent less than the 1969 output of 1.70 million tons. Average unit value increased 2 percent to \$5.19 per short ton. There was a small increase in the output of fire clay and decreases in outputs of miscellaneous, bentonite, and other clays. Bentonite output decreased 12.4 percent. Miscellaneous clay production decreased 11.4 percent but continued to be the largest volume category, accounting for 63 percent of total clay output. Leading counties in descending order of production were Hinds, Noxubee, Marshall, and Monroe. Production from these four counties was 68 percent of the State total. Miscellaneous clay used for heavy clay products and lightweight aggregates was mined in 15 counties. Bentonite was mined in five counties. Fire clay was produced in Marshall County, fuller's earth in Tippah County, and ball clay in Panola County.

**Lime.**—Hydrated lime used in the manufacture of refractory bricks was produced in Jackson County. Lime production and

value increased about one-third from the 1969 levels. Raw material for lime production was dolomite quarried in Alabama and shipped into Mississippi.

**Magnesium Compounds.**—Production of magnesium compounds used in the manufacture of refractory bricks increased significantly. Production in 1970 was 35 percent higher than comparable production in 1969. Unit price increased 4 percent.

**Perlite.**—Johns-Manville Products Corp. continued to produce expanded perlite in Adams County. Production was less than in 1969; however, unit value increased significantly.

**Sand and Gravel.**—This commodity was produced in 43 of the State's 82 counties. Output was 10.86 million short tons, a decrease of 5.4 percent from the preceding year. Unit value increased 2.8 percent to \$1.10 per ton. Leading productive counties in descending rank of output were Forrest, Copiah, Adams, Lowndes, and De Soto. Output from these five counties totaled 4.58 million tons, 42.1 percent of the State output.

Sand output totaled 4,288,000 short tons. Principal uses for sand were building, 52.6 percent, and paving, 41.7 percent; other uses included railroad ballast, fill, and molding—5.7 percent. Principal uses for the 6,570,000 tons of gravel produced were building—34.5 percent, paving—60.8 percent, and other uses—4.7 percent. The average unit value of gravel increased 5.5 percent to \$1.21 per long ton.

**Stone.**—Crushed and broken limestone was produced in Clay, Rankin, and Warren Counties, and marl was produced in Rankin County. Total stone output and value from the four quarries declined. Principal uses of stone produced in Mississippi were for cement manufacture and for agricultural purposes.

Table 10.—Mississippi: Clays sold or used by producers, by kinds  
(Thousand short tons and thousand dollars)

Year	Bentonite		Ball clay, fire clay, and fuller's earth		Miscellaneous clay		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1966	291	\$3,615	280	\$2,673	1,156	\$1,201	1,727	\$7,489
1967	259	3,067	306	3,306	1,089	1,479	1,654	7,852
1968	277	3,128	353	4,525	1,063	1,422	1,693	9,075
1969	299	3,525	305	3,999	1,099	1,136	1,703	8,660
1970	262	3,124	318	3,930	974	1,008	1,553	8,062

<sup>1</sup> Data does not add to total shown because of independent rounding.

**Table 11.—Mississippi: Sand and gravel sold or used by producers, by classes of operations and uses**  
(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	2,432	\$2,111	2,255	\$1,912
Paving.....	1,636	1,446	1,765	1,703
Other uses <sup>1</sup> .....	152	276	243	323
<b>Total</b> <sup>2</sup> .....	<b>4,220</b>	<b>3,831</b>	<b>4,263</b>	<b>3,938</b>
<b>Gravel:</b>				
Building.....	2,423	2,797	2,264	2,682
Paving.....	4,277	4,898	3,761	4,751
Other uses <sup>3</sup> .....	220	285	310	366
<b>Total</b> <sup>2</sup> .....	<b>6,920</b>	<b>7,980</b>	<b>6,335</b>	<b>7,800</b>
<b>Government-and-contractor operations:</b>				
<b>Sand:</b> Paving.....	73	99	25	37
<b>Gravel:</b> Paving.....	271	352	235	174
<b>Total sand and gravel</b> <sup>2</sup> .....	<b>11,484</b>	<b>12,263</b>	<b>10,859</b>	<b>11,950</b>

<sup>1</sup> Includes railroad ballast, fill, molding, and other sand.

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

<sup>3</sup> Includes railroad ballast (1970), fill, and other gravel.

**Sulfur.**—Recovery of sulfur from refinery and natural gases was reported for Lamar and Madison Counties. The average unit value decreased 40 percent, and production decreased 10 percent from comparable 1969 figures. Although the unit value of sulfur has declined 55 percent from a recent high

in 1968, increased recovery of sulfur is expected in Mississippi. Shell Oil Co. has started construction on plants near Laurel and Jackson. At yearend Standard Oil Co. of Kentucky was adding desulfurization equipment to its Pascagoula refinery.

Table 12.—Principal producers

Commodity and company	Address	Type of activity or producing fields	County
<b>Cement:</b>			
Marquette Cement Mfg. Co.-----	20 North Wacker Dr. Chicago, Ill. 60606	Plant-----	Rankin.
Valley Cement Ind., Inc.-----	Box 22491 Jackson, Miss. 39205	----do-----	Warren.
<b>Clays:</b>			
American Colloid Co.-----	5100 Suffield Ct. Skokie, Ill. 60076	Mine-----	Itawamba and Monroe.
Delta-Macon Brick & Tile Co., Inc.	R.F.D. 3, Box 2 Macon, Miss. 39341	Mine and plant.	Noxubee.
Dresser Minerals, div. of Dresser Industries, Inc.	Box 6504 Houston, Tex. 77005	----do-----	Attala.
Filtrol Corp.-----	3250 East Washington Blvd. Los Angeles, Calif. 90023	----do-----	Itawamba and Smith.
Holly Springs Brick & Tile Co., Inc.	Box 310 Holly Springs, Miss. 38635	----do-----	Marshall.
International Minerals & Chemical Corp.	Administration Center Old Orchard Rd. Skokie, Ill. 60076	Mine-----	Monroe.
Jackson Ready-Mix Concrete Co.	Box 1292 Jackson, Miss. 39205	Mine and plant.	Hinds.
Kentucky-Tennessee Clay Co.-----	Box 447 Mayfield, Ky. 42066	Mine-----	Panola.
Oil Dri Production Co.-----	Box 285 Ripley, Miss. 38661	----do-----	Tippah.
Tri-State Brick & Tile Co., Inc.	Box 9787 Jackson, Miss. 39206	Mine and plant.	Hinds.
Wyandotte Chemicals Corp.-----	1609 Biddle Ave. Wyandotte, Mich. 48192	----do-----	Tippah.
<b>Lime:</b>			
Corchem, Inc.-----	Box 1707 Pascagoula, Miss. 39567	Plant-----	Jackson.
<b>Magnesium compounds:</b>			
H. K. Porter Co., Inc., Refractor- ies Div.	Box 1150 Pascagoula, Miss. 39567	----do-----	Do.
<b>Perlite:</b>			
Johns-Manville Products Corp., Celite Div.	22 East 40th St. New York, N.Y. 10016	Expanding plant.	Adams.
<b>Sand and gravel:</b>			
American Sand & Gravel Co.-----	Box 272 Hattiesburg, Miss. 39401	Stationary-----	Forrest.
J. J. Ferguson Sand & Gravel-----	Box 418 Greenwood, Miss. 38930	----do-----	Carroll.
Green Bros. Gravel Co., Inc.-----	Rt. 4, Box 17 Franklinton, La. 70438	----do-----	Copiah.
Greenville Gravel Co.-----	Box 220 Greenville, Miss. 38701	Dredge-----	Washington.
Memphis Stone & Gravel Co.-----	Box 8246 Memphis, Tenn. 38111	Stationary-----	De Soto.
St. Catherine Gravel Co.-----	Box 928 Natchez, Miss. 39120	----do-----	Adams.
Traxler Gravel Co., div. of Delta Ind., Inc.	Box 1292 Jackson, Miss. 39205	Stationary and dredge.	Copiah.
Weymouth Construction Co.-----	Box 319 Jackson, Miss. 39205	Stationary-----	De Soto.
Yazoo Valley Gravel Co.-----	1115½ Jackson Ave. Oxford, Miss. 38655	----do-----	Panola.
<b>Stone:</b>			
Valley Cement Ind., Inc.-----	Box 22491 Jackson, Miss. 39205	Quarry-----	Warren.
State Dept. of Agriculture and Commerce.	West Point, Miss. 39773	----do-----	Clay.
<b>Oil and gas:</b>			
Atlantic Richfield Co.-----	Box 2819 Dallas, Tex. 75221	East Heidelberg.	Jasper.
Chevron Oil Company, Western Div.	Box 599 Denver, Colo. 80201	Brookhaven South Center Ridge. Cranfield-----	Lincoln. Smith. Adams and Franklin.
		Hub-----	Marion.
		Hub East-----	Do.
		Knox-----	Walthall.
		East Mallalieu-----	Lincoln.
		West Mallalieu-----	Do.
		Mize-----	Smith.
		Pisgah-----	Rankin.
		Puckett-----	Rankin and Smith.
		Raleigh-----	Simpson.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity or producing fields	County
Oil and Gas—Continued			
Chevron Oil Company, Western Div.—Continued			
Cities Service Oil Co.....	Box 12026 Jackson, Miss. 39211	Reedy Creek... Shongelo Creek... Hazlit Creek... North Mud Creek.	Jones. Smith. Wilkinson. Do.
Continental Oil Co.....	Box 2197 Houston, Tex. 77001	Davis.....	Clarke.
Getty Oil Co.....	Box 1404 Houston, Tex. 77001	East Nancy.... West Nancy....	Do. Do.
Gulf Oil Corp.....	Box 1166 Pittsburgh, Pa. 15230	Baxterville....	Lamar and Marion.
		Bolton..... Gwinville.....	Hinds. Jefferson
		Heidelberg....	Davis.
		East Heidelberg.	Jasper. Do.
		West Heidelberg.	Do.
		West Mallalieu.	Lincoln.
		Pistol Ridge...	Forrest and Pearl River.
		Soso.....	Jasper, Jones, and Smith.
		East Yellow Creek.	Wayne.
Humble Oil & Refining Co.....	Box 2180 Houston, Tex. 77001	Alloway..... Baxterville....	Adams. Marion and Lamar.
		Beaver Branch.	Adams.
		Bentonia.....	Yazoo.
		Bryan.....	Jones and Jasper.
		Chaparral....	Wayne.
		Cowpen.....	Adams.
		East Eucutta..	Wayne
		West Eucutta..	Do.
		East Fairview..	Adams.
		Fayette.....	Jefferson.
		Gilliard Lake..	Adams.
		Gillsburg.....	Amite.
		Gwinville.....	Jefferson Davis.
		Hub.....	Marion.
		Hub East.....	Do.
		Junction City..	Clarke.
		Kelly Hill.....	Wilkinson.
		Knoxo.....	Walthall.
		Lagrange.....	Adams.
		North Lake... Lucille.	Do.
		Loring.....	Madison.
		West Mallalieu.	Lincoln.
		Mantua.....	Adams.
		Maxie.....	Forrest.
		Otter Lake....	Adams.
		Pickens.....	Madison and Yazoo.
		Pistol Ridge...	Pearl River.
		Sandy Hook....	Marion.
		Shieldsboro...	Adams.
		Sibley.....	Do.
		Waveland.....	Hancock.
		East Yellow Creek.	Wayne.
		North Yellow Creek.	Do.
		West Yellow Creek.	Do.
Meason Operating Co.....	Natchez, Miss. 39120	Bourbon..... North Carthage Point.	Adams. Do.
		Clear Springs..	Franklin.
		Courtland....	Adams.
		Dexter.....	Walthall.
		Ellis Cliffs...	Adams.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity or producing fields	County
Oil and Gas—Continued:			
Pan American Petroleum Corp. ....	Box 591 Tulsa, Okla. 74102	Clear Springs ..	Franklin.
		Collins .....	Covington.
		Diamond .....	Wayne.
		Dollar Lake ..	Leflore.
		Dry Bayou .....	Franklin.
		East Fork .....	Amite.
		North East ..	Do.
		Fork.	
		North .....	Franklin.
		Freewoods.	
		Grange .....	Jefferson
			Davis.
		Hilo .....	Adams.
		South Ireland ..	Wilkinson.
		Kelly Hill .....	Do.
		Knoxville .....	Franklin.
		North .....	Do.
		Knoxville.	
		Lake Mary .....	Wilkinson.
		Lazy Creek .....	Pike.
		Levees Creek ..	Adams.
		Little Creek ..	Pike.
		Locust Hill .....	Adams.
		Lorene .....	Smith.
		Morgan Town ..	Adams.
		Pelahatchie .....	Rankin.
		Pine Mount .....	Adams.
		West Pine .....	Do.
		Ridge.	
		Quitman .....	Do.
		Bayou.	
		Siloam .....	Clay.
		Stringer .....	Jasper.
		Sylvarena .....	Smith.
		Tallahala .....	Do.
		Creek.	
		Thorn .....	Chickasaw.
		Wells Creek .....	Franklin.
		Zeigler Creek ..	Do.
		Tinsley .....	Yazoo.
Pennzoil Producing Co. ....	900 Southwest Tower Houston, Tex. 77002	Nancy .....	Clarke.
Placid Oil Co. ....	1401 Elm St. Dallas, Tex. 75202	Pachuta Creek ..	Do.
Shell Oil Co. ....	Shell Building 921 Common New Orleans, La. 70112	Goodwater .....	Do.
		Bay Springs .....	Jasper.
		Tallahala .....	Smith.
		Creek.	
		East Tallahala ..	Do.
		Creek.	
Skelly Oil Co. ....	Box 1650 Tulsa, Okla. 74101	Bay Springs .....	Jasper.
Sun Oil Co. ....	1608 Walnut Philadelphia, Pa. 19108	Goodwater .....	Clarke.
		Baxterville .....	Lamar.
		Bolton .....	Hinds.
		Diamond .....	Wayne.
		West Eucutta ..	Do.
		East Franklin ..	Franklin.
		East .....	Jasper.
		Heidelberg.	
		Knox .....	Walthall.
		Kokomo .....	Do.
		Mantua .....	Adams.
		McComb .....	Pike.
		Mercer .....	Adams.
		Pistol Ridge .....	Forrest and
			Pearl River.
		Sandy Hook .....	Marion.
		Smithdale .....	Amite.
		East Summit .....	Pike.
		Tom Branch .....	Franklin.
		West Yellow .....	Wayne.
		Creek.	
Texaco, Inc. ....	Box 60252 New Orleans, La. 70150	Baxterville .....	Lamar.
		Pachuta Creek ..	Clarke.



# The Mineral Industry of Missouri

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

By Lester G. Morrell,<sup>1</sup> Joseph C. Arundale,<sup>2</sup> and James A. Martin<sup>3</sup>

Mineral output in Missouri in 1970 reached a record high for the seventh consecutive year. The total value of the State's mineral products increased 7 percent over that of 1969 to \$393 million. A \$29 million increase in lead and zinc output was partly offset by reductions in materials such as cement and stone, which resulted from interruptions in the construction industry.

Highlights of mineral industry developments in Missouri in 1970 included progress on a new lead mine-mill complex in

the Viburnum Trend area of southeast Missouri and construction of a new aluminum reduction and fabrication complex near the city of New Madrid in the Boot-heel area. Exploration was stepped up in the iron-copper mineralized area near Boss in southeast Missouri.

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<sup>2</sup> Physical scientist, Bureau of Mines, Rolla, Mo.

<sup>3</sup> Chief, Mineral Resources Section, Missouri Division of Geological Survey and Water Resources, Rolla, Mo.

Table 1.—Mineral production in Missouri<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite.....thousand short tons..	304	\$4,220	230	\$3,555
Cement:				
Portland.....thousand 376-pound barrels..	21,325	74,368	21,224	64,261
Masonry.....thousand 280-pound barrels..	427	1,319	402	1,234
Clays <sup>2</sup> .....thousand short tons..	2,251	6,405	2,128	6,480
Coal (bituminous).....do.....	3,301	14,283	4,447	19,526
Copper (recoverable content of ores, etc.).....short tons..	12,664	12,039	12,134	14,003
Iron ore (usable).....thousand long tons, gross weight..	2,622	35,826	2,612	38,100
Lead (recoverable content of ores, etc.).....short tons..	355,452	105,889	421,764	131,751
Petroleum.....thousand 42-gallon barrels..	67	W	66	W
Natural gas.....million cubic feet..	126	17	87	21
Sand and gravel.....thousand short tons..	10,940	14,574	12,446	15,379
Silver (recoverable content of ores, etc.).....thousand troy ounces..	1,442	2,582	1,817	3,218
Stone.....thousand short tons..	41,977	63,251	39,726	<sup>3</sup> 57,285
Zinc (recoverable content of ores, etc.).....short tons..	41,099	12,001	50,721	15,540
Value of items that cannot be disclosed:				
Other nonmetals and fuels and values indicated by symbol				
W.....	XX	20,458	XX	22,643
Total.....	XX	367,232	XX	392,996
Total 1967 constant dollars.....	XX	346,777	XX	<sup>p</sup> 355,661

<sup>p</sup> Preliminary. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." 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, included with "Value of items that cannot be disclosed."

<sup>3</sup> Excludes value of certain stone, included with "Value of items that cannot be disclosed."



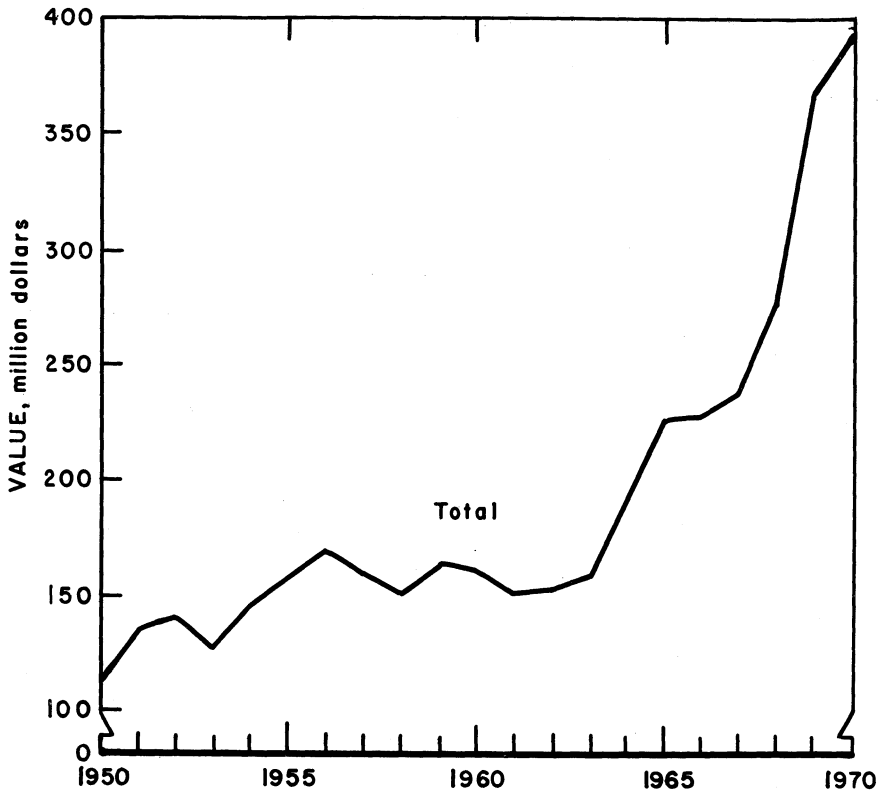


Figure 1.—Total value of mineral production in Missouri.

Table 2.—Value of mineral production in Missouri, by counties <sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Adair.....	W	W	Stone.
Atchison.....	W	W	Petroleum.
Audrain.....	W	\$756	Clays.
Barry.....	W	-----	
Barton.....	W	W	Coal, stone, native asphalt.
Bates.....	W	176	Stone.
Benton.....	\$9	-----	
Boone.....	4,321	4,131	Coal, stone, sand and gravel, clays.
Buchanan.....	412	327	Stone, sand and gravel.
Butler.....	W	W	Sand and gravel, clays.
Caldwell.....	257	W	Stone, natural gas.
Callaway.....	1,662	2,181	Clays, stone, sand and gravel, coal.
Camden.....	W	W	Stone.
Cape Girardeau.....	W	W	Cement, stone, sand and gravel, clays.
Cass.....	254	W	Stone, petroleum.
Christian.....	531	460	Stone.
Clark.....	W	W	Do.
Clay.....	W	W	Stone, sand and gravel.
Clinton.....	285	W	Stone, natural gas.
Cole.....	588	605	Stone, sand and gravel, barite, lead.
Cooper.....	W	W	Stone, sand and gravel.
Crawford.....	5,942	6,296	Lead, copper, zinc, silver, sand and gravel.
Dade.....	111	107	Stone.
Dallas.....	W	W	Do.
Davies.....	W	585	Stone, sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Missouri, by counties 1—Continued  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
De Kalb	\$363	\$107	Stone.
Douglas	238	W	Sand and gravel.
Dunklin	W	90	Do.
Franklin	608	W	Stone, clays, sand and gravel.
Gasconade	2,317	1,982	Clays.
Gentry	W	W	Stone.
Greene	4,281	W	Stone, lime.
Grundy	379	W	Stone, sand and gravel.
Harrison	W	W	Do.
Henry	W	W	Coal, stone.
Hickory	W	W	Stone.
Holt	W	W	Do.
Howard	W	W	Stone, sand and gravel.
Howell	W	2,023	Sand and gravel, stone.
Iron	57,312	84,225	Lead, iron ore, zinc, copper, silver, stone.
Jackson	14,539	W	Cement, stone, sand and gravel, clays, petroleum.
Jasper	3,980	W	Stone, sand and gravel.
Jefferson	W	W	Cement, stone, sand and gravel, clays.
Johnson	W	W	Stone.
Knox	W	W	Do.
Laclede	W	W	Do.
Lafayette	83	W	Stone, sand and gravel.
Lawrence	W	W	Stone.
Lewis	W	W	Sand and gravel, stone.
Lincoln	567	486	Sand and gravel, stone, clays.
Linn	W	W	Stone.
Livingston	805	W	Stone, clays.
Macon	W	W	Coal.
Madison	W	W	Sand and gravel, stone.
Maries	W	-----	-----
Marion	434	W	Lime, stone.
Mercer	407	383	Stone.
Miller	W	W	Sand and gravel, stone.
Moniteau	131	85	Stone.
Monroe	398	329	Stone, clays, sand and gravel.
Montgomery	883	687	Clays, stone, sand and gravel.
New Madrid	W	-----	-----
Newton	W	W	Stone.
Nodaway	649	746	Stone, sand and gravel.
Oregon	W	W	Stone.
Osage	W	W	Clays, sand and gravel.
Ozark	W	W	Sand and gravel, stone.
Pemiscot	W	W	Sand and gravel.
Perry	W	W	Stone.
Pettis	W	W	Do.
Phelps	268	W	Stone, sand and gravel.
Pike	W	W	Cement, stone, clays.
Platte	324	593	Sand and gravel, stone, clays.
Pulaski	W	W	Stone, sand and gravel.
Putnam	151	W	Coal.
Ralls	W	W	Cement, stone, clays, sand and gravel.
Randolph	1,154	W	Coal, stone.
Ray	1,321	920	Stone.
Reynolds	51,058	58,540	Lead, copper, zinc, silver, sand and gravel, stone.
St. Charles	2,721	2,061	Stone, sand and gravel, clays.
St. Francois	18,234	17,337	Lead, lime, stone, copper, zinc, silver.
St. Louis	32,923	26,213	Cement, stone, sand and gravel, clays, petroleum.
Ste. Genevieve	27,105	26,661	Lime, stone, sand and gravel.
Saline	780	466	Stone.
Scotland	W	W	Do.
Scott	W	W	Stone, clays.
Shannon	W	64	Stone.
Shelby	W	W	Do.
Stoddard	392	W	Sand and gravel.
Vernon	208	229	Stone, coal, native asphalt, petroleum.
Warren	155	264	Clays, stone, sand and gravel.
Washington	43,817	43,337	Iron ore, lead, barite, zinc, copper, silver, sand and gravel.
Wayne	W	W	Stone.
Webster	-----	W	Sand and gravel.
Wright	W	W	Stone.
Undistributed	83,900	109,548	
<b>Total</b>	<b>367,232</b>	<b>2392,996</b>	

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

<sup>1</sup> The following counties were not listed because no production was reported: Andrew, Bollinger, Carroll, Carter, Cedar, Chariton, Dent, McDonald, Mississippi, Morgan, Polk, Ripley, St. Clair, Schuyler, Stone, Sullivan, Taney, Texas, and Worth.

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

Principal mineral commodities that accounted for 84 percent of the total mineral value were lead, stone, cement, iron ore, zinc, and lime.

Missouri, which ranked 21st among the States in mineral output in 1968, jumped to 18th place in 1969 and moved to 17th in ranking in 1970.

**Trends and Developments.**—March 1970 marked the centennial anniversary of the Missouri Geological Survey. The occasion was observed by issuance of Special Publication No. 1, *Missouri Minerals—Resources, Production, and Forecasts*, prepared for the Missouri Department of Community Affairs as part of the State Mineral Resources Plan. The study and resultant report contained a summary of past commodity production and current trends for all important Missouri minerals by regions established by the State Planning Agency. Also included in the report were projections on the outlook for the mineral sector of the State's economy for the years 1975 and 1990.<sup>4</sup>

The obvious trend in Missouri minerals was an increase of over 100 percent in the value of output in the past 7 years. Most of this rapid increase was caused by new iron ore and lead-zinc-copper mines in southeast Missouri, but most of the State's other mineral commodities also set new production records.

The Missouri Geological Survey describes the recent trend in the State's lead-mining industry as follows:<sup>5</sup> "The Southeast Missouri Lead district is now the world's largest lead producing region. Geological exploration for ore deposits in the 1950's and early 1960's paid off in important new discoveries of lead, zinc, copper, and silver in what has become known to geologists as the Viburnum Trend. Mine development plus mill and smelter construction required most of the 1960's to accomplish, but as new mines came on stream and others reached capacity, production of the Southeast Missouri Lead district began to overtake and has now surpassed its nearest competitor, the Broken Hill district of New South Wales, Australia. The Southeast Missouri Lead district cinched the 'Number 1' in Lead Production title by mining 432,576 tons of lead valued at over \$135 million during 1970. This was nearly 75 percent of the entire U.S. lead mine production and just over 12 percent of the world total. And more may be coming—

one new mine is now in the developmental stage with the possibility for additional mines as yet unannounced."

"The massive transfusion of nearly \$180 million mining capital has brought about a striking economic change in the region—new jobs, new schools, even new towns springing up in support of the mining operation! Seven of the region's mines are represented among the nation's top ten domestic lead producers." It should be noted that later Bureau of Mines data showed Missouri lead production in 1970 to be 421,800 tons valued at \$132 million.

Missouri's mineral economy was also diversifying. New coal mines were opened in widely separated parts of the State, and new coal-bearing areas were being explored and tested. A major aluminum reduction and fabrication complex in the Bootheel area was under development during the year and on schedule for completion in 1971. Byproduct sulfuric acid from two of the three lead smelters was also a new product for the State.

A World Lead-Zinc Symposium was held in October at St. Louis, Mo., in conjunction with the fall meeting of the Society of Mining Engineers of the American Institute of Mining, Metallurgical and Petroleum Engineers (AIME). During the 3 days of technical sessions, emphasis was on updating literature related to technology of lead-zinc mining and metallurgy.

The Missouri Geological Survey described the 1960's as marking one of the most memorable decades in the history of Missouri mining during which output soared to new alltime records, with the largest single contributing factor being increased production from new mines.<sup>6</sup>

**Labor and Employment.**—According to the Division of Employment Security, Missouri Department of Labor and Industrial Relations, the mining industry employed 8,831 workers in 1970, compared with 9,170 (revised) in 1969. This slight reduction in

<sup>4</sup> Wharton, H. M., J. A. Martin, A. W. Rueff, C. E. Robertson, J. S. Wells, and E. B. Kisvarsanyi. *Missouri Minerals—Resources, Production, and Forecasts*. Missouri Geol. Surv. and Water Res., Rolla, Mo., Special Publication No. 1, December 1969, 303 pp.

<sup>5</sup> Wharton, H. M., J. A. Martin, A. W. Rueff, C. E. Robertson, J. S. Wells, and E. B. Kisvarsanyi. *Southeast Missouri—World's No. 1 Lead Producer!* Missouri Mineral News (Missouri Geological Survey), v. 11, No. 3, March 1971, pp. 22-23.

<sup>6</sup> Rueff, A. Milestones in Missouri Mining. *Missouri Miner. Ind. News*, v. 10, No. 3, March 1970, pp. 58-65.

number of workers was accounted for by the nonmetal segment, which employed 3,841 in 1970 and 4,491 (revised) in 1969. Employment in metal mining continued the steady increase in that segment over the past decade with 4,041 employed in 1970, compared with 3,862 (revised) in 1969. The coal mining industry employed 949 workers in 1970, compared with 817 (revised) in 1969.

The stone, clay, and glass products industries employed 12,690 workers in 1970. Of these, 1,119 were in the hydraulic cement industry, 3,889 in structural clay products and 7,682 in other industries. The primary metals industries employed 14,228 workers—3,888 in iron and steel foundries, 1,800 in nonferrous foundries, and 8,540 in other primary metals.

Table 3.—Indicators of Missouri business activity

	1969	1970	Change, percent
Employment and labor force, annual average: <sup>1 2</sup>			
Total labor force..... thousands..	2,066.2	2,083.0	+ .8
Unemployment..... do.....	66.9	95.0	+42.0
Employment..... do.....	1,999.3	1,988.0	- .6
Construction..... do.....	73.0	72.0	-1.4
Mining..... do.....	9.2	8.8	-4.3
Manufacturing..... do.....	462.2	443.7	-4.0
Personal income: <sup>3</sup>			
Total..... millions.....	\$16,085	\$17,150	+6.6
Per capita..... do.....	\$3,467	\$3,659	+5.5
Construction activity: <sup>4 5</sup>			
Building permits, total private nonresidential..... millions..	\$356.7	\$268.1	-24.8
Cement shipments to and within Missouri thousand 376-pound barrels.....	9,577	9,291	-3.0
Farm marketing receipts <sup>6</sup> ..... millions.....	\$1,446.0	\$1,479.2	+2.3
Mineral production..... do.....	\$367.2	\$393.0	+7.0

<sup>1</sup> Source: Area Trends in Employment and Unemployment.

<sup>2</sup> Source: Employment and Earnings.

<sup>3</sup> Source: Survey of Current Business.

<sup>4</sup> Source: Construction Review.

<sup>5</sup> Source: U.S. Bureau of Mines.

<sup>6</sup> Source: Farm Income Situation.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man- days worked (thou- sands)	Man- hours worked (thou- sands)	Number of injuries		Injury rates per million man-hours		
					Fatal	Non- fatal	Fre- quency	Severity	
1969:									
Coal.....	397	300	119	874	-----	28	32.03	690	
Metal.....	3,043	269	818	6,547	-----	2	305	46.89	4,104
Nonmetal and native asphalt.....	841	231	194	1,587	-----	52	32.76	810	
Sand and gravel.....	832	238	198	1,687	-----	29	17.19	507	
Stone.....	4,279	270	1,157	9,510	-----	4	179	19.24	3,727
Total <sup>2</sup> .....	9,392	265	2,487	20,205	-----	6	593	29.65	3,220
1970: <sup>p</sup>									
Coal.....	480	294	142	1,047	-----	1	42	41.07	6,613
Metal.....	3,045	293	892	7,154	-----	4	386	54.52	4,767
Nonmetal and native asphalt.....	675	242	164	1,330	-----	-----	60	45.11	4,777
Sand and gravel.....	805	225	182	1,681	-----	-----	22	13.09	345
Stone <sup>1</sup> .....	4,070	274	1,114	9,171	-----	1	188	20.61	2,036
Total <sup>2</sup> .....	9,080	275	2,494	20,384	-----	6	698	34.54	3,291

<sup>p</sup> Preliminary.

<sup>1</sup> Beginning in 1970, data on asphaltic stone operations, which formerly were included in "Native asphalt," have been included in "Stone."

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

**Exploration, Geologic Studies, and Mapping.**—Although exploratory drilling in the new Lead Belt area of southeast Missouri was off considerably from past years, exploration teams from several companies were broadening the search for ferrous and nonferrous metals, coal, and nonmetal at numerous and widely scattered points in Missouri on magnetic anomalies, geologically attractive structures, and other promising exploration targets.

**Table 5.—Exploratory drilling in Missouri**  
(Linear feet)

Year	Churn	Rotary	Diamond
1966.....	133,879	4,036	292,699
1967.....	94,908	37,978	237,031
1968.....	45,272	43,011	211,493
1969.....	73,874	21,442	167,179
1970.....	38,080	23,556	248,009

A map of Selected Deep Drill Holes in Missouri was published by Missouri Geological Survey. The map shows the location, total depth, and geologic formation or horizon in which the hole was bottomed.

To meet the increasing academic and economic interest in the basement complex in Missouri, the Missouri Geological Survey continued in 1970 its "Operation Basement"—a concentrated effort to intensify investigations, mapping, and dissemination of basic Precambrian data. Rocks of Precambrian age, as a mineral exploration target, have attracted increasing interest in recent years because significant mineral deposits have been found in these rocks in Missouri. Additional knowledge of these rocks will be useful as a guide in future mineral exploration. The second report in a series, entitled Contributions to Precambrian Geology of Missouri, was published in 1970.<sup>7</sup> Noncommercial iron ore deposits in the mapped area and important commercial deposits in the surrounding region of Precambrian rocks were probably formed during a period of widespread alteration and replacement, the evidence of which was described in this new report.

The 62d annual meeting of the Association of American State Geologists (AASG) met April 26–30 in Rolla, Mo. Hosted by the Missouri Geological Survey, the meeting was concerned mostly with determining the best geologic approaches to problems of the environment and planning for development of mineral resources to keep

pace with the Nation's growing requirements. Cooperative programs between the States and the Federal Government involving the Nation's natural resources were also emphasized during the session. Through these programs, State Surveys are able to collect essential geologic data and complete work that could not normally be done because of fund and personnel limitations. Foremost among cooperative efforts involving Missouri are the surface water and topographic mapping programs. Missouri's State Geologist, Dr. William C. Hayes, was president-elect of the AASG and will be president in 1971.

In 1970, the Missouri Geological Survey created the Missouri State Land Survey Authority, the first to be established in the Nation. The law establishing the Land Survey Authority was passed by the 75th General Assembly and became effective July 1, 1970. The primary mission of the new agency is to preserve rapidly disappearing U.S. Government boundary markers, to store records of previous land surveys, to assure greater accuracy and higher standards in land surveying, and to assist Missouri's property owners with their surveying and land boundary problems.

An updated index sheet that shows the location and price of nearly 100 aeromagnetic maps covering various parts of Missouri was made available by the Missouri Geological Survey. Nine of these aeromagnetic maps were completed and offered during 1970. They cover an area in central Missouri between Jefferson City and Kansas City.

**Environment.**—Missouri's minerals industry, both producers and consumers, was becoming increasingly conscious of environmental aspects of operations. Air and water quality, noise, and aesthetics were being closely watched and studied, not only by companies but also by State and Federal agencies. Stricter standards, additional regulations, and closer monitoring by State and Federal agencies and by the minerals industry itself were resulting in technologic improvements to control pollution of various types. Technologic studies also were underway at universities, State agencies, Federal installations, and in company laboratories to solve the problems

<sup>7</sup> Anderson, R. E. Ash-Flow Tuffs of Precambrian Age in Southeast Missouri. Contribution to Precambrian Geology No. 2, Missouri Geol. Surv. Rept. of Inv. 46, April 1970, 50 pp.

of closer control and further improvement in environmental factors.

The Department of Mining, Petroleum and Geological Engineering, of the University of Missouri at Rolla (UMR), was preparing a new graduate training program in environmental protection and control oriented toward the needs of the mining and petroleum industries. The new curriculum was to be offered in the 1971 academic year. Principal emphasis of the program was the prevention and control of water pollution, but the health and safety aspects of mining were to be included in the appropriate mining courses. The curriculum was created to fill the need for specially trained mining, petroleum, and geological engineers to guide the environmental work of mining and oil companies as well as State and Federal regulatory agencies. The program is believed to be the first of its kind in the Nation. It is designed to lead to the master of science degree in mining, petroleum, and geological engineering and is principally for engineers with degrees in those fields, but other qualified persons may be accepted.

The enormous increase in mineral production from the Viburnum Trend of southeast Missouri has been achieved under close monitoring of environmental aspects because nearly all of the new mines in that district are within the boundaries of the Clark National Forest and are subject to strict environmental controls administered by the U.S. Forest Service.

A new kind of cooperative research project, initiated by the Environmental Research Center at the University of Mis-

souri, had as participants not only the University of Missouri but also the mining industry and various State and Federal Government agencies working together to solve air pollution problems that have broad implications for the metal mining industry. In the summer of 1970 it became evident that better control of sulfur oxide gases from a new lead smelter in that area was necessary. The company and the Clark National Forest responded quickly by setting in motion the machinery of cooperation between industry, a major university, the U.S. Forest Service, and other Federal and State organizations, including Missouri Geological Survey, Missouri Air Conservation Commission, Missouri Department of Conservation, U.S. Geological Survey, U.S. Bureau of Mines, and the Missouri Environmental Trace Substance Center. The research will seek to identify specific contaminants that might cause vegetative damage. If specific pollution sources can be identified, the UMR research team will recommend equipment, techniques, and technical training to give the mining company the capability to control the problem, monitor gaseous emissions, and insure that tree damage will not occur.

When the research effort reaches satisfactory completion, results will be published, thus making the findings available to other companies engaged in mining sulfide ores. A unique condition of this research program is the cooperation between private and public interests. The judgment that the industry and the environment can be compatible has been made, and this study should serve as a model as to how it can be accomplished.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

Nonmetals accounted for 43 percent of total mineral production value in 1970, down from the nearly 50 percent contribution of the previous year. Reduced output of cement and stone was generally attributed to cutbacks in construction and road building and to major strikes in Missouri and surrounding areas.

**Barite.**—Output of barite amounted to 230,000 tons in 1970. This output was down considerably from the 304,000 tons of the previous year, owing largely to re-

duced drilling operations along the Gulf Coast where much of Missouri's barite is used as a weighting agent in oil and gas well-drilling fluids.

Dresser Industries closed two barite washing plants and opened a new washing plant in Washington County. Circle Mines, Inc. ceased operations in central Missouri and the company has gone out of business.

Field and laboratory studies were completed as a basis for evaluating the ore potential of typical barite ponds in the Washington County barite district. Nearly

200 holes totaling 4,100 feet were drilled in four areas and 880 samples were analyzed. Funding for the drilling was by State appropriation; the analytical work was done through a cooperative agreement with the U.S. Bureau of Mines. A report on the study was being prepared.

**Cement.**—The slackness in the building and construction industry caused a moderate decrease in shipments of Missouri-produced cement, closely following the nationwide pattern.

**Table 6.—Missouri: Portland cement salient statistics**

(Thousand 376-pound barrels and thousand dollars)

	1969	1970
Number of active plants . . .	7	7
Production . . . . .	20,860	20,733
Shipments from mills:		
Quantity . . . . .	21,325	21,224
Value . . . . .	\$74,368	\$64,261
Stocks at mills, Dec. 31 . . . .	2,165	2,011

**Clays.**—The quantity of clay produced in Missouri continued to decrease. The Missouri Geological Survey, in its study of the outlook of minerals in the State, predicted that the decline in refractory clay production would continue. However, the State remains one of the Nation's principal refractory manufacturing centers, with increasing quantities of raw materials being brought in from other areas.

Structural clay products output, in a temporary slump owing to the overall reduction in building and construction, was expected to resume its growth with industrial expansion, construction upturn, and population proliferation.

Field and laboratory work on a clay testing program was completed in cooperation between the Missouri Geological Survey and the U.S. Bureau of Mines. Clay and shale samples from potentially economic deposits in eastern Missouri were tested for

their ceramic properties and possible use as a raw material for expanded lightweight aggregate.

**Lime.**—Both lime and dead-burned dolomite were produced in the State. Three plants, in Greene, Marion, and Ste. Genevieve Counties, produced high-calcium lime, and a fourth plant, in St. Francois County, produced dead-burned dolomite and dolomitic quicklime.

As in the national trend, the largest percentage of Missouri production went to chemical, industrial, and metallurgical uses. Over 80 percent of the output was shipped to out-of-State markets.

**Sand and Gravel.**—Owing to the increased highway paving program, sand and gravel production in 1970 was a record 12.4 million tons valued at \$15.4 million, compared with 10.9 million tons valued at \$14.6 million in 1969.

**Stone.**—Reduced demand for concrete aggregate pulled down the State's total output of stone. Strikes in the construction industry were credited in part with stopping the steady growth in this segment of the State's economy.

Limestone, dolomite, granite, sandstone, marble, and traprock were produced.

**Sulfur.**—Two facilities recovered sulfuric acid as a byproduct of lead smelting. These plants had a combined total capacity of 500 tons of sulfuric acid per day. The larger plant, at the Herculaneum smelter of St. Joe Minerals Corp. (formerly St. Joseph Lead Co.), began steady operation in October 1969 and had its first full year of operation in 1970.

Missouri Lead Operating Co. recovered sulfur in the form of sulfuric acid from its lead smelter near Boss.

The sulfuric acid from both these plants was shipped to other companies for use in manufacturing fertilizer from phosphate rock.

**Table 7.—Missouri: Clay sold or used by producers, by kinds**

(Thousand short tons and thousand dollars)

Year	Fire clay		Miscellaneous clay		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1966 . . . . .	1,285	\$4,898	1,044	\$1,091	2,329	\$5,989
1967 . . . . .	1,131	4,747	1,174	1,473	2,305	6,220
1968 . . . . .	1,064	4,334	1,369	1,824	2,433	6,158
1969 . . . . .	1,040	4,968	1,211	1,437	<sup>1</sup> 2,251	<sup>1</sup> 6,405
1970 . . . . .	927	4,854	1,201	1,626	<sup>2</sup> 2,128	<sup>2</sup> 6,480

<sup>1</sup> Excludes bentonite and fuller's earth.

<sup>2</sup> Excludes fuller's earth.

**Table 8.—Missouri: Sand and gravel sold or used by producers, by classes of operations and uses**  
(Thousand short tons and thousand dollars)

Class of operations and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building .....	4,500	\$4,429	4,352	\$3,866
Fill .....	325	299	330	232
Paving .....	1,450	1,487	1,514	1,456
Other uses <sup>1</sup> .....	1,080	4,113	1,044	3,963
Total <sup>2</sup> .....	7,354	10,329	7,239	9,517
<b>Gravel:</b>				
Building .....	2,369	3,098	1,916	2,590
Fill .....	41	28	9	10
Paving .....	1,019	973	3,111	3,104
Miscellaneous .....	98	88	100	83
Other uses .....	5	8	20	23
Total <sup>2</sup> .....	3,533	4,195	5,156	5,810
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Paving .....			16	17
Total .....			16	17
<b>Gravel:</b>				
Paving .....	53	50	29	31
Other uses .....			5	4
Total <sup>2</sup> .....	53	50	35	35
Total sand and gravel <sup>2</sup> .....	10,940	14,574	12,446	15,379

<sup>1</sup> Includes railroad ballast (1969), ground and unground, and other sands.

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

**Table 9.—Missouri: Stone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Dimension stone .....	16	W	13	W
<b>Crushed and broken:</b>				
Bituminous aggregate .....	2,219	\$3,112	2,314	\$3,654
Concrete aggregate .....	6,741	9,354	6,084	8,529
Dense graded roadbase stone .....	8,169	11,005	5,403	7,711
Macadam aggregate .....	1,760	2,557	2,579	3,419
Surface treatment .....	2,189	3,023	3,786	5,143
Unspecified aggregate and roadstone .....	3,873	4,352	2,233	3,631
Agricultural purposes <sup>1</sup> .....	3,846	6,467	3,395	5,718
Riprap and jetty stone .....	2,742	2,965	3,519	3,317
Railroad ballast .....	49	69	36	49
Asphalt filler .....	81	168	W	123
Cement .....	5,660	5,660	5,705	4,126
Stone sand .....	W	W	73	130
Other <sup>2</sup> .....	4,633	14,519	4,585	13,759
Total <sup>3</sup> .....	41,977	63,251	39,726	59,309

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

<sup>1</sup> Data includes agricultural limestone and poultry grit.

<sup>2</sup> Includes stone for terrazzo, roofing granules, lime, filter stone, flux stone, metallurgical purposes, chemicals, other fillers, mine dusting, other and unspecified uses; also, abrasives, whitening, waste material (1969) and fill, glass (1970).

<sup>3</sup> Data may not add to totals shown because of independent rounding.



**Table 10.—Missouri: Stone sold or used by producers, by kinds**  
(Thousand short tons and thousand dollars)

Kind	1969		1970	
	Quantity	Value	Quantity	Value
Dimension limestone.....	3	\$69	3	\$43
Crushed and broken:				
Limestone.....	40,268	58,063	38,207	54,613
Dolomite.....	932	1,081	874	1,057
Other stone <sup>1</sup> .....	774	4,038	642	3,596
<b>Total.....</b>	<b>41,977</b>	<b>63,251</b>	<b>39,726</b>	<b>59,309</b>

<sup>1</sup> Includes granite, marble, sandstone, and crushed and broken traprock.

### METALS

Metals took the lead again after many years to comprise about 52 percent of the total value of Missouri's output of mineral products.

**Aluminum.**—Noranda Aluminum, Inc., located in New Madrid, represents the entry of Noranda Mines Ltd. (of Canada) into the primary aluminum industry. The new industrial complex, consisting of a 70,000-ton-per-year reduction plant and a rod, wire, and cable plant, is in St. Jude Industrial Park. Its construction was financed through a revenue bond issue provided by the city of New Madrid.

A \$98 million powerplant is being built in conjunction with and adjacent to the Noranda Aluminum complex. The \$85 million aluminum facility plus the powerplant represents the largest single industrial revenue bond investment in the history of the State of Missouri.

The plant is designed so that production can be increased in increments of 70,000 tons per year up to a total of 210,000 tons per year. To produce 70,000 tons of aluminum annually, Noranda Aluminum will require a continuous flow of nearly 125,000 kilowatts of electricity. Of the 70,000 tons per year, approximately one-third of the metal will go directly to the rod, wire, and cable plant to be fabricated into electrical cable products. The remaining two-thirds will be shipped to other locations in the form of extrusion billet, sheet ingot, or casting ingot.

Statistics on Noranda's new facility show the following: 30,000 tons of anodes to be consumed per year; 174 pots equally divided in two buildings each 1,730 feet long; each pot utilizing 145,000 amperes of electricity and producing 2,200 pounds of molten aluminum in a 24-hour period; melting and alloying furnaces having

80,000 pounds capacity; and two types of castings—direct chill and pig casting.

**Copper.**—Small deposits of copper ore are present in Missouri and have been mined on a small scale for many years. The important copper production from 1900 to the present has been as a byproduct of lead mining in the Southeast Missouri Lead District. Increasing byproduct copper production is expected as the mines in the Viburnum Trend reach full operations.

The discovery of copper-iron mineralization in deeply buried Precambrian rocks near Boss in Dent County was announced by American Zinc Co. in 1959. The area was drilled intensively in 1970, but data have not been made public. The Missouri Geological Survey calls this discovery of copper mineralization in Precambrian rocks "something of a milestone," since other copper occurrences in the State are associated with younger rocks and "little attention had previously been given to the Precambrian in the search for copper in the State."

**Iron Ore and Steel.**—Iron ore production continued to increase. Meramec Mining Co.'s iron ore pellet production was increased from the previous year, according to the annual report. In April, Meramec completed construction of an underground crushing plant and in November completed development to initiate mining by sublevel caving. The areas being mined by the new method, with mobile, trackless equipment, were operating successfully; and this permitted increased ore production.

Production schedules for Meramec's high-purity iron oxide were increased during the year, and yearend production was at a substantially higher rate. Magnetite concentrate shipments also increased and were expected to be further raised. This

material is used in coal-beneficiating plants.

According to the company's annual report, production at the Pilot Knob Pellet Co. near Ironton, also reached a new high. Granite City Steel, which owns half of the plant and is the sole customer, said that half the iron ore used by its blast furnaces in Granite City, Ill., was supplied by the Pilot Knob plant.

**Table 11.—Missouri: Ferrous scrap and pig iron consumption**  
(Thousand short tons)

Year	Ferrous scrap	Pig iron	Total scrap and pig iron
1966-----	1,063	41	1,104
1967-----	1,051	31	1,082
1968-----	1,049	24	1,073
1969-----	1,053	20	1,073
1970-----	1,062	21	1,083

**Lead.**—Citing changes in demand levels, buildups in inventories, and reductions in the prices of lead and zinc, which commenced at midyear, lead companies noted the pressure that increased new domestic mine production of lead has exerted on markets for that metal. Most operations in the Viburnum Trend of southeast Missouri cut back output moderately in the last half of the year, despite these cutbacks. 1970 was a record year.

St. Joe Minerals Corp. reported in its annual report that mining operations in Missouri were curtailed by reducing production in the second half of 1970. The higher-cost-producing units of the old Federal mines were closed during the year as reserves were depleted.

The first phase of construction at the new Brushy Creek mine and mill was completed and shaft sinking started in September. At yearend the shaft, with a planned total depth of 1,391 feet, was down to 550 feet. Construction of surface facilities was expected to start in early 1971.

Herculeum Lead Smelter's output decreased from that of the previous year because of scheduled reductions, which commenced in midyear to adjust to lower sales.

A wide variety of technical improvements were completed at Herculeum during the year. A new sinter-cooling drum permitted recirculation of dust-collector liquors, reducing metal losses; modification in the blast furnace weighing system improved control of feed, fuel, and

furnace metallurgy; installation of a gas-cooling device increased furnace drafts and lessened smoke loss; and a process change in the dross plant improved the efficiency of silver recovery. In November construction was started on an expansion of the alloy plant.

The new lead mine-mill-smelter complex of Missouri Lead Operating Co. near Boss in the Viburnum Trend completed its first full year of operations in 1970.

According to most calculations, the Magmont mine, operated as a joint venture of Cominco American and Dresser Industries, was the third largest lead mine in the United States in 1970.

The Glover lead smelter of American Smelting and Refining Co. (ASARCO) "operated well" until September when the plant was struck. At yearend, the plant was still closed.

**Silver.**—Output of silver (as a byproduct of lead-zinc-copper production) also reached a new alltime high of just under 2 million ounces valued at more than \$3 million.

**Zinc.**—With lead output up, zinc as a byproduct reached the highest tonnage since World War I, when the old Tri-State district of southwest Missouri was at its peak output.

#### MINERAL FUELS

Mineral fuels represented 5 percent of Missouri's total mineral value.

**Coal.**—The nearly 4.5 million tons of coal produced in 1970 was the largest annual output in Missouri since World War II.

Two new strip mines began operating during the latter part of the year to produce coal for nearby powerplants. A third new mine was being developed to provide fuel for a coal-fired steam powerplant being built in east-central Kansas.

Since 1958 the upward trend in production of coal in Missouri has been due almost solely to an increasing use of coal for generating electrical power. For State planning purposes, the Missouri Geological Survey forecast coal production at 5 million tons in 1975 and 7 million by 1990.

The first of a two-part report on Missouri coal resources was completed during 1970. The initial study classifies the State's coal resources by seams on the basis of thickness and tonnage, distribution and

Table 12.—Tenor of lead ore milled and concentrates produced in Missouri, 1970

Total material <sup>1</sup> .....	short tons	8,820,880
Metal content of ore: <sup>2</sup>		
Copper.....	percent	0.14
Lead.....	do	4.78
Zinc.....	do	0.58
Concentrates produced and average content:		
Copper-lead.....	short tons	28,547
Recovery ratio.....	percent	0.32
Average copper content.....	do	26.48
Average lead content.....	do	8.87
Copper-zinc.....	short tons	2,453
Recovery ratio.....	percent	0.03
Average copper content.....	do	6.11
Average zinc content.....	do	54.59
Lead.....	short tons	582,760
Recovery ratio.....	percent	6.61
Average lead content.....	do	74.24
Zinc.....	short tons	88,761
Recovery ratio.....	percent	1.01
Average zinc content.....	do	53.75

<sup>1</sup> Based on Missouri ore (dirt), old tailings treated at mills, and barite ore containing lead shipped to smelter.

<sup>2</sup> Figures represent metal content of crude ore only, as recovered in the concentrate; data on tailings losses not available.

Table 13.—Missouri: Mine production (recoverable) of silver, copper, lead, and zinc<sup>1</sup>

	1968	1969	1970
Mines producing:			
Lode.....	9	10	11
Material sold or treated:			
Ore..... thousand short tons	6,356	7,874	8,821
Barium sulphate..... do	( <sup>2</sup> )	( <sup>2</sup> )	5
Lead..... do	6,356	7,874	8,816
Production (recoverable):			
Quantity:			
Silver..... troy ounces	340,856	1,442,090	1,816,978
Copper..... short tons	5,494	12,664	12,134
Lead..... do	212,611	355,452	421,764
Zinc..... do	12,301	41,099	50,721
Value:			
Silver..... thousands	\$731	\$2,582	\$3,218
Copper..... do	4,598	12,039	14,003
Lead..... do	56,180	105,889	131,751
Zinc..... do	3,321	12,001	15,540
Total <sup>3</sup> ..... do	64,830	132,512	164,511

<sup>1</sup> Based on Missouri ore (dirt), old tailings treated at mills, and barite ore containing lead shipped to smelter (1969-70).

<sup>2</sup> Ore figure not available.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

Table 14.—Total value of mineral production in Missouri and production and value of lead in Missouri and the United States

(Short tons and thousand dollars)

Year	Total value of Missouri mineral production	Lead production					
		Missouri				United States	
		Quantity	Value	Percent of U.S. production	Percent of world production	Quantity	Value
1966.....	\$227,950	132,255	\$39,981	40.4	4.2	327,368	\$98,964
1967.....	237,010	152,649	42,742	48.2	4.8	316,931	88,741
1968.....	276,238	212,611	56,180	59.2	6.4	359,156	94,903
1969.....	367,232	355,452	105,889	69.8	10.1	509,013	151,635
1970.....	392,996	421,764	131,751	73.8	11.3	571,767	178,609

depth, and quality (particularly by sulfur content). The second phase, in progress during 1970, was to be a detailed evaluation of the more promising areas and was to include test drilling, chemical analyses, and determinations of calorific values and rank. The project is the most comprehensive study of coal resources ever to be made in Missouri. It was being partially funded by a grant from the National Air Pollution Control Administration of the U.S. Department of Health, Education, and Welfare.

**Petroleum and Natural Gas.**—Although oil and gas have been produced in Missouri for nearly 100 years, they have never been important in comparison with the major petroleum-producing States. Missouri ranked 29th in production of oil as of January 1968. However, the industry has made consistent contributions to Missouri's economy, especially in the Kansas City and adjacent areas.

A total of 36 oil and gas wells were drilled in Missouri during 1969 with a

total footage of 19,857. This included 24 oil wells, 8,212 feet; nine service wells, 10,552 feet; two dry wells, 693 feet; and one gas well, 400 feet.

According to the Missouri Geological Survey, 126 oil wells were producing in the State in 1970 from eight producing oilfields and gasfields. During 1970 there were 21 well completions: six oil wells, no gas wells, five dry holes, and 10 service wells. Sixteen permits were issued by the Missouri Oil and Gas Council: four for stratigraphic tests and 12 for oil or gas wells.

One pool was opened in the "heavy oil" area of Vernon County for research on the recovery of the low-gravity, high-viscosity crude oil in that area. Drilling and testing continued into 1971, but results of these experiments have not been made public.

A study involving Missouri's potential oil- and gas-producing areas was completed by the Missouri Geological Survey. It is to be published as part of a nationwide report by the National Petroleum Council.

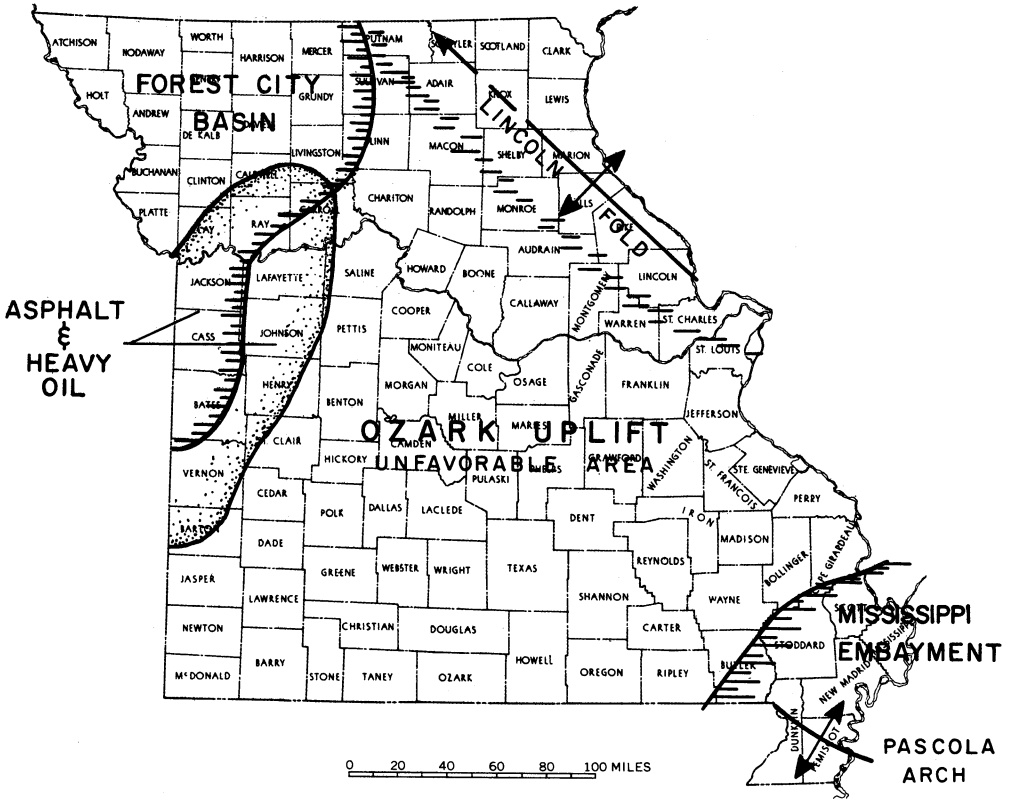


Figure 2.—Areas of interest in Missouri for oil and gas exploration and for possible development of asphalt and heavy oil production.

Table 15.—Principal producers

Commodity and company	Address	Type of activity	County
Asphalt, native:			
Bar-Co-Roc Asphalt Co....	P.O. Box 11 Lantha, Mo. 64753	Mine.....	Barton.
Silica Rock Asphalt Corp....	Sheldon, Mo. 64784.....	do.....	Vernon.
Barite:			
Dresser Minerals.....	P.O. Box 6504 Houston, Tex. 77005	do.....	Washington.
Milchem, Incorporated....	P.O. Box 22111 Houston, Tex. 77027	Mine and mill.....	Do.
National Lead Co., Baroid Division.	P.O. Box 1675 Houston, Tex. 77001	do.....	Do.
National Lead Co., DeLore Division.	P.O. Box 2808 Carondelet Sta. St. Louis, Mo. 63111	Mill.....	St. Louis.
Chas. Pfizer & Co., Inc....	Box 47 Mineral Point, Mo. 63660	Mine and mill.....	Washington.
Cement:			
Alpha Portland Cement Co.	15 South Third St. Easton, Pa. 18043	Plant and quarry...	St. Louis.
Dundee Cement Co.....	P.O. Box 317 Dundee, Mich. 48131	do.....	Pike.
Marquette Cement Mfg. Co.	20 North Wacker Dr. Chicago, Ill. 60606	do.....	Cape Girardeau.
Missouri Portland Cement.	7751 Carondelet Ave. St. Louis, Mo. 63105	do.....	Jackson, St. Louis.
River Cement Co.....	Festus, Mo. 63028.....	do.....	Jefferson.
Universal Atlas Cement Div. of U.S. Steel Corp.	Chatham Center, Box 2969 Pittsburgh, Pa. 15230	do.....	Ralls.
Clay and shale:			
Allied Chemical Corp.....	Box 70 Morristown, N.J. 07960	Mine and plant...	Gasconade.
Alton Brick Co.....	Box 1025 Maryland Heights, Mo. 63042	do.....	St. Louis.
Carter-Waters Corp.....	2440 Pennway Kansas City, Mo. 64108	do.....	Platte.
C-E Refractories Div. of Combustion Engineering.	101 Ferry St. St. Louis, Mo. 63147	do.....	Audrain, Callaway, Gasconade, Monroe, Montgomery.
Dundee Cement Co.	Dundee, Mich. 48131.....	do.....	Pike.
A. P. Green Refractories Co.	Mexico, Mo. 65265.....	do.....	Franklin, Gasconade.
Harbison-Walker Refractories Co.	2 Gateway Center Pittsburgh, Pa. 15222	do.....	Audrain, Callaway, Gasconade, Lincoln, Montgomery, St. Charles, Warren.
Kaiser Refractories.....	P.O. Box 499 Mexico, Mo. 65265	do.....	Audrain, Callaway, Gasconade, Montgomery, Osage, Warren.
Marquette Cement Mfg. Co.	20 North Wacker Dr. Chicago, Ill. 60606	do.....	Cape Girardeau.
Midland Brick & Tile Co...	Box 428 Chillicothe, Mo. 64601	do.....	Livingston.
Missouri Portland Cement Co.	7751 Carondelet Ave. St. Louis, Mo. 63105	do.....	Jackson, St. Louis.
H. K. Porter Co., Inc....	4705 Ridgewood Ave. St. Louis, Mo. 63116	do.....	Callaway, Gasconade, Monroe.
Universal Atlas Cement Div., U.S. Steel Corp.	P.O. Box 2969 Pittsburgh, Pa. 15230	do.....	Ralls.
Wellsville Fire Brick Co...	West Highway 19 Wellsville, Mo. 63384	do.....	Audrain, Mont- gomery.
Coal:			
Clayton-Hensley Coal Co...	Route 3 Fulton, Mo. 65251	Strip mine.....	Callaway.
Ellis Coal Co.....	Bronaugh, Mo. 64728.....	do.....	Vernon.
Kirkville Coal Co., Inc....	Box 332 Centerville, Iowa 52544	do.....	Putnam.
Peabody Coal Co.....	301 North Memorial Dr. St. Louis, Mo. 63102	do.....	Boone, Henry, Macon, Randolph.
Copper: See Lead.			
Iodine (consumption):			
Hoffman-Taff, Inc.....	West Bennett Rd. Springfield, Mo. 65800	Plant.....	Greene.
Interstate Chemical Co., Inc.	501 Santa Fe Kansas City, Mo. 64102	do.....	Jackson.
Mallinckrodt Chemical Works.	3600 North Second St. St. Louis, Mo. 63147	do.....	St. Louis.

Table 15.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Iron ore:</b>			
Meramec Mining Co.-----	Route 4 Sullivan, Mo. 63080	Underground mine..	Washington.
Pilot Knob Pellet Co.-----	Box 26 Ironton, Mo. 63650	----do-----	Iron.
<b>Lead:</b>			
Cominco American, Inc.---	Box 430 Salem, Mo. 65560	----do-----	Do.
Missouri Lead Operating Co. for Amax Lead Co. and Homestake Lead Co. of Mo.	Boss, Mo. 65440-----	----do-----	Do.
Ozark Lead Co.-----	Sweetwater, Mo. 63680	----do-----	Reynolds.
St. Joe Minerals Corp.-----	Boone Terre, Mo. 63628	----do-----	Crawford, Iron, Reynolds, St. Francois, Washington.
<b>Lime:</b>			
Ash Grove Cement Co.---	1000 Ten Main Center Kansas City, Mo. 64105	Plant-----	Greene.
Marblehead Lime Co.-----	300 West Washington Chicago, Ill. 60606	----do-----	Marion.
Mississippi Lime Co.-----	7 Alby St. Alton, Ill. 62002	----do-----	Ste. Genevieve.
Valley Dolomite Corp.-----	915 Olive St. St. Louis, Mo. 63101	----do-----	St. Francois.
<b>Perlite:</b>			
J. J. Brouk & Co.-----	1367 South Kingshighway Blvd. St. Louis, Mo. 63110	Expanding plant...	St. Louis.
<b>Roofing granules:</b>			
GAF Corp.-----	Box 278 Annapolis, Mo. 63620	Plant-----	Iron.
<b>Sand and gravel:</b>			
Eureka Sand & Gravel Co.	Rt. 1, Box 77 Eureka, Mo. 63025	Stationary-----	St. Louis.
Holiday Sand & Gravel Co.	6811 West 63rd St. Overland Park, Kans. 66202	Dredge-----	Various.
Mississippi River Sand & Matl. Co.	650 Rosedale St. Louis, Mo. 63112	Stationary and dredge.	St. Louis.
Missouri Aggregates, Inc.---	801 South Lindberg St. St. Louis, Mo. 63100	Stationary-----	Do.
Missouri Gravel Co.-----	313 16th St. Moline, Ill. 61265	Dredge-----	Lewis.
Norbroco, Inc.-----	P.O. Box 414 Hazelwood, Mo. 63042	----do-----	St. Louis.
PPG Industries, Inc.-----	1 Gateway Center Pittsburgh, Pa. 15219	Stationary-----	Jefferson.
Pennsylvania Glass Sand Corp.	Berkeley Springs, W. Va. 25411	----do-----	St. Louis, St. Charles.
Riverside Sand & Dredging.	5000 Bussen Rd. St. Louis, Mo. 63129	Dredge-----	St. Louis.
St. Charles Sand Co.-----	Rt. 1, Box 253 Bridgeton, Mo. 63042	Stationary-----	Do.
Stewart Sand & Material Co.	4049 Pennsylvania Ave. Kansas City, Mo. 64111	----do-----	Jackson.
Taylor Sand & Gravel Co.---	Caruthersville, Mo. 63830	Dredge-----	Pemiscot, New Madrid.
Welton & Gray Gravel Co.---	Rt. 4 Ava, Mo. 65608	Portable-----	Douglas.
Winter Bros. Material Co.---	13098 Gravois Rd. St. Louis, Mo. 63127	Stationary-----	St. Louis.
<b>Silver: See Lead.</b>			
<b>Stone:</b>			
Brown Quarries.-----	Washington, Mo. 63090	Quarry-----	Various.
Bussen Quarries, Inc.-----	5000 Bussen Rd. St. Louis, Mo. 63129	----do-----	Jefferson, St. Louis.
Dundee Cement Co.-----	P.O. Box 317 Dundee, Mich. 48131	----do-----	St. Louis.
Gordon Bros. Quarries, Inc.---	Forest City, Mo. 64451	----do-----	Holt.
Mississippi Lime Co.-----	7 Alby St. Alton, Ill. 62002	----do-----	Ste. Genevieve.
Missouri Portland Cement Co.	7751 Carondelet Ave. St. Louis, Mo. 63105	----do-----	Jackson, St. Louis.
River Cement Company---	Pestus, Mo. 63023	----do-----	Jefferson.
Vigus Quarries, Inc.-----	7929 Alabama Ave. St. Louis, Mo. 63111	----do-----	Jefferson, St. Louis.
West Lake Quarry & Material Co.	Rt. 1, Box 206 Taussig Rd. Bridgeton, Mo. 63042	----do-----	St. Louis, Scott.
<b>Tripoli:</b>			
The Carborundum Co., American Tripoli Div.	Seneca, Mo. 64865-----	Mill-----	Newton.
<b>Vermiculite:</b>			
W. R. Grace & Co., Zonolite Div.	62 Whittemore Ave. Cambridge, Mass. 01109	Exfoliating plant...	St. Louis.
<b>Zinc: See Lead.</b>			

# The Mineral Industry of Montana

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

By J. M. West <sup>1</sup>

Montana mineral production in 1970 was valued at \$313 million, an increase of 11 percent compared with the 1969 value. The year 1970 was strike-free and the mineral industry produced at close to capacity levels. Copper production rose moderately in quantity and increased significantly in value compared with the previous year.

Because of a change in the Bureau's statistical procedures, output of base metals from The Anaconda Company's slag-fuming plant at East Helena are now excluded from primary metal production figures. Therefore, 1970 data for a few metals are

not directly comparable with those of earlier years.

Petroleum production continued to decline from a high reached in 1968, falling 14 percent in quantity compared with the 1969 output. The drop in value was less because of price increases. Output of natural gas increased 4 percent. Coal continued a sharp upturn in production with a threefold rise in quantity and a threefold rise in value.

<sup>1</sup> Physical scientist, Division of Nonferrous Metals.

Table 1.—Mineral production in Montana <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays <sup>2</sup> .....thousand short tons..	34	\$63	41	\$71
Coal (bituminous and lignite).....do....	1,030	2,199	3,447	6,394
Copper (recoverable content of ores, etc.).....short tons..	103,314	98,219	120,412	138,955
Gem stones.....	NA	109	NA	109
Gold (recoverable content of ores, etc.).....troy ounces..	24,189	1,004	22,456	817
Iron ore (usable).....thousand long tons, gross weight..	13	W	14	W
Lead (recoverable content of ores, etc.).....short tons..	1,753	522	996	311
Lime.....thousand short tons..	255	2,737	208	W
Manganese ore and concentrate (35 percent or more Mn) short tons, gross weight..	755	26	512	W
Natural gas.....million cubic feet..	41,229	4,205	42,705	4,399
Petroleum (crude).....thousand 42-gallon barrels..	43,954	118,359	37,879	105,403
Pumice.....thousand short tons..	134	102	---	---
Sand and gravel.....do....	16,595	14,383	19,275	20,249
Silver (recoverable content of ores, etc.) thousand troy ounces..	3,429	6,141	4,304	7,622
Stone.....thousand short tons..	7,667	10,579	<sup>3</sup> 6,501	<sup>3</sup> 6,896
Tungsten ore and concentrate short tons, 60-percent WO <sub>3</sub> basis..	W	W	9	23
Zinc (recoverable content of ores, etc.).....short tons..	6,143	1,794	1,457	446
Value of items that cannot be disclosed:				
Antimony (1970), cement, clays (bentonite), fluorspar, gypsum, natural gas liquids, peat, phosphate rock, stone (dimension), talc, vermiculite, and values indicated by symbol W.....	XX	22,189	XX	21,321
Total.....	XX	282,631	XX	313,016
Total 1967 constant dollars.....	XX	266,888	XX	<sup>p</sup> 283,279

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

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

<sup>2</sup> Excludes bentonite; included with "Value of items that cannot be disclosed."

<sup>3</sup> Excludes certain dimension stone; included with "Value of items that cannot be disclosed."



Table 2.—Value of mineral production in Montana, by counties

(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Beaverhead.....	\$2,156	\$715	Stone, sand and gravel, talc, lead, silver, zinc, gold, copper.
Big Horn.....	1,072	1,702	Sand and gravel, stone, petroleum, lime, natural gas.
Blaine.....	498	349	Petroleum, natural gas, sand and gravel.
Broadwater.....	369	W	Iron ore, silver, zinc, lead, sand and gravel, stone, copper.
Carbon.....	7,437	7,366	Petroleum, stone, sand and gravel, natural gas, zinc, silver.
Carter.....	153	W	Clays, petroleum, sand and gravel.
Cascade.....	1,551	W	Sand and gravel, clays, stone.
Chouteau.....	56	W	Sand and gravel, stone.
Custer.....	156	935	Do.
Daniels.....	8	W	Sand and gravel, petroleum.
Dawson.....	2,680	W	Petroleum, sand and gravel, stone.
Deer Lodge.....	2,395	2,516	Lime, stone, sand and gravel, silver, copper, gold, lead, zinc.
Fallon.....	18,913	19,752	Petroleum, natural gas, sand and gravel, stone.
Fergus.....	W	W	Sand and gravel, gypsum, stone.
Flathead.....	727	W	Sand and gravel, silver, lead, copper, zinc.
Gallatin.....	W	W	Cement, stone, sand and gravel, clays.
Garfield.....	162	43	Sand and gravel.
Glacier.....	1,752	W	Petroleum, sand and gravel.
Golden Valley.....	15	W	Sand and gravel.
Granite.....	1,081	1,268	Silver, zinc, stone, copper, lead, sand and gravel, gold.
Hill.....	154	280	Sand and gravel, natural gas.
Jefferson.....	W	W	Cement, stone, silver, gold, lead, copper, sand and gravel, zinc.
Judith Basin.....	88	160	Sand and gravel, stone.
Lake.....	308	W	Sand and gravel, peat.
Lewis and Clark.....	2,114	W	Sand and gravel, lead, silver, zinc, stone, gold, copper.
Liberty.....	1,775	1,631	Petroleum, natural gas, sand and gravel.
Lincoln.....	6,561	12,691	Sand and gravel, vermiculite, stone, zinc, lead, silver.
McCone.....	1,593	1,203	Petroleum, sand and gravel.
Madison.....	W	W	Talc, silver, gold, sand and gravel, stone, copper, lead, zinc.
Meagher.....	36	W	Lead, silver, zinc, gold, copper.
Mineral.....	W	W	Sand and gravel, silver, stone, copper, lead, gold.
Missoula.....	3,278	536	Sand and gravel, stone, copper, gold, silver.
Musselshell.....	2,605	2,329	Petroleum, coal.
Park.....	191	261	Sand and gravel, stone.
Petroleum.....	23	6	Sand and gravel.
Phillips.....	103	W	Do.
Pondera.....	40	700	Sand and gravel, stone, petroleum.
Powder River.....	36,878	24,271	Petroleum, natural gas, sand and gravel, stone, coal.
Powell.....	W	W	Phosphate rock, sand and gravel, gold, silver, lead, zinc.
Prairie.....	820	1,186	Sand and gravel, stone.
Ravalli.....	W	W	Fluorspar, sand and gravel, silver, gold, lead, zinc, copper.
Richland.....	6,300	7,182	Petroleum, coal, lime, sand and gravel.
Roosevelt.....	5,784	W	Petroleum, sand and gravel.
Rosebud.....	5,174	7,425	Coal, petroleum, sand and gravel, clays, stone.
Sanders.....	252	W	Sand and gravel, stone, antimony.
Sheridan.....	6,393	W	Petroleum, sand and gravel.
Silver Bow.....	103,487	146,072	Copper, silver, gold, sand and gravel, manganese ore, clays.
Stillwater.....	1,721	1,355	Sand and gravel, stone, natural gas.
Sweet Grass.....	9	1,378	Sand and gravel, stone.
Teton.....	105	149	Sand and gravel, petroleum.
Toole.....	3,093	2,663	Petroleum, sand and gravel, natural gas.
Treasure.....	W	W	Clays.
Valley.....	287	W	Sand and gravel, clays.
Wheatland.....	136	9	Sand and gravel.
Wibaux.....	28	W	Petroleum, sand and gravel.
Yellowstone.....	1,940	2,168	Sand and gravel, talc, petroleum, stone, lime, clays.
Combined counties <sup>1</sup> .....	26,387	28,112	
Undistributed <sup>2</sup> .....	23,787	36,604	
Total <sup>3</sup> .....	282,631	313,016	

W Withheld to avoid disclosing individual company confidential data.

<sup>1</sup> Petroleum and natural gas production from fields underlying two or more counties.<sup>2</sup> Includes value of mineral production that cannot be assigned to specific counties and values indicated by symbol W.<sup>3</sup> Data may not add to totals shown because of independent rounding.

Increases were realized in outputs of some construction materials; the most significant gains were in the value of sand and gravel (41 percent).

The Montana legislature actively discussed bills related to mineral exploration and mine reclamation, but no significant laws were passed during 1970. The Montana dredge law, passed in 1969, was ruled unconstitutional.

Important agreements were signed for large-scale development and exploitation of coal deposits in southeastern Montana. Posting of bonds for reclamation was included as a part of the agreements. New estimates for strippable subbituminous and

lignite coal resources in eastern Montana fields were prepared by the Montana Bureau of Mines and Geology and indicated the presence of approximately 22,000 million tons of such coal in about 50 different fields. The State's total reserves of all types of coal was estimated at 378,000 million tons, the greatest of any State. The State published a new report based on reconnaissance and drilling of coal beds in McCone County, where at least two large strippable lignite deposits were disclosed.<sup>2</sup>

<sup>2</sup> Matson, Robert E. Preliminary Report, Strippable Coal Resources, McCone County, Montana. Montana Bur. of Mines and Geol. Bull. 78, May 1970, 13 pp.

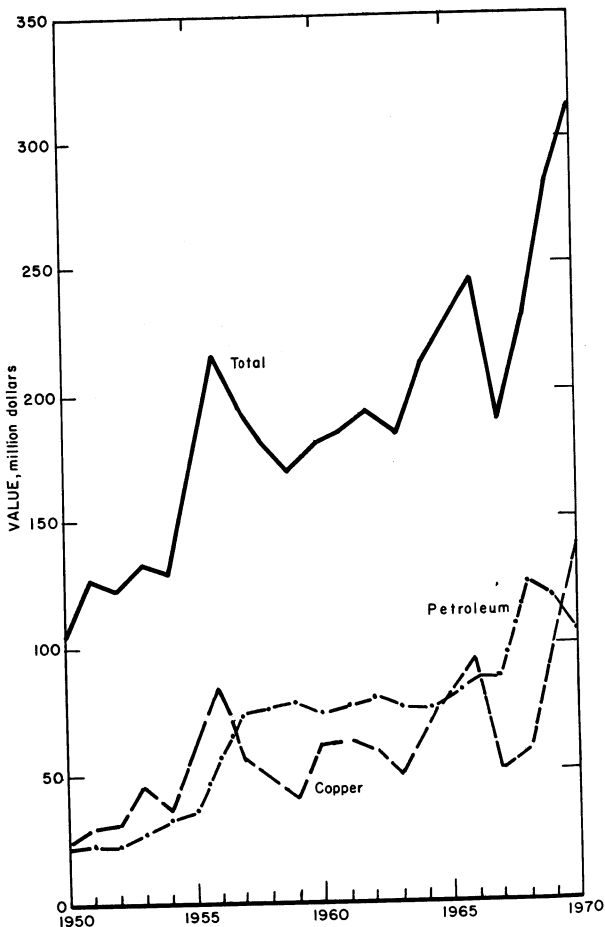


Figure 1.—Value of copper, petroleum, and total value of mineral production in Montana.

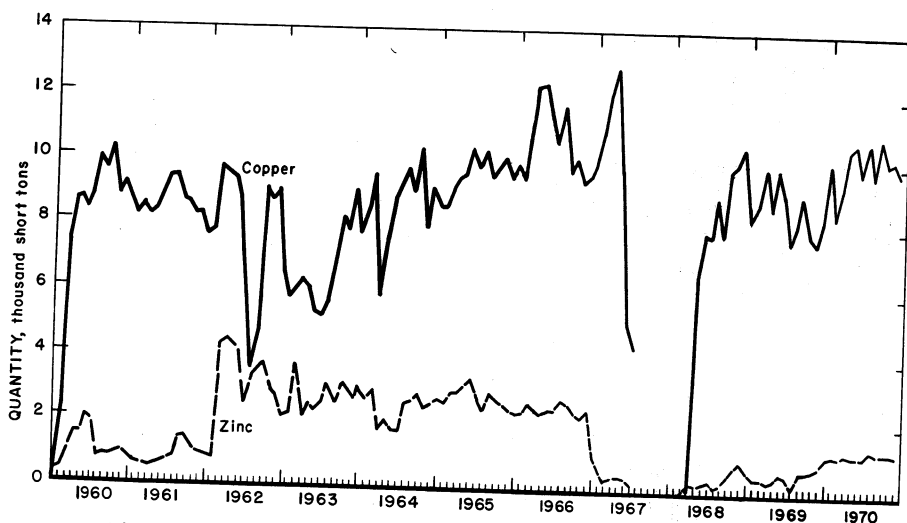


Figure 2.—Mine production of copper and zinc in Montana, by months, in terms of recoverable metals.

Elsewhere, a number of small coal mines in the Roundup area of Montana were closed, reportedly because of inability to meet requirements of the Federal Mine Health and Safety Act of 1969.<sup>3</sup>

Expansion and modernization programs were underway at The Anaconda Company's Butte and Anaconda operations, and plans were prepared or implemented for installation of various pollution abatement equipment and facilities at most of the firm's Montana operations. Recognition and response to environmental questions about existing and proposed new mineral production facilities was an increasing concern to all mining firms. The problem was heightened by enforcement of Federal Water Quality Control Standards and by expected new standards governing air pollution. Particularly threatened were smelt-

ing and other mineral operations at and near East Helena, Mont., where abatement was expected to be exceptionally costly. Other mineral-producing firms throughout the State prepared for greater expenditures to cover future pollution abatement and land reclamation costs.

Employment in most categories of mining was up for the year but in nonmetal mining employment was down. The average employment in mining was 5 percent higher than in 1969.

Vo-Tech, a vocational training school located in Butte, was selected for a federally supported program to train miners in various phases of underground work. First classes began in December 1970.

<sup>3</sup> Ozman, Ray. Law "Killing" Small Coal Mines. Great Falls Tribune, July 11, 1971, p. 1.

Table 3.—Indicators of Montana business activity

	1969	1970	Change, percent
<b>Annual average labor force and employment:</b>			
Total labor force.....	276.9	282.1	+1.9
Unemployment.....	15.5	18.8	+21.3
Employment:			
Manufacturing.....	24.1	23.6	-2.1
Wholesale and retail trade.....	47.0	48.2	+2.6
Mining.....	6.4	6.7	+4.7
Construction.....	10.5	10.9	+3.8
Transportation and public utilities.....	17.6	17.2	-2.3
Finance, insurance, and real estate.....	7.9	8.1	+2.5
Services.....	32.1	33.5	+4.4
Government.....	52.1	52.3	+4
Personal income:			
Total.....	\$2,172	\$2,350	+8.2
Per capita.....	\$3,130	\$3,381	+8.0
Construction activity:			
Value of authorized nonresidential construction.....	\$20.2	\$19.8	-2.0
Highway construction contracts awarded.....	\$76.2	\$74.7	-2.0
Cement shipments to and within Montana thousand 376-pound barrels.....	2,077	1,699	-18.2
Farm marketing receipts.....	\$534.2	\$557.5	+4.4
Mineral production.....	\$282.6	\$313.0	+10.8

Sources: Area Trends in Employment and Unemployment; Employment and Earnings; Survey of Current Business; Construction Review; Streets and Roads; Farm Income Situation; and Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Coal and peat..	81	160	13	101	-----	1	9.91	30
Metal.....	2,986	281	838	6,699	2	128	19.41	3,084
Nonmetal.....	562	248	139	1,126	1	23	21.32	5,793
Sand and gravel	881	155	129	1,124	-----	24	21.35	461
Stone.....	490	242	119	975	-----	12	12.81	481
Total <sup>1</sup> .....	4,950	250	1,237	10,025	3	188	19.05	2,810
<b>1970:<sup>p</sup></b>								
Coal and peat..	90	162	15	113	-----	1	8.88	27
Metal.....	3,425	303	1,037	8,300	2	174	21.20	3,020
Nonmetal.....	420	245	102	828	-----	28	33.82	6,551
Sand and gravel	830	160	133	1,088	-----	20	18.38	663
Stone.....	470	251	118	962	-----	16	16.63	513
Total <sup>1</sup> .....	5,230	268	1,404	11,291	2	239	21.34	2,808

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### METALS

**Aluminum.**—Production of aluminum at the Columbia Falls reduction plant of Anaconda Aluminum Co. slightly exceeded that of 1969. The plant utilized Jamaican alumina transported by rail from Everett, Wash., port facilities. A new \$1 million scrubber system was being installed to reduce average daily fluoride emissions of the plant to an expected 2,500 pounds or less. The fluorides have been a subject of complaints by environmental interests.

**Antimony.**—Only a small tonnage of antimony was produced during 1970. In the last several months of the year, concentrates totaling about 125 tons valued at \$200,000 were produced by U.S. Antimony Corp. from its property in the Prospect Creek area near Thompson Falls, Sanders County. A sink-float mill, reportedly capable of processing 1,800 tons of ore per day, was placed in operation. Reserves were estimated at 300,000 tons of ore occurring in at least two veins several inches to more than 10 feet in width.

**Copper.**—Mines of The Anaconda Company accounted for virtually all of the 120,412 tons of copper produced in the State. Major expansions were proposed or were in progress at the company's Butte properties. A new \$6 million crushing plant neared completion south of the Berkley pit. Scrap tin cans continued to be used in producing cement copper of about 80-percent purity at the firm's Butte cop-

per precipitation plant, where capacity was being expanded 60 percent. Plans were made to purchase a fleet of 150-ton trucks for use in the Berkley open pit mine, and two new 15-cubic-yard shovels were to be purchased to accompany seven 15-cubic-yard and seven 6-cubic-yard shovels already in service in the pit. Future trials were planned for several 200-ton trucks on order.

**Table 5.—Montana: Mine production of gold, silver, copper, lead, and zinc in 1970, by classes of ore or other source materials, in terms of recoverable metals**

Source	Number of mines	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
<b>Lode ore:</b>							
Dry gold.....	2	40	4	19	1	-----	-----
Gold-silver.....	4	6,263	1,407	44,626	4	56	18
Dry silver.....	28	33,035	1,357	413,095	78	154	37
<b>Total.....</b>	<b>34</b>	<b>39,338</b>	<b>2,768</b>	<b>462,740</b>	<b>83</b>	<b>210</b>	<b>55</b>
Copper.....	3	18,720,390	19,438	3,583,016	102,732	-----	-----
Lead.....	12	11,506	157	98,196	7	636	39
Lead-zinc.....	2	26	10	215	-----	3	2
Zinc.....	6	4,994	43	151,587	28	147	1,361
<b>Total.....</b>	<b>23</b>	<b>18,736,916</b>	<b>19,648</b>	<b>3,833,014</b>	<b>102,767</b>	<b>786</b>	<b>1,402</b>
<b>Other lode material:</b>							
Gold-silver and silver tailings.....	4	3,893	26	8,572	6	-----	-----
Copper precipitates.....	1	21,516	-----	-----	17,556	-----	-----
<b>Total.....</b>	<b>5</b>	<b>25,409</b>	<b>26</b>	<b>8,572</b>	<b>17,562</b>	-----	-----
<b>Total lode material.....</b>	<b>61</b>	<b>18,801,663</b>	<b>22,442</b>	<b>4,304,326</b>	<b>120,412</b>	<b>996</b>	<b>1,457</b>
<b>Placer.....</b>	<b>1</b>	-----	14	-----	-----	-----	-----
<b>Grand total.....</b>	<b>62</b>	<b>18,801,663</b>	<b>22,456</b>	<b>4,304,326</b>	<b>120,412</b>	<b>996</b>	<b>1,457</b>

**Table 6.—Montana: Gold production at placer mines**

Year	Mechanical and hydraulic methods <sup>1</sup>			Small-scale hand methods			Total <sup>2</sup>		
	Number of mines	Material treated (thousand cubic yards)	Gold (troy ounces)	Number of mines	Material treated (thousand cubic yards)	Gold (troy ounces)	Number of mines	Material treated (thousand cubic yards)	Gold (troy ounces)
1966.....	34	36	422	1	(4)	1	5	36	423
1967.....	53	15	141	-----	-----	-----	3	15	141
1968.....	62	2	20	1	(4)	2	3	3	22
1969.....	71	(4)	2	1	(4)	2	2	(4)	4
1970.....	71	(4)	14	-----	-----	-----	1	(4)	14

<sup>1</sup> Combined to avoid disclosing individual confidential data.

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

<sup>3</sup> Includes 3 dragline dredges and 1 power rocker.

<sup>4</sup> Less than ½ unit.

<sup>5</sup> Includes 1 nonfloat washing plant, 1 hydraulic, and 1 power rocker.

<sup>6</sup> Includes 1 dragline dredge and 1 nonfloat washing plant.

<sup>7</sup> Hydraulic.



Table 9.—Montana: Mine production of gold, silver, copper, lead, and zinc in Silver Bow County, in terms of recoverable metals

Year	Mines producing		Material sold or treated <sup>1</sup> (thousand short tons)	Gold, lode and placer (troy ounces)	Silver, lode and placer (thousand troy ounces)
	Lode	Placer			
1966.....	5	-----	17,503	21,608	4,864
1967.....	5	-----	9,041	8,339	1,856
1968.....	6	-----	10,089	9,782	1,466
1969.....	5	-----	16,022	15,428	2,563
1970.....	4	-----	18,745	19,454	3,590
1882-1970.....	-----		<sup>2</sup> 392,583	2,476,830	652,655
	Copper (short tons)	Lead (short tons)	Zinc (short tons)	Total value (thousands)	
1966.....	127,885	2,411	22,284	\$106,749	
1967.....	65,448	64	816	53,450	
1968.....	69,362	-----	-----	61,580	
1969.....	103,179	-----	W	103,321	
1970.....	120,292	-----	-----	145,881	
1882-1970.....	8,523,253	415,425	2,406,818	4,335,890	

W Withheld to avoid disclosing individual company confidential data.

<sup>1</sup> Does not include gravel washed.

<sup>2</sup> Complete data not available: 1882-1904.

The Anaconda Company continued exploration for copper and molybdenum in the Continental area, near Butte, where it appeared there was good chance that a large low-grade ore body would be developed into a commercial mine; the company also drove several exploratory adits at its copper-nickel claims in the Stillwater District near Nye, Mont. Other companies reported active in the Stillwater District included Cyprus Mines Corp., Freeport Sulphur Corp., and Johns-Manville Corp. Deposits were reported to lie in a zone of metamorphic rocks extending between Mouat and Boulder Creek, a distance of about 30 miles. An area encompassing over 17,000 acres was reported under claim. Concern was expressed by conservationists and by company officials over maintenance of water quality in the drainage areas below the deposits where open pit mining was contemplated. Technical studies were scheduled to establish controls.

A proposed \$50 million open pit copper-molybdenum mine development by The Anaconda Company near Lincoln, in northwestern Montana, received a setback when the State Land Board withheld easements on school lands along Alice Creek where a tailings pond was planned for the proposed Heddeston mine and mill. The State offered the land subject to 11 protective provisions, which the company decided were too restrictive for a commercial operation. Consequently, Anaconda withdrew

its application. Further work on the property was curtailed and exploration drilling was terminated in December.

Bear Creek Mining Co., subsidiary of Kennecott Copper Corp., continued exploration work at its Spar Lake copper property, south of Troy, northwestern Montana, after reportedly establishing the existence of a sizable deposit minable by underground methods. Plans were announced to build a 20,000-ton-per-day mill and proceed with development. Production is scheduled to start in 1974. Phelps Dodge Corp. announced a lease agreement with Hillside Mines, Inc., and planned to explore a group of claims for copper near Trout Creek, Sanders County.

**Gold.**—Gold was produced principally as a byproduct of copper refining. During the year, gold output declined to 22,456 ounces valued at \$817,174. One placer mining operation in Meagher County reported a small recovery of gold. Two gold mines in Missoula and Ravalli Counties and four gold-silver mines in Deer Lodge, Jefferson, Lewis and Clark, and Madison Counties contributed to production.

**Iron Ore.**—Iron ore continued to come only from the Iron Cross open pit mine of R & S Iron Co. near Radersburg; all was used in cement manufacture.

**Lead.**—The American Smelting and Refining Co. (ASARCO) smelter, at East Helena, accounted for the State's production of refined lead. Mine production was

reported from 12 lead operations throughout the State and was less than in 1969. Shipments came mainly from the Flathead and West Flathead mines, Flathead County; from the Maulden mine, Beaverhead County; and from the True Fissure and Scratchal mines, Granite County. Lead was also recovered from old slag at East Helena as a result of zinc fuming plant operations by The Anaconda Company. Lead extracted during zinc reduction at Anaconda's Great Falls plant was returned to the ASARCO smelter for processing. Mine production statistics for 1970 excluded lead from the old slag, in contrast to earlier years when lead from this source was included.

**Manganese.**—No manganese production was reported in the State in 1970, but a small quantity of metallurgical-grade ore was shipped from stocks of The Anaconda Company at Butte.

**Silver.**—The principal source of silver was byproduct output from copper operations in the Butte area. Production rose 26 percent, reflecting expanded output of copper in 1970. Values for the year rose 24 percent; the average annual price for silver declined to \$1.77 per ounce. Production came from about 65 operations in 16 counties, including 28 mines that were principally silver producers. Silver Bow County produced 3,589,679 ounces, Granite County produced 326,961 ounces, and Mineral County had mine outputs exceeding 100,000 ounces. Outputs over 10,000 ounces were reported from mines in Deer Lodge, Flathead, Jefferson, and Madison Counties.

Interest in silver exploration remained high in mining districts throughout the State. Exploration was conducted at the Nancy Lee mine near Superior, Mineral County, and in late 1970 the mill operated at a rate of 150 tons of ore per day. Tierra Exploration, Inc., took over the Nancy Lee operations in April 1970. The Neihart district's Star silver-lead mine, reopened in 1969 by Northwest Mines Development Corp., was being explored, and the mill was rehabilitated. The New Departure mine, in the Bannock district, Beaverhead County, continued production under Spokane National Mines, Inc., and used newly acquired diesel-powered trackless underground mining equipment. Ores from this and other nearby mines were milled at Bannock where it was planned to expand milling capacity to 225 tons per day.

Silver-gold, and silver-lead mines were active also in the Argenta district, Beaverhead County. Midnight Mines, Inc., shipped ore reportedly averaging 19.5 ounces of silver per ton from the Polaris mine in Beaverhead County. Golden Eagle Mining Co. made its first ore shipment from the Hi Tariff mine in the Rimini district, west of Helena. Silver Champion Mines, Inc., used geochemical tests and trench sampling to disclose a series of gold-silver veins at its Silver Bell property near Clancy, south of Helena. Mine workings and surface plant were rehabilitated at the property.

Sierra Silver Mining Co. explored a vein on the Cadgie Taylor property near Philipsburg. Diamond drilling was planned at the property of Silver Lake Silver Mining Co. near Philipsburg where a rich vein about 1-foot wide was exposed by trenching. Hecla Mining Co. reassessed its plans to develop low-grade silver ores found at the Granite-Bimetallic mine at Philipsburg. Mountain Gold & Silver Inc. explored the Blue Bell and Jack Rabbit properties east of Melrose, Madison County, and Eddy Creek Silver Mining Co. core-drilled its property near Plains, north of Superior, Mont. Trojan Silver-Lead Mines, Inc., was completing construction of a 125-ton-per-day mill at the Snowstorm mine near Troy, Lincoln County, with plans to reactivate shaft and hoist facilities and drive a raise between the 1,200-foot level and 1,000-foot portal level. Rob Roy Mining Co. changed its name to Royal Silver Mining Co. and planned to develop its Chancellor group of silver-gold claims in the Warm Springs district of Fergus County.

**Tungsten.**—Only a few tons of tungsten concentrate was produced in 1970, and none came from Beaverhead County, the source of production in 1969. Montana dropped to fifth place among States producing tungsten. ASARCO completed exploration drilling for tungsten and molybdenum on claims near Goat Creek about 6 miles northeast of Thompson Falls in Sanders County.

**Zinc.**—Zinc was derived mainly from a number of small lead-zinc-silver operations in the western half of the State and in part as a byproduct of copper mining. Output was reported by 30 mines, including six mines classified as principally zinc producers and two mines classified as principally lead-zinc producers. The largest



zinc-mining operations in the State remained the Taylor-Knapp Unit Area in Granite County. Byproduct zinc was also recovered as zinc oxide at the slag fuming plant of The Anaconda Company at East Helena (this output was excluded from primary mine production data in 1970 in contrast with previous years). Cutbacks in zinc smelter production about mid-year resulted from accumulations of slab zinc inventories. Zinc ores were calcined at Anaconda's Great Falls plant, where the product was refined electrolytically to zinc metal.

### NONMETALS

**Cement.**—Portland and masonry cement shipments declined 21 percent in quantity and 16 percent in value, chiefly because less cement was needed in construction at Libby Dam, which was nearing completion. The two firms that produced cement were Kaiser Cement & Gypsum Corp., at Montana City near Helena, and Ideal Basic Industries, Inc., with a plant at Trident near Three Forks, Mont. Because of consolidated reporting methods adopted in 1970, information on destination of cement shipments from Montana was no longer available. Of total finished portland cement shipped, about 48 percent went by rail and 52 percent by truck. The ratio of bulk to packaged cement was about 10 to 1. About 59 percent of the portland cement produced was distributed to building material dealers and companies making commercial concrete products, including ready-mix concrete. The balance went to highway contractors and Government agencies (34 percent), and to miscellaneous customers (7 percent).

Ideal Basic Industries, Inc. announced plans for a \$10 million modernization program at Trident to include replacement of four old kilns with a single kiln designed for 12 percent greater total capacity. Dust-control equipment was to be installed.

**Clays.**—Output of all types of clays and shale for use in building products, iron ore pelletizing, and in oil-well drilling muds (bentonite) rose 49 percent in quantity and 95 percent in value in 1970. More than three-fourths of all clays mined were bentonites. Lewistown Brick & Tile Co. near Lewistown, Fergus County, and Lovell Clay Products Co., near Billings, Yellowstone County, continued production of

heavy clay products from locally mined clays and shales.

Federal Ore & Mineral Corp. and Youghiogheny & Ohio Coal Co., both of Cleveland, Ohio, formed the Federal Bentonite Co. and purchased facilities of Ashland Oil, Inc., including a bentonite processing plant under construction near Glasgow and Ashland Oil's northeastern Montana bentonite reserves. The firm was expected to become one of the largest producers of western sodium-based swelling bentonite clays. The new Glasgow plant, expected to be a major supplier of clay binders for iron ore pelletizing, was to be completed in 1971 with a capacity of 300,000 tons per year of granular and pelletized clays.

National Lead Co. continued mining bentonite near Colony, Carter County, for use in drilling muds, and Hallett Minerals Co. mined bentonite near Vananda chiefly for use in pelletizing taconite iron concentrates in Minnesota.

Beds of bentonite within the Bearpaw Shaie, exposed in the Ingomar-Vananda area of Treasure and Rosebud Counties were described.<sup>4</sup>

Kiln capacity was increased to 8 cubic yards of lightweight aggregates per hour at the Treasure State Industrial Products, Inc., shale expanding plant near Great Falls; simultaneously, fuel costs were reduced to about \$.70 per cubic yard of shale processed. Work continued on the replacement and expansion of crushing and screening facilities. Treasure State Industrial Products, Inc. operated one of the State's largest concrete block manufacturing plants at Great Falls, where much of the expanded clay product was used.

**Fluorspar.**—All production and shipments of fluorspar were from the Crystal Mountain mine of Roberts Mining Co. in Ravalli County. Crude fluorspar was upgraded to metallurgical grade at a heavy-media processing plant at Darby, Mont., and sold to steelmakers in the East and Midwest.

**Gypsum.**—The Shoemaker mine, Fergus County, of United States Gypsum Co., was the State's only producer of gypsum. Output of crude gypsum at the company's Heath plant declined 12 percent; ground

<sup>4</sup> Berg, Richard B. Bentonite Deposits in the Ingomar-Vananda Area, Treasure and Rosebud Counties. Montana Bur. of Mines and Geol. Spec. Pub. 51, September 1970, 5 pp.

and calcined production remained about the same level compared with that of 1969.

**Lime.**—Lime production declined 18 percent and value decreased 8 percent in 1970. The Anaconda Company processed quicklime at its Limekiln plant, Deer Lodge County, for metallurgical use and for acid water treatment in tailings disposal. Sugar manufacturers calcined limestone for use in sugar refining in Big Horn, Yellowstone, and Richland Counties. Anaconda, using rock from its Brown's quarry, Deer Lodge County, began production of quicklime at Butte for neutralization of Silver Bow Creek waters.

**Phosphate Rock.**—Output of phosphate rock declined 51 percent in 1970 owing to a slack fertilizer market. Production, all from three mines in Powell County, went to consumers in the Rocky Mountain region and to Trail, British Columbia, for manufacture into phosphate fertilizers. The poor markets made it necessary for Cominco American, Inc., to phase out or curtail operations at the Anderson and Warm Springs sections of the Brock mine, near Garrison. Stauffer Chemical Co. continued to operate its elemental phosphorus plant at Silver Bow using rock from Soda Springs, Idaho. Litigation continued over questions of air pollution by Rocky Mountain Phosphates, Inc., from its phosphate-rock defluorination plant operations at Garrison, Mont. Phosphorus, the principal resource in Permian rocks of southwest Montana, and distribution of fluorine, uranium, oil shale, and several additional elements were subjects of a report.<sup>5</sup>

**Sand and Gravel.**—Sand and gravel output rose 16 percent, to 19.3 million tons valued at \$20.2 million, owing mainly to increased demand for highway construction. There was a total of 145 producing pits in 1970, compared with 165 in 1969.

Commercial firms operated 33 plants (22 stationary and 11 portable); total production was 2.2 million tons. Government-and-contractor production totaled 17.1 million tons from 26 plants (three stationary and 23 portable).

Sand and gravel was produced in 53 of the State's 56 counties. Production exceeded 1 million tons in Big Horn, Lincoln, Prairie, Stillwater, Sweet Grass, and Yellowstone Counties. The use distribution was as follows: Road material, 91 percent; building, 4 percent; and miscellaneous, including fill and railroad ballast, 5 percent.

**Stone.**—Output of stone declined in contrast with that of sand and gravel. Stone was produced in 29 counties, with output ranging from 0.5 to 0.75 million tons in Big Horn, Carbon, Custer, Jefferson, Stillwater, and Sweet Grass Counties.

Traprock, miscellaneous stone, granite, limestone, marble, sandstone, quartz, and quartzite were produced. The traprock and miscellaneous stone was used largely in road construction (4.0 million tons); some (855,000 tons) was also used for riprap, fill, and as railroad ballast.

Limestone output totaling 1.8 million tons came from seven quarries and was used for cement manufacture, lime, and metallurgical purposes. Some was also used as riprap in construction. Limestone was mined in Broadwater, Carbon, Chouteau, Deer Lodge, Gallatin, and Jefferson Counties.

Granite from one quarry in Gallatin County was used in embankments and jet-ties.

Marble was produced from three quarries in Madison and Park Counties and crushed and sized for use in roofing granules, for poultry grit, for manufacturing cement, and road construction.

Sandstone, quartz, and quartzite for use as a source of industrial silica came from six quarries in Broadwater, Dawson, Deer Lodge, Gallatin, Jefferson, and Lincoln Counties. Two quarries supplied sandstone for dimension stone. Crushed and sized silica products were used in cementmaking, ferrosilicon, and metallurgical processes.

**Sulfur.**—Output of high-purity elemental sulfur declined compared with the 1969 total. Sulfur was recovered by Montana Sulphur & Chemical Co. from byproduct hydrogen sulfide gas obtained from two oil refineries at Billings. Farmers Union Central Exchange operated a sulfur recovery system utilizing byproduct gases received from its oil refinery at Laurel. Sulfuric acid was produced from zinc smelter gases by The Anaconda Company.

**Talc.**—Four mines, all in Madison County, produced about 8 percent less talc than in 1969. The Smith-Dillon-Crown mine of Chas. Pfizer & Co., Inc. southeast of Dillon, in Beaverhead County reported no production in 1970. Talc was ground and sized by a firm at Barratts, Beaver-

<sup>5</sup> Swanson, Roger W. Mineral Resources of Permian Rocks of Southwest Montana. U.S. Geol. Survey Prof. Paper 313-E, 1970, pp. 661-777.

**Table 10.—Montana: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	249	\$463	272	\$440
Fill.....	3	3	5	6
Paving.....	79	149	77	122
Other uses <sup>1</sup> .....	36	47	14	32
<b>Total <sup>2</sup>.....</b>	<b>367</b>	<b>662</b>	<b>369</b>	<b>600</b>
<b>Gravel:</b>				
Building.....	377	547	502	665
Fill.....	155	109	169	118
Paving.....	1,050	1,244	1,002	1,166
Railroad ballast.....	98	140	75	92
Other uses <sup>2</sup> .....	94	152	72	120
<b>Total.....</b>	<b>1,774</b>	<b>2,192</b>	<b>1,820</b>	<b>2,161</b>
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Building.....	5	12		
Fill.....	21	11	26	18
Paving.....	3,165	2,536	2,193	3,042
Other uses.....	243	121		
<b>Total <sup>2</sup>.....</b>	<b>3,434</b>	<b>2,680</b>	<b>2,218</b>	<b>3,060</b>
<b>Gravel:</b>				
Building.....	4	12		
Fill.....	279	158	475	276
Paving.....	9,618	8,119	14,336	14,122
Other uses.....	1,119	560	57	31
<b>Total <sup>2</sup>.....</b>	<b>11,020</b>	<b>8,849</b>	<b>14,867</b>	<b>14,429</b>
<b>Total sand and gravel <sup>2</sup>.....</b>	<b>16,595</b>	<b>14,383</b>	<b>19,275</b>	<b>20,249</b>

<sup>1</sup> Includes railroad ballast (1969), blast, and other sands.

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

<sup>3</sup> Includes miscellaneous gravel (1970), and other gravel.

head County. Output from the Madison County mines of United Sierra Division of Cyprus Mines Corp. was processed at the company grinding plant at Three Forks, and some was shipped out-of-State to grinding plants in Nebraska and California. During the year, the firm initiated a 50- to 100-ton-per-hour talc-washing and upgrading operation at Alder.

The use distribution of talc by industry was as follows, in percent: paper, 38; paint, 28; ceramics, 8; and exports and miscellaneous uses including insecticides, rice polishing, roofing, rubber, textile fillers, and toilet preparations, 26.

**Vermiculite.**—Montana continued to supply almost two-thirds of the U.S. market for vermiculite. The Zonolite Division, W. R. Grace & Co., operated its open pit vermiculite mine near Libby, Lincoln County, at slightly less than the rate of production in 1969. Most sized vermiculite was shipped out-of-State for exfoliating. Trans-

fer and storage facilities at the mine were changed to permit better use of the conveyor system. Research was directed toward recovery of an asbestos byproduct. Plans were considered for a new beneficiation plant to be built at Libby. The plant would increase output by one-third, to about 1,000 tons of vermiculite per day in 1973.

#### MINERAL FUELS

**Coal.**—Bituminous coal and lignite production from 12 active mines (seven underground and five strip in four counties) increased 235 percent above the 1969 level. The increase, as in 1969, was due mainly to further expansion of coal-mining facilities at Colstrip, Rosebud County, by Western Energy Co. and by Peabody Coal Co. It was predicted that Montana coal production would double in 1971 and probably reach 10 million tons per year by 1973.

**Table II.—Montana: Bituminous coal and lignite production, by type of mine and county**

(Excludes mines producing less than 1,000 short tons per year)

County	Number of mines			Production (thousand short tons)			Value (thousand dollars)
	Under- ground	Strip	Total	Under- ground	Strip	Total	
Bituminous coal:							
Musselshell.....	4		4	28		28	\$264
Rosebud.....		2	2		3,096	3,096	5,441
Lignite:							
Powder River.....		1	1		1	1	7
Richland.....		1	1		322	322	681
Total.....	4	4	8	28	3,419	3,447	16,394

<sup>1</sup> Data does not add to total shown because of independent rounding.

A 6-year contract for shipment to Minnesota of up to 500,000 tons of coal per year from Colstrip was signed in early 1976 between Montana Power Co. and Northern States Power Co., of Minneapolis, Minn. Western Energy Co., a subsidiary of Montana Power Co., by yearend 1970 produced coal from its Colstrip mine at a rate of about 4 million tons per year as a result of expansions. During the year, the firm's output amounted to 1,658,000 tons. The coal was sold mainly for electric power generation in the Chicago, Ill., Minneapolis, Minn., and Billings, Mont. areas. Peabody Coal Co. supplied coal from its Big Sky mine to the Minnesota Power & Light Co. steam-generating plant at Co-hasset, Minn. The mine, 6 miles south of Colstrip and producing at 10,000 tons per week in early 1970, acquired a large new dragline for overburden stripping. Peabody considered construction of a rail line from Colstrip leading to extensive deposits of low-sulfur coal on the Cheyenne Reservation near Lame Deer and Ashland.

Richland County was the major source of lignite, mined by Knife River Coal Mining Co. for use at the Montana-Dakota Utilities Co.'s coal-fired steam-electric generating plant at Sidney. Pacific Power & Light Co., signed an agreement with Rosebud Coal Sales Co., subsidiary of Peter Kiewit & Sons, Inc., to mine and market 7 million tons of coal per year from southeastern Montana deposits near Decker, Big Horn County. The coal generally averaged about 9,700 Btu per pound with sulfur content of 1/2 to 1 percent and an ash content of 4 percent. An estimated 50 to 60 million tons was present in a 60-foot-thick seam. The cooperative Decker project was

established to supply coal for electric generating plants in the Midwest and Rocky Mountain States. A 60,000-ton shipment was sent to Illinois during the year for testing.

Consolidation Coal Co. conducted a core-drilling program over a wide area in the Bull Mountains of Musselshell and Yellowstone Counties without disclosing the results. The Powder River Co. drilled about 100 holes in the Moorhead coalfield during 1970. Coal mining leases were granted on 22,195 acres of State-owned lands in Rosebud, Big Horn, Powder River, and Musselshell Counties. Bids averaged \$7.20 per acre.

A proposal was made by a division of the Westmoreland Resources Group to build a \$200 to \$300 million coal-gasification plant that would utilize eastern Montana coal. Gulf Mineral Resources Co. of Denver, Colo., acquired coal exploration permits on 73,500 acres of the Crow Indian Reservation, Big Horn County, and planned a coal-based, synthetic-fuels complex capable of producing 100,000 barrels of crude oil per day. As a necessary part of the project, the firm requested the Bureau of Reclamation to set aside 50,000 acre-feet of water per year from the Yellowstone Unit of the Missouri River Basin Project for plant use. A legislative committee considered the feasibility and legality of a proposal to transport coal slurry by pipeline more than 700 miles from Colstrip to Midwest terminals.

In the Roundup area of Musselshell County, Square Deal Coal Co., Divide Mine, Nies Coal Co., P.M. Coal Co., Cow Creek Coal Co., Western Coal Co., and

Jonie's Mine closed their mines in the period between May 1 and June 7 because of inability to comply with provisions of the Federal Coal Mine Health and Safety Act of 1969. Owners contended that cost of full compliance would be prohibitive. Also closed during the year was the Milk River Coal Mine at Chinook, Mont., a long-time producer. About 10,000 consumers were estimated to have been affected by the closures.

**Petroleum and Natural Gas.**—Crude petroleum recovery declined 14 percent compared with the 1969 figure of 43.95 million barrels. Petroleum accounted for about 34 percent of the State mineral production value. About 63 percent of the crude oil produced came from the following six fields: the Bell Creek field (7.8 million barrels), in the Powder River Basin of southeastern Montana; the Cabin Creek (3.7 million barrels), Pine (3.3 million barrels), and Pennell fields (1.6 million barrels), in the Williston Basin; the Cut Bank field (5.4 million barrels), in northern Montana; and the Elk Basin field (2.1 million barrels), in south-central Montana.

The Bell Creek field, Powder River County, accounted for slightly over 20 percent of total production and operated at a significantly lower rate than in 1969. However, it remained the State's largest producing field. The Cut Bank field, Glacier and Toole Counties, which ranked second in 1970, remained the leading alltime producing field in Montana. Its cumulative output was 123.6 million barrels, about 17 percent of total cumulative State production of 721.84 million barrels.

During the year, the estimated recoverable reserves of petroleum declined 4.7 million barrels. Secondary recovery, mostly by waterflood, continued to contribute to Montana production, with good response reported at the Kevin Sunburst, Bell Creek, and Big Coulee fields. A total of 58 secondary recovery projects throughout the State provided an estimated 25 percent of overall production.

Marketed production of natural gas increased 4 percent to 42.7 billion cubic feet valued at \$4.4 million. The Bell Creek field was the largest source of natural gas, followed by the Cut Bank field. Although

an expected international pipeline outlet to Saskatchewan, Canada, failed to gain approval, development of important natural gas reserves in the Tiger Ridge field, north of the Bearpaw Mountains continued; the number of shut-in wells reached about 100 on a 640-acre grid spacing. Ten wells connected to a local pipeline produced slightly over 2 billion cubic feet of gas in 1970. Several large new lease blocks were assembled in Montana, principally for gas exploration. Montana-Dakota Utilities Co. announced plans for construction at Miles City, Custer County, of a 20-megawatt, natural gas-fired, steam-electric generating plant, to be operational about May 1972.

Montana Power Co., through its subsidiary, Canadian-Montana Pipe Line Co., entered into an agreement with Alberta & Southern Gas Co. Ltd. to purchase an additional 20 million cubic feet of Canadian natural gas per day, which was to start in November 1971. An application was filed with the National Energy Board of Canada for authority to export the gas from Canada, which would bring to 100 million cubic feet per day the volume imported into Montana from the Canadian firm.

Exploratory drilling declined both in footage and in the number of wells. The average depth of hole was slightly less in 1970, reflecting increased drilling for gas which tends to be at shallower depths. Percentage of successful oil and gas completions in 1970 was less than in 1969. Table 12 shows results by county, as reported by the American Petroleum Institute.

An estimated 42.33 million barrels of oil was refined in Montana at 10 oil refineries. The three largest refiners, which processed 87 percent of the total refined, were Humble Oil & Refining Co. (14.5 million barrels), Continental Oil Co. (13.8 million barrels), and Farmers Union Central Exchange, Inc. (8.7 million barrels). Montana wells supplied only part of the crude oil refined; other crude entered the State from Wyoming and Canada. During the year Canadian Hydrocarbons Ltd. of Calgary, Alberta, purchased the 4,100-barrel-per-day Union Oil Co. refinery at Cut Bank and planned to continue operation under the name of its U.S. affiliate, Wesco Inc.

Table 12.—Montana: Oil and gas well drilling completions in 1970, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Beaverhead.....						1	1	4,125
Big Horn.....						9	9	41,543
Blaine.....		14	13			44	71	203,755
Carbon.....			1		1	2	4	25,967
Carter.....	1					39	40	164,534
Chouteau.....					1	10	11	18,590
Custer.....						8	8	43,810
Daniels.....				1		8	9	53,552
Dawson.....	1					3	4	41,450
Fallon.....	3		1	2		5	11	79,841
Fergus.....						10	10	29,047
Garfield.....						4	4	24,126
Glacier.....	10	5	3			2	20	62,969
Golden Valley.....						1	1	1,700
Hill.....		27	22		9	53	111	203,212
Jefferson.....						1	1	1,005
Judith Basin.....						4	4	3,809
Liberty.....		3	3	1	2	20	29	81,555
McCone.....						4	4	28,479
Musselshell.....	2		6	5		10	23	100,824
Petroleum.....	1		1			3	5	6,296
Phillips.....					1	10	11	33,572
Pondera.....	11		5			5	21	65,370
Powder River.....	3		14			48	65	350,507
Prairie.....						4	4	22,545
Richland.....	3			5		7	15	173,495
Roosevelt.....				2		3	5	42,136
Rosebud.....			2			23	25	145,749
Sheridan.....	6		3	4		12	25	213,818
Stillwater.....						1	1	2,822
Sweet Grass.....						1	1	2,548
Teton.....						2	2	13,300
Toole.....	2	5	7	1	6	15	36	71,422
Treasure.....						4	4	19,113
Valley.....						2	3	30,895
Wibaux.....	1					4	4	17,839
Yellowstone.....								
Total.....	43	54	82	21	20	383	603	2,447,497

Source: American Petroleum Institute.

Table 13.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Metals:</b>			
<b>Aluminum:</b>			
Anaconda Aluminum Co.---	Columbia Falls, Montana 59912.	Reduction plant...	Flathead.
	Great Falls, Montana 59401....	Rolling mill.....	Cascade.
<b>Copper:</b>			
The Anaconda Company <sup>1</sup> ..	Anaconda, Montana 59711.....	Smelter.....	Deer Lodge.
	Butte, Montana 59701.....	Mine, concentrator, precipitating plant.	Silver Bow.
	Great Falls, Montana 59401....	Refinery, rolling mill.	Cascade.
<b>Iron ore:</b>			
R & S Iron Co.....	Radersburg, Montana 59641.....	do.....	Broadwater.
<b>Lead-zinc:</b>			
American Smelting and Refining Co.	East Helena, Montana 59635...	Smelter.....	Lewis and Clark.
The Anaconda Company...	do.....	Slag fuming plant.	Do.
	Great Falls, Montana 59401....	Zinc plant.....	Cascade.
John Hand <sup>2</sup> .....	Dillon, Montana 59725.....	Mine.....	Beaverhead.
J. W. Keenan <sup>2</sup> .....	Helena, Montana 59601.....	do.....	Lewis and Clark.
William Schneider <sup>2</sup> .....	Philipsburg, Montana 59858....	do.....	Granite.
Taylor-Knapp Co. <sup>3</sup> .....	do.....	Mine and mill....	Do.
<b>Silver:</b>			
Frank Antonioli <sup>4</sup> .....	Butte, Montana 59701.....	Mine.....	Granite, Silver Bow.
Delbert Bullock <sup>4</sup> .....	Basin, Montana 59631.....	do.....	Jefferson.
Flathead Mines, Inc. <sup>5</sup> .....	Kalispell, Montana 59901.....	do.....	Flathead.
Harold Giulio <sup>4</sup> .....	Boulder, Montana 59632.....	do.....	Jefferson.
Joe Metesh <sup>6</sup> .....	Philipsburg, Montana 59858....	do.....	Granite.
Moulton Mines <sup>7</sup> .....	Niehart, Montana 59465.....	do.....	Broadwater.

See footnotes at end of table.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Metals—Continued</b>			
<b>Silver—Continued</b>			
Pacific Mines, Inc. <sup>4</sup> .....	Virginia City, Montana 59755	Mine	Madison.
Tierra Explorations, Inc. <sup>4</sup> .....	2003 Wilco Bldg. Midland, Texas 79701	do.	Mineral.
Dick Tunstall <sup>6</sup> .....	Phillipsburg, Montana 59858	do.	Deer Lodge, Granite.
Albert Walkup <sup>6</sup> .....	do.	do.	Granite.
James W. Young <sup>8</sup> .....	do.	do.	Do.
<b>Tungsten:</b>			
Minerals Engineering Co....	Glen, Montana 59732	Mine and mill	Beaverhead.
<b>Nonmetals:</b>			
<b>Cement:</b>			
Ideal Cement Co.....	420 Ideal Cement Bldg. Denver, Colorado 80202	Plant	Gallatin.
Kaiser Cement & Gypsum Corp.	Permanente Road Permanente, California 95014	do.	Jefferson.
<b>Clays:</b>			
Hallett Minerals Co.....	P.O. Box 491 Forsyth, Montana 59327	Pit	Rosebud, Treasure.
Ideal Cement Co.....	420 Ideal Cement Bldg. Denver, Colorado 80202	Pit and plant	Gallatin.
Kanta Products, Inc.....	P.O. Box 96 Three Forks, Montana 59752	do.	Do.
Kaiser Cement & Gypsum Corp.	Permanente Road Permanente, California 95014	do.	Jefferson.
Lewistown Brick & Tile Co....	P.O. Box 573 Lewistown, Montana 59457	do.	Fergus.
Lovell Clay Products Co....	1312 Lockwood Road Billings, Montana 59101	do.	Yellowstone.
Baroid Division (NL) Industries.	P.O. Box 1675 Houston, Texas 77001	Pit	Carter.
Stauffer Chemical Co.....	P.O. Box 3146 Butte, Montana 59701	Pit and plant	Silver Bow.
Treasurelite, Division of Treasure State Industrial Products, Inc.	P.O. Box 2750 Great Falls, Montana 59401	do.	Cascade.
<b>Fluorspar:</b>			
Roberts Mining Co.....	P.O. Box 365 Darby, Montana 59829	Mine and plant	Ravalli.
<b>Gypsum:</b>			
United States Gypsum Co....	Lewistown, Montana 59457	Underground mine and calcining plant.	Fergus.
<b>Lime:</b>			
The Anaconda Company....	Butte, Montana 59701	Plant	Deer Lodge.
<b>Phosphate rock:</b>			
Cominco American, Inc.....	Garrison, Montana 59731	Mine and plant	Powell.
A. G. Jackson.....	Elliston, Montana 59728	Mine	Do.
Stauffer Chemical Co.....	299 Park Ave. New York, New York 10017	Plant	Silver Bow.
<b>Sand and gravel:</b>			
Billings Sand & Gravel.....	215 N. 16th St. Billings, Montana 59101	Pit and plant	Yellowstone.
McElroy & Wilken, Inc.....	Box 35 Kalispell, Montana 59901	do.	Flathead.
Midland Materials Co.....	Box 2521 Billings, Montana 59103	do.	Yellowstone.
Oscar J. Mortenson.....	Cascade, Montana 59421	do.	Cascade.
Pioneer Ready Mix.....	Box 818 Bozeman, Montana 59715	do.	Gallatin.
Richardson Constr. Co.....	Box 449 Miles City, Montana 59301	do.	Various.
<b>Stone:</b>			
The Anaconda Company....	Anaconda, Montana 59711	Quarry and plant	Deer Lodge.
Ideal Cement Co.....	420 Ideal Cement Bldg. Denver, Colorado 80202	do.	Gallatin.
Kaiser Cement & Gypsum Corp.	Permanente Road Permanente, California 95014	do.	Jefferson.
R. J. Studer & Sons.....	Billings, Montana 59101	do.	Blaine, Toole, Yellowstone.
Washington Constr. Co....	500 Taylor Missoula, Montana 59801	do.	Granite.
<b>Sulfur:</b>			
Farmer's Union Central Exchange, Inc.	P.O. Box 126 Laurel, Montana 59044	Plant	Yellowstone.
Montana Sulphur & Chemical Co.	P.O. Box 1084 Billings, Montana 59103	do.	Do.
<b>Sulfuric acid:</b>			
The Anaconda Company....	Anaconda, Montana 59711	do.	Deer Lodge.

See footnotes at end of table.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Nonmetals—Continued			
Talc and soapstone:			
Chas. Pfizer & Co., Inc. ....	Dillon, Montana 59725 .....	Plant .....	Beaverhead.
		Mine .....	Madison.
United Sierra Division of	Cameron, Montana 59720 .....	.....do.....	Do.
Cyprus Mines Corp.	Three Forks, Montana 59752 .....	Plant .....	Gallatin.
Vermiculite:			
W. R. Grace & Co. ....	62 Whittemore Ave. Cambridge, Massachusetts 01109	Pit and plant .....	Lincoln.
Exfoliated vermiculite:			
Robinson Insulation Co. ....	12th St. N. & River Drive Great Falls, Montana 59401	Plant .....	Cascade.
Mineral fuels:			
Coal:			
Divide Coal Mining Co. ....	P.O. Box 342 Roundup, Montana 59072	Mine .....	Musselshell.
Knife River Coal Mining Co.	Savage, Montana 59262 .....	.....do.....	Richland.
Nies Coal Co. ....	905 First St. W Roundup, Montana 59072	.....do.....	Musselshell.
Peabody Coal Co. ....	Box 235 St. Louis, Missouri 63166	.....do.....	Rosebud.
P & M Coal Mine .....	Goulding Creek Route Roundup, Montana 59072	.....do.....	Musselshell.
John H. Schoonover .....	P.O. Box 94 Ashland, Montana 59003	.....do.....	Powder River.
Square Deal Coal Co. ....	220 7th St. W Roundup, Montana 59072	.....do.....	Musselshell.
Western Energy Co. ....	40 E. Broadway Butte, Montana 59701	.....do.....	Rosebud.
Natural gas processing:			
Union Texas Petroleum Division, Allied Chemical Corp.	P.O. Box 2120 Houston, Texas 77001	Plant .....	Fallon.
Westco Refining Co. ....	Box 318 Cut Bank, Montana 59427	.....do.....	Glacier.
Peat:			
Martin's Peat & Potting Soils.	Swan Lake, Montana 59872 .....	Bog .....	Lake.
Petroleum Refining:			
Big West Oil Co. of Mon- tana.	Kevin, Montana 59454 .....	Refinery .....	Toole.
Continental Oil Co. ....	Billings, Montana 59101 .....	.....do.....	Yellowstone.
Diamond Asphalt Co. ....	Chinook, Montana 59523 .....	.....do.....	Blaine.
Farmer's Union Central Ex- change, Inc.	Laurel, Montana 59044 .....	.....do.....	Yellowstone.
Humble Oil & Refining Co. ....	Billings, Montana 59101 .....	.....do.....	Do.
Jet Fuel Refinery .....	Mosby, Montana 59053 .....	.....do.....	Garfield.
Phillips Petroleum Co. ....	Great Falls, Montana 59401 .....	.....do.....	Cascade.
Spruce Oil Corp. ....	Wolf Point, Montana 59201 .....	.....do.....	Roosevelt.
Westco Refining Co. ....	Box 318 Cut Bank, Montana 59427	.....do.....	Glacier.

<sup>1</sup> Also gold and silver.<sup>2</sup> Also copper, gold, and silver.<sup>3</sup> Also silver.<sup>4</sup> Also copper, gold, lead, and zinc.<sup>5</sup> Also copper, lead, and zinc.<sup>6</sup> Also copper and gold.<sup>7</sup> Also lead and zinc.





# The Mineral Industry of Nebraska

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Conservation & Survey Division of the University of Nebraska, (Nebraska Geological Survey) for collecting information on all minerals except fuels.

By Donald E. Eilertsen <sup>1</sup> and Raymond R. Burchett <sup>2</sup>

Outputs of nearly all minerals declined in 1970 compared with 1969; however, new discoveries of oil were made, an enormous high-grade gypsum deposit of great potential value was discovered, and two new nuclear reactors under construction will soon provide commercial electrical power for greater industrial expansion.

Nebraska's total mineral production, valued at \$72.66 million in 1970, was 6.9 percent less than that for 1969 and about 33 percent below the record of 1962. Output value of nonmetallic minerals consisting of clay, gem stones, lime, sand and gravel, stone, cement, and pumice decreased 11.7 percent from the record in 1969 to a value of \$35.00 million in 1970.

Outputs of natural gas, liquid petroleum gases, and petroleum were the lowest in 10 years, and the output of natural gasoline and cycle products ranked among the lowest in the decade.

**Employment and Injuries.**—In the mineral industries, 1,425 men worked 3,256,000 man-hours, compared with 1,441 men and 3,112,000 man-hours in 1969, an increase of 5 percent.

There were 49 lost-time injuries in the mineral industries, compared with 48 in 1969.

<sup>1</sup> Physical scientist, Division of Nonmetallic Minerals.

<sup>2</sup> Research geologist, Nebraska Geological Survey.

Table 1.—Mineral production in Nebraska <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays.....thousand short tons..	149	\$223	90	\$147
Gem stones.....do.....	NA	5	NA	5
Lime.....thousand short tons..	35	W	27	W
Natural gas (marketed).....million cubic feet..	6,989	1,209	5,991	1,024
Natural gas liquids:				
LP gases.....thousand 42-gallon barrels..	408	738	365	858
Natural gasoline and cycle products.....do.....	128	387	W	W
Petroleum (crude).....do.....	12,106	36,075	11,451	35,384
Sand and gravel.....thousand short tons..	12,758	13,592	12,232	12,974
Stone.....do.....	4,665	9,494	4,265	7,378
Value of items that cannot be disclosed: Cement, pumice, and values indicated by symbol W.....	XX	16,307	XX	14,887
Total.....	XX	78,030	XX	72,657
Total 1967 constant dollars.....	XX	73,684	XX	<sup>p</sup> 65,755

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

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

Table 2.—Value of mineral production in Nebraska, by counties <sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Adams.....	\$103	W	Sand and gravel.
Antelope.....	78	W	Do.
Banner.....	4,727	\$4,148	Petroleum, sand and gravel.
Blaine.....	7	--	
Boone.....	31	W	Sand and gravel.
Box Butte.....	10	--	
Boyd.....	23	W	Sand and gravel.
Brown.....	54	140	Do.
Buffalo.....	355	430	Do.
Butler.....	327	333	Do.
Cass.....	18,567	14,978	Cement, stone, sand and gravel.
Cedar.....	W	W	Sand and gravel.
Chase.....	12	10	Do.
Cherry.....	12	W	Do.
Cheyenne.....	7,052	W	Petroleum, sand and gravel.
Clay.....	W	W	Sand and gravel.
Colfax.....	80	170	Do.
Cuming.....	560	476	Do.
Custer.....	54	63	Do.
Dakota.....	W	W	Do.
Dawson.....	342	384	Do.
Deuel.....	W	W	Do.
Dixon.....	W	W	Sand and gravel, stone.
Dodge.....	559	637	Sand and gravel.
Douglas.....	2,349	W	Sand and gravel, clays, stone.
Dundy.....	12	7	Petroleum, sand and gravel.
Fillmore.....	56	22	Sand and gravel.
Franklin.....	64	W	Do.
Frontier.....	229	242	Petroleum.
Furnas.....	W	W	Sand and gravel, petroleum.
Gage.....	422	W	Sand and gravel, stone.
Garden.....	52	W	Petroleum, sand and gravel.
Garfield.....	W	--	
Hall.....	934	247	Sand and gravel.
Hamilton.....	W	49	Do.
Harlan.....	W	W	Petroleum, sand and gravel.
Hayes.....	W	W	Sand and gravel.
Hitchcock.....	689	608	Petroleum, sand and gravel.
Holt.....	173	241	Sand and gravel.
Hooker.....	3	W	Do.
Howard.....	44	W	Do.
Jefferson.....	W	W	Sand and gravel, clays.
Johnson.....	3	W	Stone, sand and gravel.
Kearney.....	18	25	Sand and gravel.
Keith.....	70	71	Do.
Keya Paha.....	6	1	Do.
Kimball.....	8,974	7,474	Petroleum, sand and gravel.
Knox.....	113	139	Sand and gravel.
Lancaster.....	274	250	Stone, clays, sand and gravel.
Lincoln.....	98	W	Sand and gravel, petroleum, pumice.
Loup.....	16	W	Sand and gravel.
McPherson.....	--	W	Do.
Madison.....	553	445	Do.
Merrick.....	W	W	Do.
Morrill.....	2,052	W	Petroleum, sand and gravel, lime.
Nance.....	W	W	Sand and gravel.
Nemaha.....	W	W	Stone.
Nuckolls.....	W	W	Cement, sand and gravel, stone.
Otoe.....	188	W	Clays.
Pawnee.....	195	W	Stone.
Perkins.....	7	14	Sand and gravel.
Phelps.....	W	W	Do.
Pierce.....	W	43	Do.
Platte.....	971	W	Do.
Polk.....	W	77	Do.
Red Willow.....	12,801	13,396	Petroleum, sand and gravel.
Richardson.....	304	W	Petroleum, stone.
Rock.....	7	1	Sand and gravel.
Saline.....	W	W	Do.
Sarpy.....	W	W	Sand and gravel, stone.
Saunders.....	1,621	W	Do.
Scotts Bluff.....	2,597	W	Petroleum, lime, sand and gravel.
Seward.....	W	W	Stone.
Sherman.....	--	21	Sand and gravel.
Sioux.....	30	--	
Stanton.....	W	W	Sand and gravel.
Thayer.....	W	195	Do.
Thomas.....	W	W	Do.
Thurston.....	--	W	Stone.
Valley.....	W	W	Sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Nebraska, by counties <sup>1</sup>—Continued

(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Washington.....	W	W	Stone, sand and gravel.
Webster.....	\$105	\$65	Sand and gravel.
Wheeler.....	W	W	Do.
York.....	166	126	Do.
Undistributed <sup>2</sup> .....	8,885	27,128	
<b>Total <sup>3</sup>.....</b>	<b>78,030</b>	<b>72,657</b>	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."  
<sup>1</sup> The following counties are not listed because no production was reported: Arthur, Burt, Dawes, Gosper, Grant, Greeley, Logan, Sheridan and Wayne.  
<sup>2</sup> Includes gem stones, some sand and gravel, natural gas, and natural gas liquids that cannot be assigned to specific counties.  
<sup>3</sup> Data may not add to totals shown because of independent rounding.

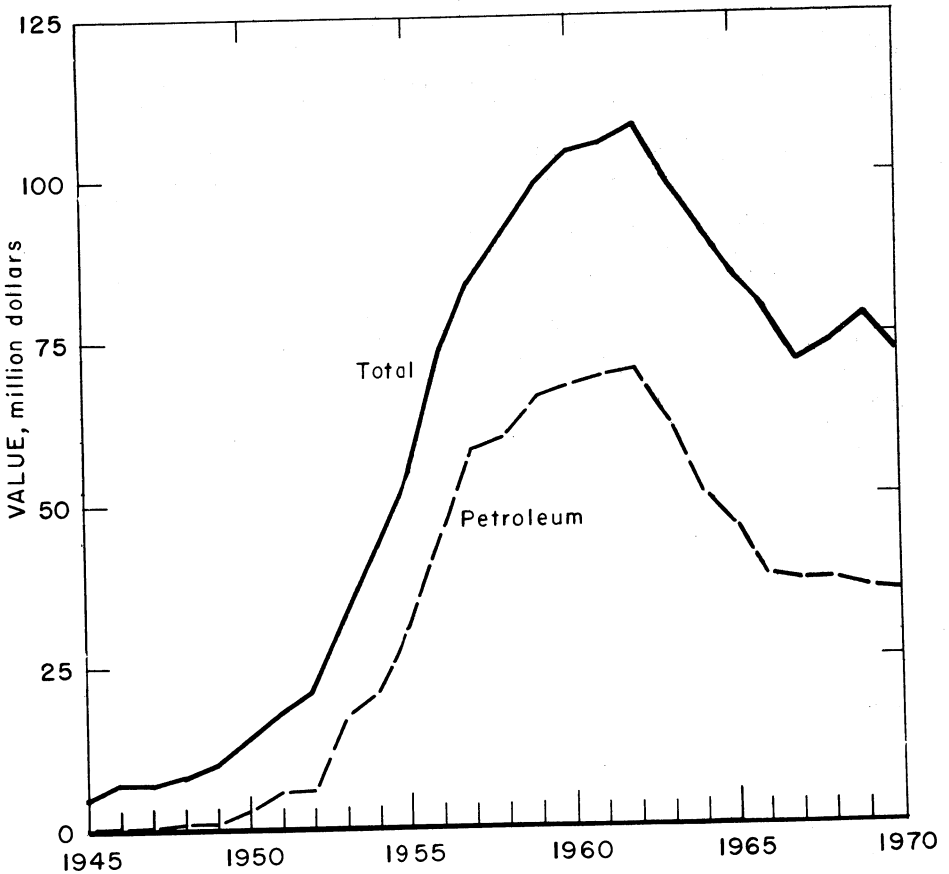


Figure 1.—Value of petroleum and total value of mineral production in Nebraska.

Table 3.—Indicators of Nebraska business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total labor force.....	658.2	671.2	+2.0
Unemployment.....	14.6	18.8	+28.8
Employment.....	643.6	652.4	+1.4
Mining.....	1.7	1.6	-5.9
Construction.....	25.2	24.8	-1.6
Manufacturing.....	86.7	85.2	-1.7
Government.....	97.3	101.2	+4.0
Other nonagricultural employment <sup>1</sup> .....	261.0	268.5	+2.9
<b>Personal income:</b>			
Total.....	\$5,230	\$5,498	+5.1
Per capita.....	\$3,548	\$3,700	+4.3
<b>Construction activity:</b>			
Value of nonresidential construction.....	\$67.7	\$63.1	-6.8
Number of authorized new housing units.....	7,418	7,726	+4.2
Highway construction contracts awarded.....	\$59.0	\$60.7	+2.9
Cement shipments to and within the State thousand 376-pound barrels.....	4,554.6	4,437.0	-2.6
Farm marketing receipts.....	\$1,933.3	\$1,987.1	+2.8
Mineral production.....	\$78.0	\$72.7	-6.8

<sup>1</sup> Includes services, wholesale and retail trade, finance, insurance, real estate, and transportation and public utilities.

Sources: Area Trends in Employment and Unemployment, Survey of Current Business, Employment and Earnings, Construction Review, Farm Income Situation, Streets and Roads, and U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Nonmetal.....	15	205	3	25	--	1	39.46	592
Sand and gravel.....	925	213	197	1,829	--	26	14.21	3,733
Stone.....	501	295	148	1,257	--	21	16.70	309
Total <sup>1</sup> .....	1,441	241	348	3,112	--	48	15.42	2,353
<b>1970:<sup>p</sup></b>								
Nonmetal.....	15	207	3	23	--	--	--	--
Sand and gravel.....	845	230	194	1,823	--	18	9.88	204
Stone.....	570	239	165	1,411	--	31	21.98	340
Total <sup>1</sup> .....	1,425	253	361	3,256	--	49	15.05	262

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Cement.**—Ash Grove Cement Co., near Louisville in Cass County, and Ideal Cement Co., near Superior in Nuckolls County, produced portland and masonry cement. Output decreased 8 percent.

Apparent cement consumption in Nebraska was 4,511,000 barrels.

**Clays.**—Four firms produced common clay in 1970. Clay output declined sharply to 90,500 tons, valued at \$147,000; the tonnage was the smallest since 1951, and the value was the lowest since 1967. Endicott Clay Products Co., near Endicott in Jefferson County, produced clay to make build-

ing brick. Omaha Brick Works, near Ralston in Douglas County, and Yankee Hill Brick Manufacturing Co., near Lincoln in Lancaster County, also produced clay to make building brick. Western Brick & Aggregate Co., near Nebraska City in Otoe County, produced clay and made building brick and lightweight aggregate.

**Fertilizer Materials.**—Fertilizer consumption in Nebraska during crop year 1970, which ended June 30, 1970, totaled 1.24 million tons compared with 1.08 million tons in crop year 1969.<sup>3</sup> Nitrogen is the

<sup>3</sup> U.S. Department of Agriculture. Commercial Fertilizers—Consumption in the United States, Fiscal Year Ended June 30, 1970, No. SpCr 7 May 1971, 26 pp.

only one of the three principal fertilizer materials that is produced in the State; phosphorus and potassium source materials are obtained elsewhere. According to the Bureau of the Census, anhydrous ammonia output in Nebraska totaled 542,866 tons in 1969, compared with 566,983 tons in 1968. Anhydrous ammonia was produced by Allied Chemical Corp., Omaha; Farmland Industries, Inc., Hastings; Fel-Tex, Inc., Fremont; and Phillips Petroleum Co., Beatrice.<sup>4</sup>

Deliveries of domestic and imported potash salts into Nebraska in 1970 totaled 33,502 tons of  $K_2O$  equivalent for agricultural purposes (25th in national ranking on deliveries), and 376 tons of  $K_2O$  equivalent for chemical purposes (29th in national ranking on deliveries). Of the agricultural potash, 8.1 percent was in the form of standard potassium muriate, 32.5 percent was coarse muriate, 35.4 percent was granular muriate, 13.1 percent was soluble muriate, and 10.9 percent was potassium sulfates. The industrial potash was mostly potassium muriate.<sup>5</sup>

**Gypsum.**—The first discovery of gypsum in Nebraska was reported. The deposit, located west of Auburn in Nemaha County, is high-purity, about 10 feet thick, ranges in depth to 350 feet below surface, and extends over an area of 118 square miles. The discovery was made by Conservation & Survey Division geologists in cooperation with the U.S. Geological Survey while drilling test holes for ground water as part of a State-wide program of ground-water exploration.

**Lime.**—Great Western Sugar Co. processed limestone from its Wyoming quarry to make lime in plants near Bayard in Morrill County, and near Gering, Mitchell, and Scottsbluff in Scotts Bluff County. The lime was used in refining beet sugar. Output of lime, totaling 26,841 tons, was 24 percent less than in 1969. The reduction was caused by a drop in beet-sugar output resulting from crop losses owing to adverse weather during crop year 1970.

Apparent lime consumption in Nebraska was 43,000 tons.

**Perlite.**—W. R. Grace & Co., Zonolite Division, produced expanded perlite near Omaha from out-of-State crude perlite. The quantity of expanded perlite sold or used in 1970 was larger than that in 1969;

uses included applications in horticulture, plaster, and concrete.

**Pumice.**—LaRue Axtell Pumice Co. produced pumice in its LeMaster strip mine near Arnold in Lincoln County. The material was used in cleaning and scouring compounds, and hand soaps. Output data on pumice are withheld to avoid disclosing company confidential information.

**Sand and Gravel.**—Nebraska produced 4.1 percent less sand and gravel in 1970 than in 1969. Domestically, Nebraska ranked 30th in the output of these materials in 1970 and accounted for 1.30 percent of the national output, compared with the rank of 24th largest producer in 1969 accounting for 1.36 percent of the national output. The average value of sand and gravel in 1970 was \$1.061 per ton compared with \$1.065 (revised) in 1969.

Leading producers were Lyman-Richey Sand & Gravel Corp. in Cass, Dodge, Douglas, Morrill, Platte, Sarpy, and Saunders Counties; Hartford Sand & Gravel Co. in Douglas County; Central Sand & Gravel Co. in Butler, Madison, and Platte Counties; Western Sand & Gravel Co. in Cass and Saunders Counties; and Luther Sand & Gravel Co. in Buffalo County. These five companies accounted for 36 percent of the output of sand and gravel.

Of the total output, 12 percent was produced by 102 plants, each producing less than 25,000 tons; 20 percent by 65 plants, each producing between 25,000 and 50,000 tons; 20 percent by 33 plants, each producing between 50,000 and 100,000 tons; and 48 percent by 27 plants, each producing more than 100,000 tons.

**Stone.**—Limestone is the only stone produced in Nebraska. Dimension and crushed and broken limestone was produced at 29 operations in 14 of the State's 93 counties. Output of limestone (sold or used) was 8.6 percent less than in 1969, the lowest since 1965. The average value of limestone was \$1.73 per ton compared with \$2.04 in 1969 and \$1.68 in 1968. The largest uses, in descending order, were surface treatment, cement, riprap, concrete aggregate, and road base. Nebraska ranked 35th among the States in stone output in 1970 and accounted for 0.49 percent of the

<sup>4</sup> Farm Chemicals, 1970 Handbook, Meister Publishing Co., Willoughby, Ohio, 496 pp.

<sup>5</sup> Potash Institute of North America, Atlanta, Ga. Deliveries of Potash Salts, Calendar Year and Fourth Quarter 1970. Press Release E-208, Feb. 16, 1971, 12 pp.

Table 5.—Nebraska: Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Adams.....	2	93	\$103	2	W	W
Antelope.....	3	93	78	4	93	W
Banner.....	1	--	--	1	46	\$23
Blaine.....	1	5	7	--	--	--
Boone.....	2	36	31	1	W	W
Box Butte.....	1	10	10	--	--	--
Boyd.....	2	23	23	2	W	W
Brown.....	7	55	54	6	72	140
Buffalo.....	12	437	355	11	737	430
Butler.....	4	284	327	4	286	333
Cass.....	4	328	291	3	W	W
Chase.....	1	33	12	1	20	10
Cherry.....	1	11	12	1	W	W
Cheyenne.....	4	113	114	3	W	W
Colfax.....	4	88	80	4	141	170
Cuming.....	6	479	560	5	435	476
Custer.....	5	71	54	4	84	63
Dawson.....	9	454	342	11	468	384
Dixon.....	1	18	20	1	W	W
Dodge.....	8	623	559	10	473	637
Douglas.....	10	1,884	2,334	10	1,903	2,503
Dundy.....	--	--	--	1	3	3
Fillmore.....	2	56	56	1	5	22
Franklin.....	4	81	64	3	W	W
Gage.....	8	179	279	6	W	W
Garden.....	2	42	19	2	W	W
Hall.....	10	911	934	8	298	247
Hamilton.....	3	W	W	1	49	49
Hitchcock.....	3	30	33	4	29	32
Holt.....	9	178	173	8	273	241
Hooker.....	1	4	3	1	W	W
Howard.....	6	73	44	4	W	W
Jefferson.....	9	290	304	8	253	301
Johnson.....	1	2	3	1	4	12
Kearney.....	1	50	18	1	50	25
Keith.....	6	121	70	4	100	71
Keya Paha.....	1	11	6	1	4	1
Kimball.....	1	17	12	2	83	17
Knox.....	6	112	113	10	142	139
Lincoln.....	7	117	90	7	W	113
Loup.....	2	17	16	2	W	W
Madison.....	7	390	553	8	395	445
Morrill.....	3	191	198	2	W	W
Perkins.....	1	28	7	2	73	14
Phelps.....	2	110	W	2	143	W
Pierce.....	2	W	W	1	38	43
Platte.....	6	663	971	6	639	W
Polk.....	2	W	W	4	65	77
Red Willow.....	4	109	103	5	105	90
Rock.....	1	9	7	1	1	1
Saline.....	6	106	133	4	W	W
Sarpy.....	9	636	509	9	558	510
Saunders.....	9	995	1,382	9	1,048	1,015
Scotts Bluff.....	6	296	229	6	241	236
Sherman.....	--	--	--	3	10	21
Sioux.....	1	30	30	--	--	--
Thayer.....	5	124	143	6	139	195
Washington.....	3	52	78	1	8	34
Webster.....	4	119	105	4	W	65
York.....	5	152	166	4	109	126
Undistributed <sup>1</sup> .....	38	1,316	1,377	37	2,555	3,658
Total <sup>2</sup> .....	283	12,758	13,592	273	12,232	12,974

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."  
<sup>1</sup> Includes Cedar, Clay, Dakota, Deuel, Furnas, Garfield (1969), Harlan, Hayes, Lancaster, McPherson (1970), Nance, Nuckolls, Pawnee (1969), Richardson (1969), Stanton, Thomas, Valley, and Wheeler Counties, and some sand and gravel that cannot be assigned to specific counties.

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

**Table 6.—Nebraska: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building .....	2,387	\$2,315	2,591	\$2,709
Fill .....	695	680	699	608
Paving .....	1,211	1,219	1,477	1,658
Railroad ballast .....	--	--	2	2
Other uses <sup>1</sup> .....	2	2	17	17
Total <sup>2</sup> .....	4,235	4,215	4,787	4,994
Gravel:				
Building .....	1,519	1,843	825	864
Fill .....	60	34	298	160
Paving .....	5,972	6,676	5,055	5,758
Railroad ballast .....	16	21	--	--
Miscellaneous .....	160	151	209	175
Other uses .....	--	--	127	113
Total <sup>2</sup> .....	7,728	8,725	6,514	7,071
<b>Government-and-contractor operations:</b>				
Sand:				
Building .....	2	3	--	--
Fill .....	14	7	11	5
Paving .....	35	35	96	181
Total <sup>2</sup> .....	51	46	107	187
Gravel:				
Building .....	10	37	29	44
Fill .....	4	2	38	25
Paving .....	732	567	748	630
Other uses .....	--	--	9	25
Total <sup>2</sup> .....	745	606	824	722
Total sand and gravel .....	12,758	13,592	12,232	12,974

<sup>1</sup> Includes blast sand (1970).

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

**Table 7.—Nebraska: Limestone sold or used by producers, by uses**

(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Dimension stone total .....	3	\$16	( <sup>1</sup> )	\$3
<b>Crushed and broken stone:</b>				
Dense graded road base stone .....	383	657	341	632
Macadam aggregate .....	--	--	52	101
Unspecified aggregate and roadstone .....	8	18	17	29
Agricultural limestone .....	222	391	216	401
Riprap .....	977	1,413	757	1,172
Other uses <sup>2</sup> .....	3,073	6,999	2,881	5,039
Crushed total <sup>3</sup> .....	4,663	9,478	4,264	7,375
Grand total <sup>3</sup> .....	4,665	9,494	4,265	7,378

<sup>1</sup> Less than ½ unit.

<sup>2</sup> Includes stone used in asphalt filler, bituminous, concrete, and surface treatment aggregates, cement, poultry grit, and whitening.

<sup>3</sup> Data may not add to totals shown because of independent rounding.



national output compared with ranking 34th and producing 0.54 percent of the national total in 1969.

Leading producers were Hopper Bros. Quarries, Ash Grove Cement Co., Fort Calhoun Stone Co., and Kerford Limestone Co., which together accounted for 73 percent of the stone output.

**Talc.**—The United Sierra Division of Cyprus Mines Corp., produced ground talc at its plant near Grand Island. The talc came from company mines in Montana and California and from a firm in California. The total quantity of ground talc sold or used was almost 28 percent larger than that in 1969; the material was prepared for export and for use in making paper, ceramics, paint, textiles, rubber, and toilet powders.

**Vermiculite.**—W. R. Grace & Co., Zonolite Division, produced exfoliated vermiculite near Omaha from out-of-State crude vermiculite. The quantity of expanded vermiculite sold was about 4 percent less than that in 1969. The material was used in loose-fill insulation, aggregates for concrete, horticulture, and plaster, and for fire base.

#### MINERAL FUELS

The Nebraska Oil and Gas Commission issued 245 permits for drilling for oil and gas in 1970. Of these permits, 158 were for exploration in 19 counties, principally in Kimball (38), Cheyenne (30), and Morrill (25); 84 were for development in nine counties, mostly in Kimball (28) and Cheyenne (22); and three were for drilling at facilities. Approximately 20 percent of Nebraska's total land area was under lease for oil and gas at yearend. Drilling data on oil and gas well exploration and development completions are shown in table 8.

**Natural Gas.**—A total of 6.31 billion cubic feet of natural gas was produced in 1970, consisting of 3.99 billion cubic feet of dry gas, principally methane and ethane, and 2.32 billion cubic feet of casinghead gas, rich in petroleum condensate. Of the total natural gas output, 5.99 billion cubic feet was sold and 0.32 billion cubic feet was used in repressuring.

At yearend, 35 dry-gas wells were in production and five others were shut-in. Also at yearend, the proven reserves of natural gas were reported at 58.17 billion cubic feet, of which 41 percent was dry gas, 32

percent casinghead gas, and 27 percent was in underground storage. Proved reserves of natural gas increased 2.8 percent over that for yearend 1969.<sup>6</sup>

**Natural Gas Liquids.**—Production of liquid petroleum (LP) gases has declined steadily since 1968. The drop in output since 1969 was 10.5 percent. The average value of \$2.35 per barrel of LP gases in 1970 was one of the highest.

Output of natural gasoline and cycle products was one of the lowest ever reported. The value was withheld from publication to avoid disclosure of company confidential data.

Yearend proved reserves of natural gas liquids in Nebraska totaled 1.86 million barrels in 1970, compared with 2.27 million barrels at yearend 1969.<sup>7</sup>

**Petroleum.**—Output of crude petroleum decreased 5.4 percent in quantity, but increased 1.9 percent in value compared with 1969. Prices averaged \$3.09 per barrel in 1970, compared with \$2.98 per barrel in 1969. At yearend, 1,244 wells were in production and 646 other wells were shut-in.

At yearend the reserves of crude oil in Nebraska totaled 40.94 million barrels, compared with 46.84 million barrels at the end of 1969.<sup>8</sup> Data on crude oil production by county are shown in table 9, and from the 25 largest fields, in table 10.

Sundance Oil Co. and Braden-Gear Drilling Co. discovered oil in their one State Dunlap well in Morrill County early in 1970. The hole initially yielded 529 barrels of oil per day from the "D" Dakota Cretaceous Sand at the depth of 3,900 to 3,911 feet.<sup>9</sup>

Petroleum Inc., made a new discovery of oil in the Nebraska portion of the Denver basin in Kimball County. The firm's one Petsch well initially yielded 128 barrels of oil and an equal quantity of water daily from the "D" Dakota Cretaceous Sand at the depth of 6,568 to 6,569 feet. The discovery will add production to the field, which already produced over 251,000 barrels of oil and 184 million cubic feet of gas from the "J" Dakota Sand since 1958.

<sup>6</sup> American Gas Association, Inc., American Petroleum Institute, and Canadian Petroleum Association. Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States and Canada and United States Productive Capacity as of December 31, 1970. V. 25, May 1971, 256 pp.

<sup>7</sup> Work cited in footnote 6.

<sup>8</sup> Work cited in footnote 6.

<sup>9</sup> Oil & Gas Journal. Nebraska Area Drilling Successful. V. 68, No. 13, Mar. 30, 1970, p. 163.

Table 8.—Nebraska: Oil and gas well drilling completions, by counties—1970

County	Oil	Gas	Dry	Total	Footage
Exploratory completions:					
Banner	--	--	15	15	88,746
Cheyenne	2	--	29	31	149,141
Dawes	--	--	5	5	14,333
Dawson	--	--	1	1	3,496
Deuel	--	--	2	2	7,741
Frontier	--	--	3	3	11,600
Furnas	--	--	3	3	10,843
Harlan	--	--	1	1	3,795
Hitchcock	--	--	2	2	8,420
Keith	--	--	1	1	4,582
Kimball	3	--	35	38	238,231
Morrill	3	--	22	25	110,819
Phelps	--	--	1	1	4,010
Red Willow	2	--	5	7	26,438
Richardson	--	--	1	1	2,527
Scotts Bluff	--	--	12	12	60,491
Sioux	--	--	13	13	49,975
Total	10	--	151	161	795,188
Development completions:					
Banner	2	--	3	5	31,694
Cheyenne	6	2	11	19	95,279
Frontier	--	--	1	1	3,995
Garden	--	--	2	2	6,850
Harlan	1	--	--	1	3,400
Hitchcock	--	--	1	1	4,275
Kimball	8	--	19	27	173,057
Morrill	3	--	4	7	28,760
Red Willow	4	--	1	5	17,492
Richardson	2	--	--	2	4,706
Scotts Bluff	3	--	3	6	28,514
Total	29	2	45	76	398,022
Total all drilling	39	2	196	237	1,193,210

Source: American Petroleum Institute.

Table 9.—Nebraska: Crude petroleum production by counties

(Thousand 42-gallon barrels)

County	1969	1970	Principal fields in 1970 in order of production
Banner	1,572	1,335	Singleton, Johnson, Harrisburg, Willson Ranch.
Cheyenne	1,906	1,811	Southwest Sidney, Graff, Southwest Potter, Doran, West Engelland.
Dundy	4	1	East Indian Creek, Rock Canyon.
Frontier	77	79	Bed Canyon. <sup>1</sup>
Furnas	4	6	Southwest Wilsonville.
Garden	11	9	Richards and McCord.
Harlan	24	27	South Alma.
Hitchcock	220	186	Reiher.
Kimball	2,776	2,414	Sloss, Enders, Bertramson, Axial, Houtby, Fernquist, Jacinto.
Lincoln	2	1	Red Willow Creek.
Morrill	568	551	Bridgeport.
Red Willow	4,261	4,306	Sleepy Hollow, Ackman, Silver Creek, Northwest Sleepy Hollow, Bed Canyon. <sup>1</sup>
Richardson	72	63	Dawson, Falls City, Barada.
Scotts Bluff	609	662	Cedar Valley and Minatare.
Total	12,106	11,451	

<sup>1</sup> Partly in Frontier and Red Willow Counties.

Source: Nebraska Oil and Gas Conservation Commission.

Currently, only one well is producing oil from the "J" sand and it produces 18 barrels of oil per day.<sup>10</sup>

**Nuclear Energy.**—Construction continued on the Nebraska Public Power District and Iowa Power and Light Co.'s \$127 million, 778-megawatt Cooper nuclear power station near Brownville, and on Omaha Public Power District's \$125 million, 457-megawatt Fort Calhoun power station near Fort Calhoun. The Cooper station, which is a boiling-water reactor, was scheduled for testing in 1971 and operation in 1972. The Fort Calhoun plant has a pressurized-water

reactor that is to be tested and operational in 1972.

#### METALS

No minerals were mined for metals in Nebraska. However, American Smelting and Refining Company at its Omaha refinery recovered antimony, bismuth, gold, lead, and silver from out-of-State lead bullion and other smelter products.

<sup>10</sup> Oil & Gas Journal. Nebraska's Denver Basin Has New Field. V. 68, No. 44, Nov. 2, 1970, p. 138.

**Table 10.—Nebraska: Crude oil production in the 25 largest fields in 1970**

(42-gallon barrels)

Field	County	Annual output	Average per day output
Sleepy Hollow	Red Willow	3,470,101	9,507
Cedar Valley	Scotts Bluff	392,812	1,076
Ackman	Red Willow	259,995	712
Silver Creek	do	253,960	696
Singleton	Banner	248,627	681
Bridgeport	Morrill	224,672	616
Sloss	Kimball	204,264	560
Enders	do	177,266	486
Southwest Sidney	Cheyenne	158,140	433
Reiher	Hitchcock	142,300	390
Johnson	Banner	134,599	369
Minatare	Scotts Bluff	128,527	352
Bertramson	Kimball	122,116	335
Northwest Sleepy Hollow	Red Willow	117,797	323
Graff	Cheyenne	108,285	297
Harrisburg	Banner	104,983	288
Axial	Kimball	102,568	281
Southwest Potter	Cheyenne	102,472	280
Houtby	Kimball	100,959	277
Bed Canyon	Frontier and Red Willow	90,140	247
Willson Ranch	Banner	86,785	238
Doran	Cheyenne	83,171	228
Fernquist	Kimball	79,416	218
West Engelland	Cheyenne	76,535	210
Jacinto	Kimball	74,891	205

Source: Nebraska Oil and Gas Conservation Commission.

Table 11.—Nebraska: Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Ash Grove Cement Co.-----	1000 Tenmain Center Kansas City, Mo. 64105	Wet process, 6-rotary kiln plant.	Cass.
Ideal Cement Co., a division of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	Wet process, 2-rotary kiln plant.	Nuckolls.
<b>Clays:</b>			
Endicott Clay Products Co..	Endicott, Nebr. 68350	Open pit mine and plant	Jefferson.
Western Brick & Aggregate Co.	Box 1141 Nebraska City, Nebr. 68410	do-----	Otoe.
Yankee Hill Brick Manufac- turing Co.	Route 1 Lincoln, Nebr. 68502	do-----	Lancaster.
<b>Lime:</b>			
The Great Western Sugar Co., a subsidiary of Great West- ern United Corp.	Box 5308 Denver, Colo. 80217	Pot kiln at beet-sugar plant. 5 pot kilns at beet- sugar plants.	Morrill. Scotts Bluff.
<b>Natural gas and petroleum</b> <sup>1</sup>			
<b>Pumice:</b> LaRue Axtell Pumice Co..	Callaway, Nebr. 68825	Open pit mine and plant	Lincoln.
<b>Sand and gravel (commercial):</b>			
Central Sand & Gravel Co....	Box 626 Columbus, Nebr. 68601	Dredging operation....	Butler.
Hank Stalp Gravel Co.-----	Box 6 West Point, Nebr. 68788	2 dredging operations..	Madison.
Hartford Sand & Gravel Co..	Box 571 Valley, Nebr. 68064	3 dredging operations..	Platte.
Lyman-Richey Sand & Gravel Corp.	4315 Cuming St. Omaha, Nebr. 68131	do-----	Cuming.
McCann Sand & Gravel Co..	Box 268 Lincoln, Nebr. 68501	2 dredging operations..	Douglas.
Overland Sand & Gravel Co..	Valley, Nebr. 68064 22 Main St. Stromberg, Nebr. 68666	Pit and plant.....	Cass.
Western Sand & Gravel Co..	Box 268 Lincoln, Nebr. 68501	2 pits and plants.....	Dodge.
		do-----	Douglas.
		Pit and plant.....	Morrill.
		do-----	Platte.
		2 pits and plants.....	Sarpy.
		Pit and plant.....	Saunders.
		2 dredging operations..	Douglas.
		4 dredging operations..	Merrick.
		Dredging operation....	Nance.
		do-----	Polk.
		do-----	Cass.
		3 dredging operations..	Saunders.
<b>Stone:</b>			
Ash Grove Cement Co.-----	1000 Tenmain Center Kansas City, Mo. 64105	Quarry and plant.....	Cass.
Fort Calhoun Stone Co.-----	1255 South St. Blair, Nebr. 68008	do-----	Thurston.
Hopper Bros. Quarries.....	Weeping Water, Nebr. 68463	do-----	Washington.
		3 quarries and plant...	Cass.
		Quarry and plant.....	Nemaha.
		do-----	Pawnee.
		do-----	Saunders.
		do-----	Cass.
Kerford Limestone Co.-----	Box 434 Weeping Water, Nebr. 68463	do-----	Do.
United Rock Construction, Inc.	1117 Woodman of the World Bldg. Omaha, Nebr. 68102		

<sup>1</sup> Most of the major oil and gas companies and many smaller companies operate in Nebraska, and several commercial directories contain complete lists of them.



# The Mineral Industry of Nevada

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

By V. Anthony Cammarota, Jr.<sup>1</sup>

The value of Nevada's mineral output reached an alltime high of \$186.3 million in 1970, and exceeded the 1969 record production of \$168.3 million by 11 percent. Of the 29 mineral commodities produced, 10 were metals and 18 were nonmetals; petroleum was the sole fuel commodity. Production value of metals as a group increased 15 percent, nonmetals declined slightly, and mineral fuels (petroleum) decreased 32 percent.

Copper production value was 23 percent greater than the 1969 record output, and accounted for 66 percent of the total value of the State's mineral production. Iron ore, tungsten, and antimony also showed increases in production, but lead, zinc, mercury, and molybdenum production was off sharply. Gold output was higher but the value was lower. The production of silver decreased.

In the nonmetals group brucite, clays, stone, and salt increased the most. Sand and gravel increased 1.5 percent. The largest declines in production were noted for barite, fluorspar, and talc.

The pace of mineral exploration activity in Nevada slowed during 1970. Exploration programs reported to the U.S. Bureau of Mines were primarily for copper, gold, silver, and molybdenum, with many of the operations centered in Lyon County. The 16 well-drilling permits issued by the Nevada Oil and Gas Conservation Commission increased crude oil exploration. Only two permits were issued in 1969.

**Consumption, Trade, and Markets.**—All of Nevada's requirements for mineral fuels and metals, and most of its nonmetal needs other than for construction materials, were supplied by out-of-State processors.

All of the talc and fluorspar, most of the barite and perlite, and some of the gypsum and limestone produced were shipped out-of-State in crude form. Most of the lime output went to consumers in California. All petroleum production, except for a small quantity refined in Nevada, was consigned to refineries in Utah and California. With few exceptions, metal ores, concentrates, and precipitates were processed in mills and smelters outside the State. The one smelter (copper) in the State, at McGill, White Pine County, was dependent on Nevada ores. Antimony and tungsten ores were processed at a new mill at Oreana, Pershing County. All usable iron ore was exported or shipped to steel plants in other States. The electrolytic manganese dioxide plant of American Potash & Chemical Corp., Clark County, operated on ore purchased from out-of-State producers, and the tungsten carbide plant of Nevada-Scheelite Division of Kennametal Inc., Churchill County, used concentrates purchased from various domestic and foreign producers.

**Trends and Developments.**—As a result of the influx of geologists and engineers interested in exploration and development of the State's ore deposits, an organization called Exploration Geologists of Nevada was formed in Reno. One of the prime considerations of the new organization is the urgent need to minimize disturbance of the surface and general damage to the environment during prospecting and exploration.

The Geothermal Steam Bill, which became law on December 24, 1970, was effective immediately and granted private

<sup>1</sup> Physical scientist, Division of Nonferrous Metals.

developers the right to develop geothermal energy from under public lands.

The Nevada Land Office reported that four major oil companies filed for oil and gas leases covering nearly 170,000 acres in Nye, White Pine, and Lincoln Counties.

Black Mesa Pipeline, Inc., a subsidiary of Southern Pacific Railroad, completed construction of a pipeline to transport powdered coal mixed with water from mines near Kayenta, Ariz., to an electric generating plant owned jointly by Southern California Edison Co. and Nevada Power Co., in Mohave, Nev.

The Anaconda Company completed the installation of a \$250,000 modern dust-collection and retention system in the ore-concentration plant at its Yerington mine, Lyon County. The system will provide effective in-plant control of dust with no visible effluent in the stacks.

Cliffs Copper Corp. and E. I. du Pont de Nemours & Co., Inc. agreed to participate in a joint venture to recover an estimated 25,000 tons of copper by leaching from an inactive mine near Mountain City, Elko County.

The Nevada Mines Division of Kennecott Copper Corp. installed additional haulage equipment in connection with the development of the New Ruth pit. As a result of successful feasibility tests on the Sunshine-Puritan waste dump, a leaching plant was built that became operational in late 1970.

The Anaconda Company, which has been drilling in the Liberty mining district near Tonopah, Nye County, for more than 10 years, added 3,161 acres of land to its holdings in the area through a U.S. Bureau of Land Management trade for property previously held in the Lake Mead National Recreational Area. An additional 370 acres was acquired by the company in the same area upon receipt of a patent for 18 lode claims.

Carlin Gold Mining Co. installed equipment for pretreating carbonaceous gold ore using the chlorine oxidation process. Carlin is believed to be the first in the world to attempt to recover gold from carbonaceous ore.

Goldfield Corp. and Comanche Exploration, a subsidiary of Cyprus Mines Corp., agreed to a joint exploration and development program of the Getchell gold mining property, 40 miles northeast of Winnemucca, Humboldt County.

General Electric Co. signed a contract to purchase tungsten concentrates from Tungsten Properties, Ltd., of Imlay. A plant to process tailings is being constructed, and plans were underway for mining and concentrating tungsten ore from the property at Tungsten.

Arizona-Colorado Land and Cattle Co. has entered into a limited partnership with Minbanco Corp. to explore and develop the Indian Springs tungsten deposit in Elko County.

The National Lead Co. built a small mill to process antimony ore at Oreana, Pershing County.

Mountain States Machinery and Supply Co. acquired an all-portable mill for use at its Battle Mountain antimony property. The mill has a reported capacity of 150 tons of ore per day. Because of its portability and ease of assembly, the mill is particularly suitable for small, short-term operations.

Silver King Mines, Inc., acquired 1,500 acres of silver-lead-zinc mining properties in the Tybo Mining District, Nye County. Some drilling and other exploration work, in conjunction with the rehabilitation of the Hales Shaft, was conducted jointly by Silver King Mines, Inc., and Pacific Silver Corp. of Hawaii.

Hecla Mining Co. continued the drilling program at the Ruby Hill lead-zinc-silver mine, Eureka County, to locate an extension of high-grade ore discovered in 1969.

A joint venture of Phillips Petroleum Co. and Silver King Mines, Inc., completed a drilling program begun in 1966 in the Ward Mountain Mining District, White Pine County. Ore reserves containing copper, lead, zinc, and silver within the drilled area are reported to be 11.5 million tons.

Ordrich Gold Reserves Co., Inc., and Copper Range Exploration Co. reached an agreement whereby Copper Range will conduct a 2-year drilling and exploration program at Round Mountain, Nye County, on the property of Nevada Porphyry Gold Mines, Inc., which Ordrich has under a lease-option agreement to purchase.

Titanium West, Inc., completed installation of a third melting furnace for production of 5,800-pound titanium ingots. This furnace increased plant capacity to 3,600 tons of ingot per year.

Mt. Wheeler Mines, Inc., and W. S. Moore Co. have started development and

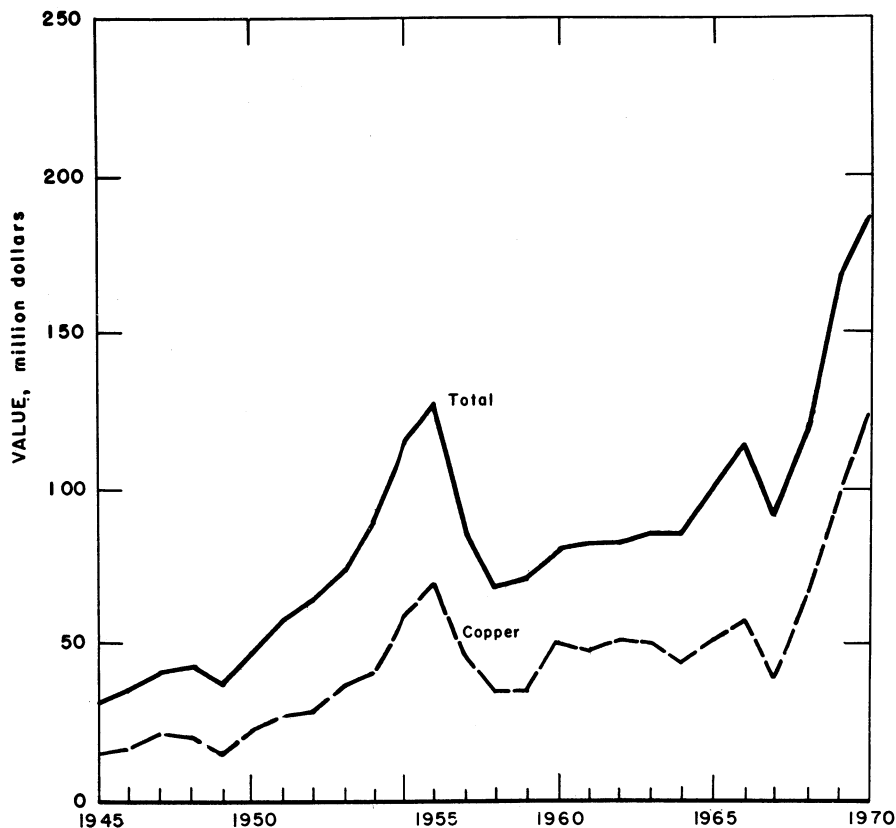


Figure 1.—Value of copper and total value of production in Nevada.

exploratory work in the Mount Washington mining district of the Snake Range, White Pine County. The property has long been recognized as a potential producer of beryllium, which occurs as phenacite and bertrandite. Supplementary values are present as scheelite and fluorite.

Fred H. Lenway & Co., Inc., ceased mercury mining at its Quinn River (Cordero) mine, Humboldt County, but continued to process ore from stockpile.

U.S. Steel Corp. continued its drilling program southeast of Yerington, Lyon County, to determine the economic feasibility of developing the extensive iron ore deposits in the Mason Valley area. Previous drilling located additional deep-lying deposits, which had a lower iron content, but had more promising indications of copper.

Basic Inc. announced that new heavy

media equipment will help extend the life of its magnesite reserves at Gabbs, Nye County, by increasing substantially the capacity to convert low-grade ores to usable grades. Expenditures have been authorized to provide an electrostatic dust-collection system, which will simultaneously reduce air pollution and recover raw materials.

**Legislation and Government Programs.**—Public land orders by the U.S. Bureau of Land Management withdrew 7,119 acres of land in Clark and Nye Counties from mineral location under U.S. mining laws. The State received U.S. Treasury checks totaling \$456,106.55 in bonuses, royalties, and rentals covering mineral leases and permits.

State Liaison Offices in 35 States have been established by the U.S. Bureau of Mines to achieve closer and more produc-



Table 1.—Mineral production in Nevada <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite (crude)..... thousand short tons..	320	\$2,275	192	\$1,455
Copper (recoverable content of ores, etc.)..... short tons..	104,924	99,749	106,688	123,118
Gem stones.....	NA	100	NA	100
Gold (recoverable content of ores, etc.)..... troy ounces..	456,294	18,941	480,144	17,472
Gypsum..... thousand short tons..	521	1,550	451	1,457
Iron ore (usable)..... thousand long tons, gross weight..	W	W	575	W
Lead (recoverable content of ores, etc.)..... short tons..	1,420	423	364	114
Mercury..... 76-pound flasks..	8,165	4,124	4,916	2,005
Perlite..... short tons..	8,998	77	8,470	73
Petroleum (crude)..... thousand 42-gallon barrels..	223	W	149	W
Pumice, pumicite, and volcanic cinder..... thousand short tons..	83	188	80	191
Sand and gravel..... do.....	8,447	10,834	8,574	9,819
Silver (recoverable content of ores, etc.)..... thousand troy ounces..	884	1,583	718	1,271
Stone..... thousand short tons..	1,494	2,433	1,860	2,722
Talc and soapstone..... short tons..	6,434	81	W	W
Tungsten concentrate..... short tons, 60 percent WO <sub>3</sub> basis..	34	69	122	306
Zinc (recoverable content of ores, etc.)..... short tons..	941	275	127	39
Value of items that cannot be disclosed: Antimony, brucite, cement, clays, diatomite, fluorspar, lime, lithium minerals, magnesite, molybdenum concentrates (content), pyrites, salt, and values indicated by symbol W.....	XX	25,593	XX	26,207
Total.....	XX	168,295	XX	186,349
Total 1967 constant dollars.....	XX	158,922	XX	168,646

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

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

Table 2.—Value of mineral production in Nevada, by counties

(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Churchill.....	\$101	\$113	Tungsten, salt, antimony, sand and gravel.
Clark.....	13,054	13,443	Sand and gravel, lime, stone, gypsum, clays.
Douglas.....	W	W	Iron ore, sand and gravel, stone.
Elko.....	2,792	584	Sand and gravel, barite, copper, lead, silver, tungsten, zinc, antimony, stone, gold.
Esmeralda.....	3,307	2,982	Lithium, diatomite, mercury, sand and gravel, talc and soapstone, clays.
Eureka.....	9,819	8,285	Gold, iron ore, sand and gravel, antimony, lead, silver, mercury, stone, copper, zinc.
Humboldt.....	3,005	W	Mercury, sand and gravel, silver, lead, zinc, copper, gold, antimony, tungsten.
Lander.....	21,683	25,853	Copper, gold, barite, silver, mercury, antimony, sand and gravel, lead, zinc.
Lincoln.....	697	334	Fluorspar, perlite, pyrites, copper, sand and gravel, silver, stone, lead, pumicite, zinc, gold.
Lyon.....	53,054	56,813	Copper, cement, stone, sand and gravel, diatomite, silver, gold, clays.
Mineral.....	960	36	Barite, sand and gravel, mercury, silver, lead, stone, zinc, copper, gold.
Nye.....	3,128	2,515	Magnesite, petroleum, fluorspar, brucite, sand and gravel, pumice, clays, lead, silver, stone, zinc, copper, mercury, gold.
Ormsby.....	139	W	Volcanic cinder, sand and gravel, stone.
Pershing.....	5,246	16,454	Copper, diatomite, gypsum, mercury, tungsten, iron ore, gold, silver, sand and gravel, antimony, perlite, clays, lead, zinc.
Storey.....	W	W	Diatomite, pumice.
Washoe.....	2,533	3,193	Sand and gravel, stone, clays, pumicite, gold, silver.
White Pine.....	44,224	49,283	Copper, gold, molybdenum, lime, silver, stone, lead, sand and gravel, zinc.
Undistributed <sup>1</sup> .....	4,553	6,461	
Total.....	168,295	186,349	

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

<sup>1</sup> Includes gem stones, gold, lead, mercury, silver, tungsten, and zinc that cannot be assigned to specific counties and values indicated by symbol W.

Table 3.—Indicators of Nevada business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total labor force..... thousands..	229.2	241.0	+5.1
Employed..... do.....	219.3	227.9	+3.9
Unemployed..... do.....	9.9	13.1	+32.3
<b>Employment:</b>			
Mining..... do.....	4.0	4.1	+2.5
Contract construction..... do.....	11.6	11.8	+1.7
Manufacturing..... do.....	8.0	8.3	+3.8
Government..... do.....	35.8	37.2	+3.9
Other <sup>1</sup> ..... do.....	134.1	139.7	+4.2
<b>Personal income:</b>			
Total..... millions..	\$2,037	\$2,258	+10.8
Per capita..... do.....	\$4,244	\$4,544	+7.1
<b>Construction activity:</b>			
Valuation of private authorized nonresidential construction.. millions..	\$61.9	\$80.6	+30.2
Total authorized residential units.....	5,185	9,062	+74.8
Cement shipments to and within Nevada thousand 376-pound barrels..	1,683	1,600	-4.9
Farm marketing receipts..... millions..	\$76.2	\$80.5	+5.6
Mineral production..... do.....	\$168.3	\$186.3	+10.7

<sup>1</sup> Includes transportation, utilities, trade (wholesale and retail), finance, insurance, real estate, and services. Sources: Construction Review, Survey of Current Business, Farm Income Situation, Area Trends in Employment and Unemployment, Employment and Earnings, and U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Metal.....	2,127	310	660	5,298	4	115	22.46	5.135
Nonmetal.....	740	254	188	1,526	1	49	32.76	5.024
Sand and gravel.....	620	183	113	907	--	22	24.26	1,045
Stone.....	198	280	55	453	--	7	15.46	660
Total <sup>1</sup> .....	3,685	276	1,017	8,184	5	193	24.19	4,413
<b>1970:<sup>p</sup></b>								
Metal.....	1,915	304	582	4,694	4	78	17.47	5,950
Nonmetal.....	735	250	184	1,484	--	50	33.70	2,355
Sand and gravel.....	655	213	140	1,174	--	16	13.63	588
Stone.....	225	278	63	509	--	13	25.55	1,189
Total <sup>1</sup> .....	3,530	274	968	7,860	4	157	20.48	4,162

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

tive relationships between State and Federal Governments in matters of mineral supply. The Nevada office is located in Reno.

The Bureau of Mines continued to provide consulting service to the Atomic Energy Commission (AEC) on preshot and postshot structural surveys of mines, tunnels, and surface installations in connection with underground nuclear tests on and adjacent to AEC's Nevada Test Site.

Approximately 60,000 acres of National Forest land in the Mount Moriah area in White Pine County were closed to all tracked vehicles and earthmoving equipment June 9. Miners who have claims in the area have been given a deferment of

the September 1 deadline for assessment work in the area. The closure is to permit studies to plot access roads that will not upset the area's ecology.

The Bureau of Mines San Francisco Office of Mineral Resources concluded work initiated in 1968 to provide forecasts for the mineral industry in the Great Basin hydrologic region for an interagency Type I Comprehensive Framework Study. The Great Basin Region includes nearly all of Nevada, and parts of Idaho, Utah, and Wyoming.

The Heavy Metals Program was terminated in June. The most significant accomplishment was the development of the process for extracting gold from carbonaceous ores.

The Region II Field Office, Office of Minerals Exploration (OME), U.S. Geological Survey, received no new applications from persons interested in exploring for minerals in Nevada under the OME program.

At the Bureau of Mines Reno Metallurgy Research Center, research and cooperative pilot-plant studies with Newmont Mining Corp. on the electro-oxidation method culminated in putting into operation, by the Carlin Gold Mining Co., a 500-ton-per-day plant for pretreating carbonaceous gold ores, using the chlorine oxidation option of the process. Continued research has successfully adapted this process to the recovery of mercury from low-grade cinnabar ores, molybdenum and rhenium from molybdenite flotation concentrates and tails, and silver from selected low-grade ores and tailings.

The ferric chloride leach method developed for the recovery of copper from chalcopyrite cleaner concentrate was adapted to treat the rougher concentrate. Copper was extracted by a ferric chloride leach as in treating the cleaner concentrate. Recovery of molybdenum from the rougher concentrate required calcining the leach residue, leaching with hydrochloric acid, and adsorbing molybdenum on activated

carbon. Recovery of molybdenum from the rougher concentrate by this method was 87 percent compared with about 50 percent by the conventional flotation procedure.

The optimum as-melted composition of samarium-cobalt alloy for magnet fabrication was determined to be 37.4 weight-percent samarium. These magnets are markedly superior to the platinum-cobalt magnets.

Molten-salt electrorefining was investigated at the Bureau of Mines Boulder City Metallurgy Research Laboratory for recovering metal values from municipal incinerator residues and obsolete electronic equipment. Aluminum was recovered as a cathode product from both. The anode residue from treating the electronic scrap was melted to give a copper bullion containing silver and gold. The silver, gold, and copper values can be recovered by the conventional aqueous electrorefining technique.

A procedure was developed for treatment of titanium alloy chips that were unsatisfactory for direct remelting because of the excessive contamination introduced by machining and handling operations. After chemical and electrolytic cleaning procedures, the product was suitable for recycle into ingot production.

## COMMODITY REVIEW

### METALS

**Antimony.**—Production of ore, stimulated by higher antimony prices, increased significantly as more antimony mines became active. The largest producer, the Antimony King mine, Lander County, shipped its ore to the Bullion Monarch mill at Austin. Most of the output from the other mines was shipped to the Oreana, Pershing County, or Laredo, Tex., smelters of National Lead Co. In addition, the new antimony mill at Oreana will process from 50 to 75 tons of antimony ore per day from tailings of two leased mines. The ore contains from 2 to 3 percent antimony. There was enough ore on hand for 6 months, and operations beyond that time depended on the price of antimony. Metro-dyne International, Inc., is operating a small antimony mine, the Bloody Canyon, at Oreana, Pershing County.

**Copper.**—Copper output was up about 2 percent from 1969; value increased 23 per-

cent. Most of the output came from operations of The Anaconda Company, Lyon County; Kennecott Copper Corp., White Pine County; and Duval Corp., Lander County. Ranchers Exploration and Development Corp. became a significant producer with its Big Mike mine in Pershing County, although the mine suspended operations in September. The higher grade sulfide ores were shipped to West Germany for processing. About 300,000 tons of ore have been stockpiled at the mine site, and another 300,000 tons of lower grade ore is yet to be mined. The remaining copper oxide will not be mined until the property is more fully explored. The Nevada Mines Division of Kennecott Copper Corp. opened a new area, the New Ruth pit, which will significantly extend the life of its copper property.

Lesser quantities of copper were recovered as a byproduct from complex lead, zinc, and silver ores.

**Gold.**—Gold output continued to

increase, exceeding that of 1969 by 5 percent, although the value declined 8 percent. Four lode gold mines represented almost 86 percent of the total production; the quantity of byproduct gold, primarily from copper ores, was 14 percent, and gold from all other sources, less than 1 percent. Cortez Gold Mines, which became a major producer with its Cortez mine, Lander County, announced that ore reserves as of January 1 were 2,981,000 tons grading 0.275 ounce of gold per ton. A continuous program of exploration is being carried out to increase presently known reserves.

The Carlin Gold Mining Co. expected its plant for extracting gold from carbonaceous ores to be operational early in 1971. The carbon removal cycle will handle 500 tons per day, compared with the 2,000-

ton-per-day milling capacity of the normal oxidized ore circuit. The technique allows extraction of gold from otherwise untreatable ore.

Uranium Services, Inc., announced discovery of gold values on its property near Carlin, Lander County.

**Iron Ore.**—Usable iron ore production was higher than in 1969. Most of the total output was exported. The remaining output was shipped as direct shipping-grade ore. Direct shipping-grade ores were produced by Nevada Barth Corp., Eureka County, and by Cooney Brothers and Nevada Iron Ore Co., Inc., both in Pershing County. The Standard Slag Co. produced iron ore in Douglas County and concentrated it at its Wabuska plant, Lyon County, for export to Japan.

Table 5.—Nevada: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by counties

County	Mines producing		Material sold or treated <sup>1</sup> (short tons)	Gold		Silver		Total value
	Lode	Placer		Troy ounces	Value	Troy ounces	Value	
<b>Total:</b>								
1968.....	49	4	14,209,028	317,382	\$12,460,417	645,192	\$1,383,679	
1969.....	48	1	20,214,657	456,294	18,940,764	884,155	1,583,231	
<b>1970:</b>								
Elko.....	6	--	3,611	23	836	17,577	31,125	
Eureka.....	2	--	W	W	W	W	W	
Humboldt.....	4	1	566	21	654	4,266	7,555	
Lander.....	5	--	2,469,963	227,189	8,267,407	497,669	881,282	
Lincoln.....	3	--	1,454	21	765	11,369	20,132	
Lyon.....	1	--	W	W	W	W	W	
Mineral.....	3	--	210	6	218	2,447	4,333	
Nye.....	1	--	W	W	W	W	W	
Pershing.....	2	--	95,860	1,916	69,723	37,963	67,225	
Washoe.....	1	--	W	W	W	W	W	
White Pine.....	5	--	W	W	W	W	W	
Undistributed.....	5	--	17,570,342	250,968	9,132,725	146,720	259,816	
<b>Total<sup>2</sup>.....</b>	<b>38</b>	<b>1</b>	<b>20,142,006</b>	<b>480,144</b>	<b>17,472,328</b>	<b>718,011</b>	<b>1,271,468</b>	
	<b>Copper</b>			<b>Lead</b>		<b>Zinc</b>		
	<b>Short tons</b>	<b>Value</b>		<b>Short tons</b>	<b>Value</b>	<b>Short tons</b>	<b>Value</b>	
<b>Total:</b>								
1968.....	77,213	\$64,622,648	863	\$228,039	2,104	\$568,080	\$79,262,863	
1969.....	104,924	99,749,148	1,420	423,019	941	274,771	120,970,933	
<b>1970:</b>								
Elko.....	30	34,389	100	31,097	31	9,484	106,931	
Eureka.....	W	W	W	W	W	W	W	
Humboldt.....	1	692	20	6,107	15	4,673	19,681	
Lander.....	13,140	15,163,099	9	2,671	3	797	24,315,256	
Lincoln.....	29	33,640	33	10,465	16	4,979	69,981	
Lyon.....	W	W	W	W	W	W	W	
Mineral.....	( <sup>3</sup> )	289	9	2,796	5	1,471	9,107	
Nye.....	W	W	W	W	W	W	W	
Pershing.....	9,682	11,173,432	4	1,343	( <sup>3</sup> )	138	11,311,861	
Washoe.....	W	W	W	W	W	W	W	
White Pine.....	W	W	W	W	W	W	W	
Undistributed.....	83,808	96,712,931	190	59,352	57	17,494	106,182,313	
<b>Total<sup>2</sup>.....</b>	<b>106,688</b>	<b>123,118,472</b>	<b>364</b>	<b>113,831</b>	<b>127</b>	<b>39,036</b>	<b>142,015,135</b>	

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

<sup>1</sup> Does not include gravel washed.

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

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

**Table 6.—Nevada: Mine production of gold, silver, copper, lead, and zinc in 1970, by classes of ore or other source materials, in terms of recoverable metals**

Source	Number of mines <sup>1</sup>	Material sold or treated (thousand short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
<b>Lode ore:</b>							
Dry gold.....	4	1,656	410,646	3,687	142	--	--
Dry silver.....	11	5	59	13,808	1	33	10
Total <sup>2</sup> .....	15	1,662	410,705	17,495	143	33	10
Copper.....	6	18,465	69,188	660,757	100,426	2	--
Copper-lead, copper-lead-zinc, lead-zinc <sup>3</sup> .....	5	1	20	10,585	32	55	37
Lead.....	8	4	222	23,303	8	266	78
Total <sup>2</sup> .....	19	18,470	69,430	694,645	100,465	323	115
<b>Other lode material:</b>							
Copper precipitates.....	4	8	--	--	6,080	--	--
Gold cleanup, silver tailings, and uranium <sup>3</sup> .....	2	2	6	5,871	1	8	2
Total <sup>2</sup> .....	6	10	6	5,871	6,081	8	2
Total lode material <sup>2</sup> .....	38	20,142	480,141	718,011	106,688	364	127
Placer.....	1	--	3	--	--	--	--
Total all sources <sup>2</sup> .....	39	20,142	480,144	718,011	106,688	364	127

<sup>1</sup> Detail will not necessarily add to totals shown because some mines produce more than one class of material.

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

<sup>3</sup> Combined to avoid disclosing individual company confidential data.

**Table 7.—Nevada: Mine production of gold, silver, copper, lead, and zinc in 1970, by types of material processed and methods of recovery, in terms of recoverable metals**

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
<b>Lode:</b>					
Amalgamation and cyanidation: Ore.....	410,126	5	--	--	--
Smelting of concentrates from—					
Ore <sup>1</sup> .....	67,059	630,292	<sup>2</sup> 90,372	30	17
Tailings.....	2	5,032	1	8	2
Total.....	67,061	635,324	90,373	38	19
Direct smelting of—					
Ore.....	2,951	82,676	10,235	326	109
Cleanup.....	3	6	--	--	--
Copper precipitates.....	--	--	6,080	--	--
Total.....	2,954	82,682	16,315	326	109
Placer.....	3	--	--	--	--
Grand total <sup>3</sup> .....	480,144	718,011	106,688	364	127

<sup>1</sup> Includes concentrate from uranium ore.

<sup>2</sup> Includes copper from heap leaching, combined to avoid disclosing individual company confidential data.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

**Lead.**—Although there were 26 lode mines in 1970 compared with 24 in 1969, lead production decreased 74 percent. In terms of recoverable metals, silver, lead, lead-zinc, and lead-copper ores accounted for 97 percent of the total lead output. Six mines (four lead, one lead-zinc, and one lead-copper) produced over 80 percent of the total.

**Mercury.**—Although production of mercury decreased 40 percent from that of 1969, Nevada retained its position as the second largest mercury-producing State. Only 13 mines operated in 1970, compared with 24 in 1969.

The Ruja Mining Co. (Ruja mine) and Fred H. Lenway & Co., Inc. (Quinn River (Cordero) mine), both in Humboldt

County, each produced over 1,000 flasks. Those reporting over 100 flasks included Kollman Mineral & Chemical Corp. (B & B mine), Esmeralda County; Star City Mines, Ltd. (Goldbank mine), Pershing County; and Basic Resources Corp. (Basic McCoy mine), Lander County. The Ruja mine was the only one in the group operating at yearend.

Six producers recovered mercury by furnace operations and seven used retorts. Carlin Gold Mining Co. continued to produce a small quantity of byproduct mercury at its large, low-grade gold mine in Eureka County. No mercury was recovered from old surface ores, dumps, or placers during the year.

The Crofoot Mining and Lumber Co. built a mercury mill near Lovelock, which treated mercury ore from the Cahill mine.

**Molybdenum.**—Molybdenum was recovered by Kennecott Copper Corp. as a co-product of treating copper ores from the Liberty Pit mine, White Pine County. Both production and shipments were substantially lower than in 1969. Kennecott was investigating techniques for reprocessing reject low-grade molybdenum concentrates.

**Silver.**—The production of silver decreased 19 percent from that of 1969. There were 11 lode silver mines in 1970, eight less than in the previous year. Copper ores yielded 92 percent of the total lode silver, and lead and lead-zinc ores supplied 5 percent. The remainder came from lode gold mines, treatment of lead and silver tailings, cleanup operations, and uranium mines.

New Products Corp. reported a silver discovery in the Hamilton District, White

Pine County, where 46-ounce silver was intercepted 22 feet below the surface.

**Tungsten.**—Nineteen tungsten properties, six more than in 1969, were active during the year. The quantity of tungsten concentrates produced was almost four times that of 1969, and nearly all of the output was shipped to the tungsten carbide plant of Kennametal Inc., in Churchill County. Several tungsten producers also shipped concentrates to the Pine Creek paratungstate plant of Union Carbide Corp. near Bishop, Calif.

The Crofoot Mining and Lumber Co. built a tungsten mill near Lovelock for treating ore from the company's mine in the Stillwater Range 40 miles south of the mill. The concentrate was sold to Kennametal Inc.

Silver Star-Queens Mines reported discovery of a commercial tungsten ore deposit on its property near Wells. Twenty-four holes were drilled into the ore body in a limited program, and approximately 30,000 tons of tungsten ore averaging 0.7 to 1 percent tungsten oxide has been proved.

**Zinc.**—Zinc production in Nevada was 127 short tons, down 87 percent from that of 1969. Nearly 91 percent of the total recoverable zinc came from lead and copper-lead-zinc ores. Twenty-two lode mines, the same as in 1969, contributed to the total zinc output. The three largest mines, one each in Elko, Lincoln, and White Pine Counties, accounted for most of the recoverable metal.

#### NONMETALS

**Barite.**—The quantity of primary barite sold or used by Nevada producers was 40

Table 8.—Nevada: Mercury production, by methods of recovery

Year	Recovery method					Total	
	Operating mines	Furnaced		Retorted		76-pound flasks	Value <sup>1</sup>
		Ore treated (short tons)	76-pound flasks	Ore treated (short tons)	76-pound flasks		
1966.....	29	48,813	3,021	14,633	334	3,355	\$1,482,306
1967.....	25	51,693	4,457	1,567	246	4,703	2,301,460
1968.....	17	67,711	4,325	5,842	455	4,780	2,559,977
1969.....	24	108,715	27,735	9,985	430	8,165	4,123,650
1970.....	13	89,200	4,884	343	32	4,916	2,004,597

<sup>1</sup> Value calculated at average New York price.

<sup>2</sup> Includes mercury recovered from old surface ores, dumps, and placers.

<sup>3</sup> Includes 1,800 short tons of tailings.

<sup>4</sup> Includes less than 100 flasks of byproduct mercury.

percent below that of 1969. Sales of ground barite, including tonnages used by producers, decreased 38 percent.

The National Lead Co. and Dresser Minerals ground barite in their respective plants at Dunphy, Eureka County, and Battle Mountain, Lander County. Ground barite was also produced by Milchem, Inc., in its Bateman plant near Battle Mountain. Nearly all the ground and crushed barite was sold for use in well drilling. Crude ore from the Lander County mine of FMC Corp. was shipped to a company plant in Modesto, Calif., for use in manufacturing barite chemicals.

**Cement.**—Portland cement was produced by Nevada Cement Co. in a dry-process plant at Fernley, Lyon County. Both shipments and value increased 5 percent over that of 1969. Most of the cement was used by building-material dealers, concrete products manufacturers, and ready-mix concrete manufacturers; lesser amounts went to highway contractors.

Total consumption of cement in Nevada, including material received from out-of-State, was 1.6 million barrels, 6 percent less than in 1969.

**Clays.**—Clays were produced from six operations—one each in Clark, Esmeralda, Lyon, Pershing, Washoe, and Nye Counties. Bentonite was mined by Western Talc Co. from the Toddy (Francis) pit near Apex, Clark County, the Blanco pit near Mina, Esmeralda County, the New Discovery pit near Beatty, Nye County, and the Buff pit near Lovelock, Pershing County. The Kelley-Moore Paint Co., Inc., mined bentonite in Lyon County. Common clay was obtained from a deposit near Flanigan, Washoe County, by Nevada Cement Co. for use at the company cement plant in Lyon County. Clays sold or used increased 24 percent in quantity above the 1969 figure.

**Diatomite.**—Sales of prepared diatomite increased 3 percent in quantity and 2 percent in value compared with that of 1969. No sales of crude materials were reported. As in 1969, four deposits were mined. Eagle-Picher Industries, Inc., remained the largest Nevada producer from its Celatom mine and filtration-media preparation plant at Colado, Pershing County, and the Tunnel Hill mine and Clark Siding plant east of Reno, Storey County. GREFCO, Inc., the second largest producer, operated its mine at Basalt and a plant near Mina,

both in Esmeralda County. United Sierra Division of Cyprus Mines Corp. supplied diatomite from its mine and plant at Fernley, Lyon County. Product sales were mainly for filtration filler and lightweight aggregate, and lesser amounts were used for coating and fertilizer anticaking agents, insecticide carriers, insulation, and abrasives.

**Fluorspar.**—Production and shipments of fluorspar were significantly lower than in 1969. J. Irving Crowell, Jr., produced and shipped ceramic and metallurgical-grade fluorspar from its Crowell (Daisy) mine in Nye County. Carp Fluoride Co. produced and shipped metallurgical-grade fluorspar from its Carp Spar mine, Lincoln County. The Caliente Fluorspar Corp. expanded its fluorspar processing plant in Caliente, Lincoln County.

**Gypsum.**—Crude gypsum production was 13 percent lower in quantity than in 1969. Output was 451,000 tons for use at Nevada and California plants making plaster and board products, and as a retarder in portland cement.

Gypsum was mined by United States Gypsum Co. (Empire Quarry) in Pershing County for use in the company plant at Gerlach, Washoe County. In Clark County, the Flintkote Co. (Blue Diamond mine) and Johns-Manville (Apex mine) mined gypsum for use at their respective Blue Diamond and Las Vegas plants and for shipment to plants in California. The three Nevada plants produced 240,000 tons of calcined gypsum, compared with 325,000 tons in 1969. Sales of gypsum decreased for building and agricultural uses.

**Lime.**—Output of lime was 1 percent lower in quantity than in 1969, although value increased 10 percent. Most of the shipments were made to the steel and paper industries; some went into the manufacture of glass. Shipments were made throughout the Western States, and most went to consumers in California.

U.S. Lime Division of the Flintkote Co. operated three plants in Clark County, producing quicklime at Apex, hydrated lime at Sloan, and both quicklime and hydrated lime at Henderson. The Sloan plant closed during the year. Morrison & Weatherly Chemical Products produced lime at McGill, White Pine County, primarily for use in the concentration of copper ores.

**Lithium Compounds.**—The output of

lithium carbonate from the Silver Peak facility of Foote Mineral Co. in Esmeralda County increased 7 percent over that of 1969. Further expansion of capacity at Silver Peak will be completed early in 1971.

**Magnesite and Brucite.**—Basic Inc. produced magnesite and brucite from open pit operations near Gabbs, Nye County, and upgraded the ore in nearby processing facilities. Mine production and combined consumption and shipments of all materials were higher than in 1969. Most of the ore was used in the manufacture of refractories and special products.

Additional equipment was installed for expansion of the ore beneficiation plant, which will extend the life of the magnesite reserves.

**Perlite.**—As in 1969, three companies produced all of the crude perlite. Combined Metals Reduction Co. (Hollinger pit) and Delamar Perlite (Mackie claims) both operated mines in Lincoln County, and United States Gypsum Co. operated the Pearl Hill quarry in Pershing County. Most of the crude perlite output was sold to out-of-State consumers. Total sales, however, declined for the 13th consecutive year.

**Pumice (Volcanic Cinder).**—Output of pumice, pumicite, and volcanic cinder was 4 percent lower than in 1969. The greater demand for the materials in concrete admixtures, road construction, and landscaping, was more than offset by decreased

demand for concrete aggregate and fill. Cind R Lite Co. mined volcanic cinders from the Cinder Cone deposit southeast of Beatty, Nye County, for landscaping and concrete aggregate use. Volcanic cinders (scoria) from the Cinderlite Aggregates property of Savage Construction Co., Inc., Ormsby County, was prepared for use in concrete admixture, road construction, and landscaping. Pumicite from the Lory Free pit of Kemway Enterprises, Lincoln County, was prepared for use in concrete admixtures.

Pumicite from the Naturalite group of claims of Kaiser Industries Corp., Storey County, and pumice from the Rillite Aggregate Co. property, Washoe County, were prepared for use in concrete aggregates.

**Salt.**—The only salt producer in the State was Fallon Development Co., which operated a solar evaporation plant in Churchill County. All of the production was used in Nevada. Most of the output was sold for use in ice control on roads by State, county, and local agencies. The remainder was used in the meatpacking, tanning, casing, and dairy industries, in feed mixes and weed killers, and by water-conditioning service companies.

**Sand and Gravel.**—Output of sand and gravel rose from 8.4 million tons in 1969 to 8.6 million tons in 1970. There were 106 active sand and gravel operations, 15 more than in 1969. Of these, 40 were classified as commercial and 66 were classified as Government-and-contractor.

Table 9.—Nevada: Sand and gravel sold or used by producers, by counties  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Clark.....	27	4,077	\$5,390	28	4,439	\$5,558
Elko.....	9	1,368	1,408	13	303	356
Esmeralda.....	1	3	3	3	W	W
Eureka.....	2	243	243	3	W	W
Humboldt.....	4	91	129	5	166	101
Lander.....	2	55	50	1	W	W
Lincoln.....	3	20	260	9	255	302
Lyon.....	8	166	260	2	W	W
Mineral.....	4	216	213	3	72	70
Nye.....	4	234	407	4	16	13
Ormsby.....	2	33	40	3	59	62
Pershing.....	4	235	243	3	59	62
Washoe.....	13	1,612	2,319	18	2,741	3,005
White Pine.....	5	49	56	7	43	38
Undistributed <sup>1</sup> .....	3	50	52	4	453	280
Total <sup>2</sup> .....	91	8,447	10,834	106	8,574	9,819

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

<sup>1</sup> Includes Churchill and Douglas Counties.

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



**Table 10.—Nevada: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	973	\$1,543	393	\$1,473
Fill.....	125	122	114	167
Paving.....	428	559	25	39
Other uses <sup>1</sup> .....	187	877	239	990
<b>Total <sup>2</sup>.....</b>	<b>1,713</b>	<b>3,101</b>	<b>1,271</b>	<b>2,668</b>
<b>Gravel:</b>				
Building.....	1,307	2,392	1,119	1,894
Fill.....	350	294	1,365	1,110
Paving.....	1,465	1,506	2,090	2,066
Railroad ballast.....	--	--	525	236
Miscellaneous <sup>3</sup> .....	84	228	34	169
<b>Total.....</b>	<b>3,206</b>	<b>4,420</b>	<b>5,133</b>	<b>5,475</b>
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Building.....	23	23	1	5
Fill.....	6	4	70	34
Paving.....	1,043	1,084	189	285
Other uses.....	16	16	8	4
<b>Total.....</b>	<b>1,088</b>	<b>1,127</b>	<b>268</b>	<b>328</b>
<b>Gravel:</b>				
Building.....	19	19	389	234
Fill.....	371	365	141	116
Paving.....	1,991	1,728	1,368	994
Other uses.....	59	73	4	4
<b>Total <sup>2</sup>.....</b>	<b>2,440</b>	<b>2,185</b>	<b>1,902</b>	<b>1,349</b>
<b>Total sand and gravel <sup>2</sup>.....</b>	<b>8,447</b>	<b>10,834</b>	<b>8,574</b>	<b>9,819</b>

<sup>1</sup> Includes glass, molding, fire-furnace, and other sands.

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

<sup>3</sup> Includes gravel for other uses (1969).

**Stone.**—About 1.9 million tons of stone were quarried, compared with 1.5 million tons in 1969. The increase was due mostly to larger outputs of limestone and granite. The limestone was used in Lyon County for the manufacture of cement, and the granite was used in Clark County for road construction. Production of sandstone increased slightly; the production of all other types of stone remained at 1969 levels.

Limestone was also produced in Clark County for metallurgical flux, and other chemical and industrial uses, and for conversion to lime for sugar refining. Limestone from White Pine County was used as a flux in the smelting of copper. Marble was quarried in Mineral County for terrazzo.

Public works crews and contractors produced sandstone, limestone, granite, and miscellaneous stone in several counties for use as riprap, road base, and concrete aggregate.

**Talc and Soapstone.**—Talc and soapstone production came from two deposits in Esmeralda County. Talc was mined from the Wellington group of claims near Goldfield. The soapstone was obtained from the Hideout claims near Lida. Sales were substantially lower than those of 1969, and all shipments went to out-of-State grinding mills.

#### MINERAL FUELS

**Petroleum.**—Eagle Springs oilfield with 13 wells in Nye County remained the only producing area in the State. Production decreased 33 percent from that of 1969. The field has yielded a total of 2,412,721 barrels of oil through December 1970. The Nevada Oil and Gas Conservation Commission issued 16 well-drilling permits, up sharply from the two issued in 1969. Most of the wells were in White Pine County. Nine wells were plugged and abandoned,

and five had not yet been drilled. One well reached a depth of 13,116 feet, a new record depth for Nevada.

There was no activity at the Monte Cristo Oil Co. well in Esmeralda County.

Oil shows were reported in 1969, but confirmatory tests have not been run. Drilling continued intermittently at the Damale Brothers No. 2 well in northern Elko County.

Table 11.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Antimony:</b>			
DOWCO Mining Co.....	Battle Mountain, Nev. 89820	Open pit mine....	Eureka and Lander.
<b>Barite:</b>			
Baroid Division, National Lead Co.	P.O. Box 1675 Houston, Tex. 77001	...do.....	Elko.
Dresser Minerals.....	P.O. Box 94 Houston, Tex. 77005	...do.....	Lander.
FMC Corp.....	P.O. Box 3808 Modesto, Calif. 95352	...do.....	Do.
Milchem, Inc., Mineral Division....	Box 22111 Houston, Tex. 77027	...do.....	Do.
<b>Brucite:</b>			
Basic Inc.....	845 Hanna Bldg. Cleveland, Ohio 44115	...do.....	Nye.
<b>Cement:</b>			
Nevada Cement Co.....	Fernley, Nev. 89408.....	Dry-process, portland- cement plant.	Lyon.
<b>Clays:</b>			
Nevada Cement Co.....	Fernley, Nev. 89408.....	Open pit mine....	Washoe.
Western Talc Co.....	P.O. Box 368 Yermo, Calif. 92398	...do.....	Clark, Esmeralda, Nye, Pershing.
<b>Copper:</b>			
The Anaconda Co.....	P.O. Box 1000 Weed Heights, Nev. 89443	...do.....	Lyon.
Bristol Silver Mines Co.....	P.O. Box 276 Pioche, Nev. 89043	Underground mine.	Lincoln.
Cliffs Copper Corp.....	P.O. Box 1211 Rife, Colo. 81650	Open pit mine....	Elko.
Duval Corp.....	P.O. Box 451 Battle Mountain, Nev. 89820	...do.....	Lander.
Kennecott Copper Corp., Nevada Mines Division.	McGill, Nev. 89318.....	...do.....	White Pine.
<b>Diatomite:</b>			
Eagle-Picher Industries, Inc.....	P.O. Box 1869 Reno, Nev. 89505	...do.....	Pershing and Storey.
GREFCO, Inc.....	630 Shatto Pl. Los Angeles, Calif. 90005	...do.....	Esmeralda.
United Sierra Division, Cyprus Mines Corp.	P.O. Box 1201 Trenton, N.J. 08606	...do.....	Churchill.
<b>Fluorspar:</b>			
Carp Fluoride Co.....	P.O. Box 536 Delta, Utah 84624	...do.....	Lincoln.
J. Irving Crowell, Jr.....	P.O. Box 96 Beatty, Nev. 89003	Underground mine.	Nye.
<b>Gold:</b>			
Carlin Gold Mining Co.....	P.O. Box 672 Elko, Nev. 89801	Open pit mine....	Eureka.
Cortez Gold Mines.....	Cortez, Nev. 89821.....	...do.....	Lander.
Duval Corp.....	P.O. Box 451 Battle Mountain, Nev. 89820	...do.....	Do.
Kennecott Copper Corp., Nevada Mines Division.	McGill, Nev. 89318.....	...do.....	White Pine.
<b>Gypsum:</b>			
The Flintkote Co.....	P.O. Box 2678 Terminal Annex Los Angeles, Calif. 90054	...do.....	Clark.
Johns-Manville Products Corp.....	4301 East Firestone Blvd. South Gate, Calif. 90280	...do.....	Do.
United States Gypsum Co.....	101 South Wacker Dr. Chicago, Ill. 60606	...do.....	Pershing.
<b>Iron ore:</b>			
Nevada Barth Corp.....	P.O. Box 425 Carlin, Nev. 89822	...do.....	Eureka.
Standard Slag Co.....	Box 4400 Reno, Nev. 89501	...do.....	Douglas.

Table 11.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Lead:</b>			
John F. Ala.....	P.O. Box 55 Montello, Nev. 89830	Underground mine.	Elko.
Bristol Silver Mines Co.....	P.O. Box 276 Pioche, Nev. 89043	.....do.....	Lincoln.
Eureka-Nevada Limited.....	P.O. Box 297 Eureka, Nev. 89316	.....do.....	Eureka.
International Energy Co.....	628 Patterson Bldg. Denver, Colo. 80202	.....do.....	White Pine.
<b>Lime:</b>			
The Flintkote Co.....	P.O. Box 57367 Flint Station Los Angeles, Calif. 90057	Rotary kilns, batch and continuous hydrators.	Clark.
Morrison & Weatherly Chemical Products.	Box 1105 McGill, Nev. 89318	Rotary kilns.....	White Pine.
<b>Lithium:</b>			
Foote Mineral Co.....	Route 100 Exton, Pa. 19341	Dry lake brines...	Esmeralda.
<b>Magnesite:</b>			
Basic Inc.....	845 Hanna Bldg. Cleveland, Ohio 44115	Open pit mine....	Nye.
<b>Mercury:</b>			
Kollsman Mineral & Chem. Corp....	1441 Angelo Dr. Beverly Hills, Calif. 90210	.....do.....	Esmeralda.
Fred H. Lenway & Co., Inc.....	100 California St. San Francisco, Calif. 94111	Underground mine.	Humboldt.
Ruja Mining Co.....	P.O. Box 31 McDermitt, Nev. 89421	.....do.....	Do.
Star City Mines, Ltd.....	P.O. Box 1008 Winnemucca, Nev. 89445	Open pit mine....	Pershing.
<b>Molybdenum:</b>			
Kennecott Copper Corp., Nevada Mines Division.	McGill, Nev. 89318.....	.....do.....	White Pine.
<b>Perlite:</b>			
Combined Metals Reduction Co., Panacalite Division.	218 Felt Bldg. Salt Lake City, Utah 84110	.....do.....	Lincoln.
Delamar Perlite.....	Pioche, Nev. 89043.....	Underground mine.	Do.
United States Gypsum Co.....	101 South Wacker Dr. Chicago, Ill. 60606	Open pit mine....	Pershing.
<b>Petroleum:</b>			
James L. Davis.....	21 Boyd Rd. Pleasant Hill, Calif. 94523	Producing crude oil wells.	Nye.
North American Resources Corp....	811 San Jacinto Bldg. Houston, Tex. 77002	.....do.....	Do.
Western Oil Lands, Inc.....	380 Linden St. Reno, Nev. 89502	.....do.....	Do.
<b>Pumice:</b>			
Kaiser Industries Corp.....	300 Lakeside Dr. Oakland, Calif. 94612	Open pit mine....	Storey.
Rilite Aggregate Co.....	P.O. Box 5665 Reno, Nev. 89503	.....do.....	Washoe.
Savage Construction Co. Inc.....	P.O. Box 970 Carson City, Nev. 89701	.....do.....	Ormsby.
<b>Salt:</b>			
Fallon Development Co.....	Harrigan Rd. Fallon, Nev. 89406	Dry lake brines...	Churchill.
<b>Sand and gravel:</b>			
C. M. Brown Construction Co.....	1770 North Leonard Lane Las Vegas, Nev. 89108	Open pit mine....	Clark.
Frehner Trucking Service, Inc.....	Las Vegas, Nev. 89101.....	.....do.....	Do.
R. Helms Construction Co.....	3025 Mill St. Reno, Nev. 89502	.....do.....	Washoe.
Las Vegas Building Materials, Inc....	P.O. Box 530 Las Vegas, Nev. 89101	.....do.....	Clark.
Nevada Aggregates & Asphalt.....	P.O. Box 7424 Reno, Nev. 89502	.....do.....	Washoe.
Simplot Silica Products.....	P.O. Box 308 Overton, Nev. 89040	.....do.....	Clark.
Stewart Brothers Co.....	P.O. Box 2775 Huntridge Station Las Vegas, Nev. 89101	.....do.....	Do.
Stock Mill & Supply Co.....	3336 Cinder Lane Las Vegas, Nev. 89103	.....do.....	Do.
Wells-Cargo, Inc.....	2894 West Spring Mountain Rd. Las Vegas, Nev. 89114	.....do.....	Do.
Whiting Bros.....	6418A East Vegas Valley Rd. Las Vegas, Nev. 89109	.....do.....	Do.
W. M. K. Transit Mix, Inc.....	1606 Industrial Rd. Las Vegas, Nev. 89102	.....do.....	Do.

Table 11.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Silver:</b>			
John F. Ala.....	P.O. Box 55 Montello, Nev. 89830	Underground mine.	Elko.
The Anaconda Company.....	P.O. Box 1000 Weed Heights, Nev. 89443	Open pit mine....	Lyon.
Bristol Silver Mines Co.....	P.O. Box 276 Pioche, Nev. 89043	Underground mine.	Lincoln.
Duval Corp.....	P.O. Box 451 Battle Mountain, Nev. 89820	Open pit mine....	Lander.
Eureka-Nevada Limited.....	P.O. Box 297 Eureka, Nev. 89316	Underground mine.	Eureka.
Kennecott Copper Corp., Nevada Mines Division.	McGill, Nev. 89318.....	Open pit mine....	White Pine.
Rancher's Exploration and Devel- opment Corp.	620 Melarkey St. Winnemucca, Nev. 89445	---do-----	Pershing.
<b>Stone:</b>			
Morrison & Weatherly Chemical Products.	Box 1105 McGill, Nev. 89318	Open quarry....	White Pine.
Nevada Cement Co.....	Fernley, Nev. 89408.....	---do-----	Lyon.
U.S. Lime Division, the Flintkote Co.	P.O. Box 57367 Flint Station Los Angeles, Calif. 90057	---do-----	Clark.
<b>Talc and soapstone:</b>			
H. N. Stewart.....	P.O. Box 176 Big Pine, Calif. 93513	Open pit mine....	Esmeralda.
<b>Tungsten:</b>			
Henry C. & John Crofoot.....	P.O. Box 797 Lovelock, Nev. 89419	---do-----	Churchill.
<b>Zinc:</b>			
John F. Ala.....	P.O. Box 55 Montello, Nev. 89830	Underground mine.	Elko.
International Energy Co.....	628 Patterson Bldg. Denver, Colo. 80202	---do-----	White Pine.



# The Mineral Industry of New Hampshire

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the New Hampshire Department of Resources and Economic Development for collecting information on all minerals except fuels.

By Avery H. Reed <sup>1</sup>

Total value of mineral production increased 8 percent but was 5 percent below the 1968 record. The increase in value was due to increased stone and sand and gravel production.

Leading mineral producing counties were Hillsboro, Merrimack, and Rockingham. Leading companies were Kitledge Granite Corp., with dimension granite quarries in Hillsboro County; R.S. Audley, Inc., with sand and gravel pits in Merrimack County; and John Swenson Granite Co., Inc., with dimension granite quarries in Hillsboro County.

Plans were announced for a new industry, dredging diatomaceous earth from the bottom of Lake Umbagog. When refined and processed, diatomaceous earth has a variety

of uses, such as for filters, paper filler, paint filler, and insulation. The deposit is reported to be 30 feet thick and to underlie most of the 8,000 acre lake. A mining permit from the State is required.

**Employment and Injuries.**—In the mineral industries, 570 men worked 971,000 man-hours, compared with 602 men and 1,091,000 man-hours in 1969. Employment increased 4 percent at stone quarries but decreased 15 percent at sand and gravel mines and 29 percent at other nonmetal mines.

There were 18 lost-time injuries in the mineral industries, compared with 27 in 1969.

<sup>1</sup> Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Mineral production in New Hampshire <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays..... thousand short tons..	44	\$40	40	\$32
Sand and gravel..... do.....	6,310	5,149	6,529	4,753
Stone..... do.....	320	2,888	W	W
Value of items that cannot be disclosed:				
Feldspar (1969), gem stones, and mica.....	XX	43	XX	3,945
Total.....	XX	8,120	XX	8,730
Total 1967 constant dollars.....	XX	7,668	XX	7,901

<sup>p</sup> Preliminary. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

**Table 2.—Value of mineral production in New Hampshire, by counties**  
(Thousand dollars)

County	1969	1970	Minerals produced in 1970 in order of value
Belknap.....	W	W	Sand and gravel.
Carroll.....	W	W	Sand and gravel, stone.
Cheshire.....	W	W	Sand and gravel, mica.
Coos.....	\$171	\$184	Sand and gravel.
Grafton.....	677	677	Sand and gravel, stone, clays, mica.
Hillsboro.....	2,513	3,036	Stone, sand and gravel.
Merrimack.....	2,280	2,051	Sand and gravel, stone.
Rockingham.....	959	900	Stone, sand and gravel, clays.
Strafford.....	256	275	Sand and gravel, clays.
Sullivan.....	W	147	Sand and gravel.
Undistributed <sup>1</sup> .....	1,265	1,410	
Total.....	<sup>2</sup> 8,120	8,730	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."  
<sup>1</sup> Includes value of sand and gravel and gem stones not assigned to specific counties and values indicated by symbol W.

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

**Table 3.—Indicators of New Hampshire business activity**

	1969	1970 <sup>p</sup>	Change, percent	
<b>Employment and labor force, annual average:</b>				
Total labor force.....	thousands..	297.6	301.2	+1.2
Unemployment.....	percent of work force..	2.3	3.4	+47.8
<b>Employment:</b>				
Manufacturing employment.....	thousands..	97.9	92.1	-5.9
Durable goods.....	do.....	46.9	44.4	-5.3
Nondurable goods.....	do.....	51.0	47.7	-6.5
Nonmanufacturing employment.....	do.....	165.5	171.2	+3.4
Mining and construction.....	do.....	13.6	13.1	-3.7
<b>Payroll—average weekly earnings:</b>				
Manufacturing.....		\$103.10	\$108.92	+5.6
Durable goods.....		\$107.73	\$113.54	+5.4
Nondurable goods.....		\$99.46	\$104.78	+5.3
<b>Personal income:</b>				
Total.....	millions..	\$2,489	\$2,677	+7.6
Per capita.....		\$3,437	\$3,608	+5.0
<b>Construction activity:</b>				
Highway construction contracts.....	thousands..	\$37,272	\$34,583	-7.2
Cement shipments to and within New Hampshire.....	thousand 376-pound barrels..	994	887	-10.8
Mineral production value.....	thousands..	\$8,120	\$8,730	+7.5

<sup>p</sup> Preliminary.

Source: State of New Hampshire Department of Employment Security; State Department of Public Works and Highways; Survey of Current Business; Employment and Earnings, Department of Labor.

**Table 4.—Worktime and injury experience in the mineral industries**

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Nonmetal.....	49	217	11	85	-----	1	11.76	235
Sand and gravel.....	409	191	78	725	-----	14	19.32	1,037
Stone.....	144	242	35	281	-----	12	42.69	1,131
Total <sup>1</sup> .....	602	205	123	1,091	-----	27	24.75	998
<b>1970:<sup>p</sup></b>								
Nonmetal.....	35	222	8	60	-----	-----	-----	-----
Sand and gravel.....	385	179	69	618	-----	6	9.71	104
Stone.....	150	239	36	293	-----	12	41.01	369
Total.....	570	198	113	971	-----	18	18.54	177

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

## NONMETALS

**Clays.**—W. S. Goodrich, Inc., The Kane-gonic Brick Corp., and Densmore Brick Co., mined 40,400 tons of common clay valued at \$31,700 for building brick, in Rockingham, Strafford, and Grafton Counties. Output declined 9 percent and value declined 20 percent.

**Gem Stones.**—Rockhounds and amateur collectors collected gem stones and mineral specimens in Grafton County.

**Gypsum.**—National Gypsum Co. calcined gypsum at Portsmouth. The crude material was imported from Canada.

**Mica.**—Concord Mica Co. ground mica at Penacook in Merrimack County. Scrap mica was produced in Cheshire and Grafton Counties by Otto K. Lassman and RPM, Inc.

**Perlite.**—National Gypsum Co. expanded

perlite at Portsmouth. The crude material was mined in Colorado.

**Sand and Gravel.**—Twenty five firms operated 61 pits in 12 counties, and produced 6,529,000 tons of sand and gravel valued at \$4,753,000 for building, paving, fill, and other uses. Leading counties were Merrimack, Hillsboro, and Rockingham. Leading producers were R. S. Audley, Inc., the State Highway Department, Palazzi Corp., and Thomopoulos Sand and Gravel Pit. Output increased 3 percent, but value decreased 8 percent.

**Stone.**—Kitledge Granite Corp., in Hillsboro County, and John Swenson Granite Co., Inc., in Merrimack County, quarried dimension granite for rough construction, rough monumental, dressed architectural, dressed construction, and dressed monumental stone, and for curbing. Lebanon

Table 5.—New Hampshire: Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building.....	697	\$743	794	\$701
Fill.....	714	322	434	259
Paving.....	543	554	656	548
Other uses <sup>1</sup> .....	52	47	649	392
Total <sup>2</sup> .....	2,004	1,667	2,533	1,901
Gravel:				
Building.....	748	1,120	385	554
Fill.....	479	238	239	129
Paving.....	793	936	1,095	1,104
Other uses <sup>3</sup> .....	307	323	909	771
Total <sup>2</sup> .....	2,327	2,617	2,627	2,557
Government-and-contractor operations:				
Sand:				
Fill.....	18	6	18	6
Paving.....	664	287	396	119
Total <sup>2</sup> .....	682	293	414	125
Gravel:				
Paving.....	1,298	571	955	171
Total <sup>2</sup> .....	1,298	571	955	171
Total sand and gravel <sup>2</sup> .....	6,310	5,149	6,529	4,753

<sup>1</sup> Includes engine and filtration sand (1969), and sand for other uses.

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

<sup>3</sup> Includes miscellaneous and other gravel.



Crushed Stone, Inc., in Grafton County, and Iafolla Construction Co., Inc., in Rockingham County, crushed traprock for concrete aggregate, bituminous aggregate, road base, surface treatment and other aggregate, and for riprap. North Country Aggregates,

Inc., crushed quartz in Hillsboro County for exposed aggregate in decorative concrete.

Total stone production was 397,000 tons valued at \$3,924,000, an increase of 24 percent in quantity and 36 percent in value.

Table 6—Principal producers

Commodity and company	Address	Type of activity	County
<b>Clay:</b>			
Densmore Brick Co.....	Lebanon, N.H. 03766.....	Pit.....	Grafton.
W. S. Goodrich, Inc.....	Epping, N. H. 03042.....	Pit.....	Rockingham.
The Kane-Gonic Brick Corp.....	Gonic, N. H. 03867.....	Pit.....	Strafford.
<b>Gypsum (calcined):</b>			
National Gypsum Co.....	325 Delaware Ave. Buffalo, N. Y. 14202	Plant.....	Rockingham.
<b>Mica:</b>			
Otto Lassman.....	Gilsum, N. H. 03448.....	Pit.....	Cheshire.
RPM Inc.....	Newport, N. H. 03773.....	Pit.....	Grafton.
<b>Perlite (expanded):</b>			
National Gypsum Co.....	325 Delaware Ave. Buffalo, N. Y. 14202	Plant.....	Do.
<b>Sand and gravel:</b>			
R. S. Audley, Inc.....	Rt. 3A Bow, N. H. 03302	Pit.....	Merrimack.
Campton Sand & Gravel, Inc.....	Box 2 W. Campton, N. H. 03228	Pit.....	Grafton.
Cold River Sand & Gravel Corp.....	P.O. Box 429 Bellows Falls, Vt. 05101	Pit.....	Cheshire.
J. J. Cronin Company.....	P.O. Box 176 N. Reading, Mass. 01864	Pit.....	Hillsboro.
Iafolla Construction Co., Inc.....	Peverly Hill Rd. Portsmouth, N. H. 03801	Pit.....	Rockingham and Strafford.
Keene Sand & Gravel, Inc.....	725 Main Street Keene, N. H. 03431	Pit.....	Cheshire.
Lebanon Crushed Stone, Inc.....	Plainfield Rd. W. Lebanon, N. H. 03784	Pit.....	Grafton.
Lessard Sand & Gravel, Inc.....	Lancaster Rd. Gorham, N. H. 03581	Pit.....	Coos.
Nashua Sand & Gravel.....	Route 130 Nashua, N. H. 03060	Pit.....	Hillsboro.
Palazzi Corp.....	2321 Hartford Ave. Johnston, R. I. 02900	Pit.....	Merrimack.
Thomopoulos Sand & Gravel Pit.....	Londonderry, N. H. 03053.....	Pit.....	Rockingham.
Tilton Sand & Gravel, Inc.....	Tilton, N. H. 03276.....	Pit.....	Belknap.
Twin States Sand & Gravel.....	Box 203 W. Lebanon, N. H. 03784	Pit.....	Grafton.
<b>Stone:</b>			
<b>Granite, dimension:</b>			
Kitledge Granite Corp.....	Oak Street Milford, N. H. 03055	Quarry.....	Hillsboro.
The John Swenson Granite Co., Inc.....	North State Street Concord, N. H. 03301	....do.....	Merrimack.
<b>Miscellaneous stone, crushed:</b>			
Iafolla Construction, Inc.....	Peverly Hill Rd. Portsmouth, N. H. 03801	....do.....	Rockingham.
Lebanon Crushed Stone, Inc.....	Plainfield Rd. W. Lebanon, N. H. 03784	....do.....	Grafton.
<b>Quartz, crushed:</b>			
North Country Aggregates, Inc.....	P.O. Box 55 S. Lyndeboro, N. H. 03082	....do.....	Hillsboro.

# The Mineral Industry of New Jersey

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the New Jersey Division of Resource Development, Bureau of Geology and Topography, for collecting information on all minerals except fuels.

By Donald C. Winingar<sup>1</sup>

The value of New Jersey's mineral production totaled \$89.3 million, a 7-percent increase over that of 1969; this established a new high for the second consecutive year. Although output of sand and gravel, one of the State's major mineral products, declined, the decrease was offset by higher unit values for stone and sand and gravel. The leading commodity continued to be stone, which accounted for 46 percent of the total value of all minerals produced. Somerset County continued to be the leading mineral producing area and was followed, in decreasing order of value, by Sussex, Cumberland, Morris, Ocean, and Passaic Counties. Mineral production was reported for all counties except Salem.

**Employment and Injuries.**--In the mineral industries, 2,395 men worked 4,996,000 man-hours in 1970, compared with 2,553 men and 5,426,000 man-hours in 1969, a decrease of 8 percent. Employment increased 26 percent at peat mines and 5 percent at other nonmetal mines but decreased 10 percent at sand and gravel mines and 12 percent at stone quarries.

There were 190 lost-time injuries in the mineral industries, including one fatality, compared with 185 injuries, including one fatality in 1969.

<sup>1</sup> Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Mineral production in New Jersey<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays..... thousand short tons..	327	\$1,123	262	\$990
Gem stones.....	NA	10	NA	10
Peat..... thousand short tons..	46	551	45	557
Sand and gravel..... thousand short tons..	20,325	33,977	16,732	31,571
Stone..... do.....	15,162	34,034	<sup>2</sup> 15,160	<sup>2</sup> 40,567
Zinc <sup>3</sup> (recoverable content of ores, etc.)... short tons..	25,076	7,322	28,683	8,788
Value of items that cannot be disclosed:				
Lime, magnesium compounds, manganese residuum, greensand marl, and titanium concentrate (ilmenite).....	XX	† 6,122	XX	6,798
Total.....	XX	† 83,139	XX	89,281
Total 1967 constant dollars.....	XX	78,508	XX	† 80,799

† Preliminary. † 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 dimension stone; included with "Value of items that cannot be disclosed."

<sup>3</sup> Recoverable zinc valued at yearly average price of Prime Western slab zinc, East St. Louis market. Represents value established after transportation, smelting, and manufacturing charges have been added to the value of ore at the mine.

Table 2.—Value of mineral production in New Jersey, by counties <sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Atlantic.....	\$516	\$254	Sand and gravel.
Bergen.....	1,941	1,749	Do.
Burlington.....	1,842	1,700	Sand and gravel, clays.
Camden.....	2,092	1,256	Do.
Cape May.....	W	W	Magnesium compounds, sand and gravel.
Cumberland.....	12,579	11,960	Sand and gravel, clays.
Essex.....	W	W	Stone.
Gloucester.....	559	573	Sand and gravel, greensand marl.
Hudson.....	W	W	Stone.
Hunterdon.....	W	3,253	Do.
Mercer.....	W	W	Do.
Middlesex.....	2,421	2,043	Sand and gravel, clays.
Monmouth.....	1,201	1,347	Sand and gravel.
Morris.....	7,565	7,735	Sand and gravel, stone.
Ocean.....	6,040	4,168	Sand and gravel, ilmenite.
Passaic.....	5,838	6,194	Stone, sand and gravel.
Somerset.....	14,706	18,436	Stone, clays.
Sussex.....	13,360	15,141	Zinc, stone, sand and gravel, lime, peat, manganiferous residuum.
Union.....	W	W	Stone.
Warren.....	938	1,832	Sand and gravel, peat, stone.
Undistributed <sup>2</sup> .....	11,543	11,640	
Total <sup>3</sup> .....	83,139	89,281	

<sup>1</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

<sup>2</sup> No production reported in Salem County.

<sup>3</sup> Includes value of gem stones and values indicated by symbol W.

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

Table 3.—Indicators of New Jersey business activity

	1969	1970	Change, percent
Employment and labor force, annual average: <sup>1</sup> <sup>2</sup>			
Total work force.....	thousands... 3,018.6	3,085.2	+2.2
Unemployment.....	percent of work force... 4.4	5.5	+25.0
Employment:			
Manufacturing.....	thousands... 893.8	867.0	-3.0
Nonmanufacturing:			
Construction.....	do... 116.8	119.6	+2.4
Transportation and public utilities.....	do... 176.2	181.6	+3.1
Finance, insurance and real estate.....	do... 112.6	117.3	+4.2
Service.....	do... 396.7	412.4	+3.9
Government.....	do... 359.8	372.0	+3.4
Mining.....	do... 3.3	3.3	---
Payroll, average weekly earnings:			
Manufacturing.....	\$132.60	\$139.26	+5.0
Personal income: <sup>3</sup>			
Total.....	millions... \$30,312	\$32,673	+7.8
Per capita.....	\$4,272	\$4,539	+6.3
Construction activity:			
Housing units authorized <sup>4</sup> .....	4,492	5,018	+11.7
Portland cement shipments to and within New Jersey thousand 376-pound barrels... 10,963	10,963	10,995	+0.3
Mineral production.....	thousands... \$83,139	\$89,281	+7.4

<sup>1</sup> U.S. Department of Labor, Bureau of Labor Statistics.

<sup>2</sup> U.S. Department of Labor, Manpower Administration.

<sup>3</sup> U.S. Department of Commerce, Survey of Current Business.

<sup>4</sup> U.S. Department of Commerce, Construction Review.

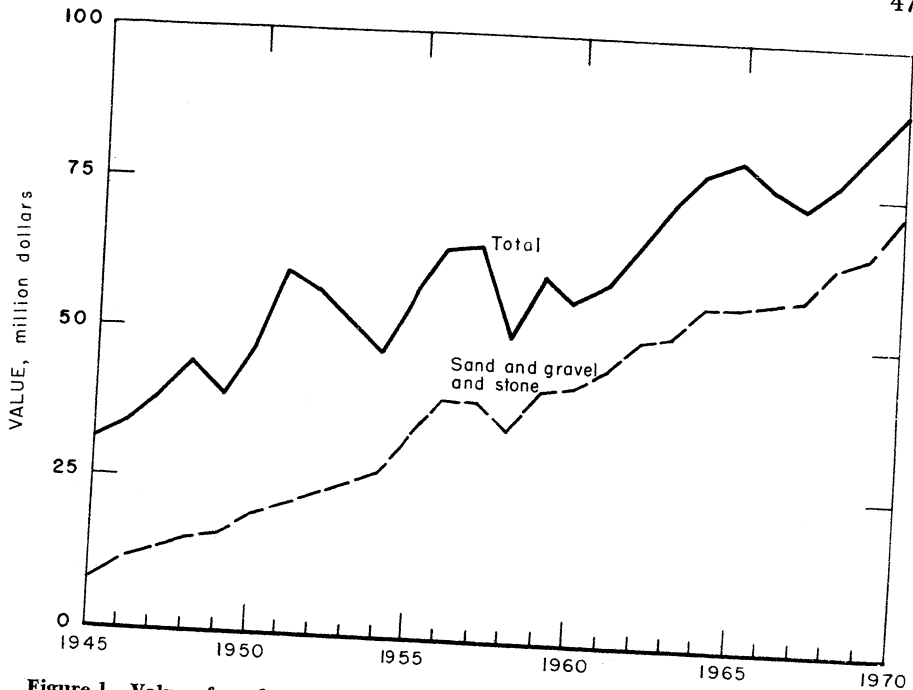


Figure 1.—Value of sand and gravel and stone, and total value of mineral production in New Jersey.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Peat.....	21	206	4	35	-----	1	28.60	343
Metal.....	176	265	47	379	-----	26	68.66	2,345
Nonmetal.....	290	273	79	634	-----	17	26.80	875
Sand and gravel.....	1,131	239	271	2,233	-----	63	28.22	2,857
Stone.....	935	269	252	2,146	-----	77	36.36	4,178
Total <sup>1</sup> .....	2,553	256	653	5,426	1	184	34.09	3,095
<b>1970:<sup>P</sup></b>								
Peat.....	25	226	6	44	-----	1	22.75	227
Metal.....	160	292	47	380	-----	19	52.66	21,748
Nonmetal.....	300	275	83	666	-----	24	36.05	910
Sand and gravel.....	990	245	243	2,009	-----	56	27.87	772
Stone.....	915	247	225	1,897	-----	89	46.92	744
Total <sup>1</sup> .....	2,395	252	604	4,996	1	189	38.03	2,370

<sup>P</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Cement.**—Shipments of portland cement into New Jersey totaled 11 million barrels, the same as in 1969. Masonry cement shipments were 580,000 barrels, 3 percent less

than in 1969. Most of the portland and masonry cement was manufactured in eastern Pennsylvania and eastern New York. Cement was distributed from five terminals, two in Jersey City and one each in Bayonne, Elizabethport, and Newark.

**Clays.**—The quantity of clay sold or used by producers declined 20 percent as compared with that of 1969, continuing the trend since 1965. Total value, however, was only 12 percent lower, reflecting an increase in the average unit value. Miscellaneous clay and shale, used for building brick and other heavy clay products, accounted for 72 percent of the output, but fireclay contributed more than half of the value. Fireclay was used principally for firebrick, foundry clay, and refractory mortar. Fireclay was also used for insecticides, drilling mud, wall and floor tile, white-ware, and other uses. Miscellaneous clay and shale were produced in Middlesex, Somerset, Camden, and Burlington Counties, in descending order of tonnage. The leading producer was Glen-Gery Corp. Fireclay was mined in Middlesex and Cumberland Counties. The leading producer was A.P. Green Refractories Co.

**Gem Stones.**—Collectors and dealers collected mineral specimens from several localities, mine dumps, and quarries, principally in the northern part of the State. The value of the material collected was estimated to be about \$10,000, the same as in 1969.

**Gypsum.**—Crude gypsum was calcined at four plants, two in Burlington County and one each in Bergen and Camden Counties. The production of 334,000 tons of calcined gypsum was 13-percent lower than that in 1969. Output was used mainly in the manufacture of wallboard, lath, and sheathing. Leading producers were Celotex Corp. and The Flintkote Co.

**Iodine.**—Consumption of organic and inorganic iodine by chemical and pharmaceutical companies in the State totaled 668,000 pounds compared with 608,000 pounds in 1969. The iodine was used for medicines, sanitation products, and other chemicals.

**Lime.**—Output of hydrated lime declined 10 percent in tonnage, but value was about the same as that of 1969. Lime produced by Limestone Products Corp. of America at one plant in Sussex County was used for construction, agriculture, water purification, and sewage treatment.

**Magnesium Compounds.**—Production of refractory magnesia expanded 17 percent. An increase in the average unit value was also reported. The refractory magnesia was produced in Cape May County from sea water and imported dolomite. J. T. Baker

Chemical Co., Warren County, converted purchased materials into a variety of magnesium compounds.

**Marl, Greensand.**—Production of greensand marl was greater in quantity and value than in 1969. Marl, recovered by hydraulic mining from a pit in Gloucester County, was processed and used for water treatment.

**Perlite.**—Crude perlite mined in Colorado, Nevada, and New Mexico was expanded at three plants, two in Middlesex County and one in Mercer County. Expanded perlite was used primarily in roof insulation board and acoustical plaster; other uses included aggregate for ultralight-weight concrete, loose-fill insulation, soil conditioning and as a lightweight filler.

**Pigments.**—Metal-base pigments used primarily in the manufacture of paint, were produced at a number of plants in New Jersey. Iron oxide pigments were produced by Cities Service Co. in Mercer and Middlesex Counties and by E. I. du Pont de Nemours & Co., Inc., in Essex County. Titanium dioxide was produced by The New Jersey Zinc Co., Gloucester City, and National Lead Co., near Sayreville. National Lead Co. manufactured lead pigments. Zinc oxide pigments were produced by Royce Chemical Co., Carlton Hill.

**Sand and Gravel.**—The total output of sand and gravel declined 18 percent from 1969, but the total value was only 7 percent lower. Production of sand and gravel for construction decreased 18 percent in quantity and 3 percent in value as compared with 1969. Average value per ton increased \$0.21 to \$1.38 per ton. Of the 13.9 million tons of sand and gravel used for construction, 2.8 million (20 percent) was unprocessed. Output of industrial sand for all uses decreased 17 percent in quantity and 12 percent in value, reflecting an increase of \$0.25 in the average value per ton. Industrial sand accounted for 17 percent of the tonnage and 35 percent of the value of all sand and gravel produced in the State. Most of the industrial sand was produced in Cumberland County, where most operations used suction pumps mounted on barges that floated on ponds fed by ground water. The sand and water slurry was pumped to processing plants for sizing, grinding, or other treatment. Many of the ponds created by removal of the sand are used for fishing and other recreational activities.

The number of sand and gravel operations dropped to 86 from 100 in 1969. Production was reported from 14 of the State's 21 counties and exceeded 1 million tons in each of six counties. Cumberland County ranked first in tonnage and value; its industrial sand accounted for more than one-third of the total value of sand and gravel produced in the State. Only one operation produced more than 1 million tons, three produced from 500,000 to 1 million tons, and 43 produced from 100,000 to 500,000 tons. Shipments to consumers were primarily by truck (13.6 million tons) and rail (2.3 million tons).

**Stone.**—A high level of building activity continued, especially in highway construction, in the State's northern and northwestern counties and created a steady demand for stone aggregates. Total stone output was virtually the same as in 1969, but the value increased by nearly 20 percent. Stone was quarried in 10 counties, led by Somerset, Passaic, Sussex, and Hunterdon Counties, in decreasing order of

value. Types of stone produced in decreasing order of tonnage were basalt, granite, limestone, marble, miscellaneous stone, and sandstone. Basalt (traprock) continued as the leading type of stone quarried and accounted for 80 and 79 percent of the State's total stone production and value respectively. Output of 12.1 million tons of crushed basalt was 2 percent lower than in 1969; average value increased from \$2.14 per ton to \$2.65. Somerset County with 6.4 million tons and Passaic County with 2 million tons were the leading basalt producers. Quarries were also active in Essex, Hudson, Hunterdon, Mercer, and Union Counties. Ninety-six percent of the output was used as aggregate for highway and building construction, but quantities were also sold for riprap, railroad ballast, and other uses.

Crushed granite production increased 26 percent to 2.4 million tons. Average value increased \$0.05 per ton to \$2.11. Quarries were operated at eight locations in Hunterdon, Morris, Passaic, and Sussex Coun-

Table 5.—New Jersey: Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building.....	6,344	\$6,501	4,358	\$5,573
Fill.....	1,363	636	1,002	575
Paving.....	4,189	4,426	1,833	2,159
Blast.....	129	647	114	455
Molding.....	1,431	5,216	613	2,949
Other uses <sup>1</sup> .....	1,866	8,206	4,639	12,354
Total <sup>2</sup> .....	15,322	25,634	12,559	24,064
Gravel:				
Building.....	2,595	5,092	1,532	3,356
Fill.....	296	245	1,235	1,856
Paving.....	1,832	2,489	1,016	1,450
Other uses <sup>3</sup> .....	280	517	380	833
Total <sup>2</sup> .....	5,003	8,343	4,163	7,499
<b>Government-and-contractor operations:</b>				
Sand:				
Other uses.....			5	5
Total <sup>2</sup> .....			5	5
Gravel:				
Building.....			3	2
Fill.....			2	1
Total <sup>2</sup> .....			5	3
Total sand and gravel <sup>2</sup> .....	20,325	33,977	16,732	31,571

<sup>1</sup> Includes fire or furnace, engine, filtration, railroad ballast (1970), glass, oil (hydrafrac) (1969), ground, and other sands.

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

<sup>3</sup> Includes miscellaneous and other gravel.

ties. Small quantities were sold for riprap; the bulk of the output was used for concrete aggregate and roadstone.

Crushed limestone was produced at two quarries in Sussex County and one in Warren County. Output was 10 percent greater than that of 1969, but total value increased only 5 percent, reflecting a decrease in average value. The limestone was used principally for agricultural stone (ag-stone), concrete aggregate, filler, lime, and poultry grit. Dimension sandstone was quarried for flagstone in Hunterdon County, and marble was quarried and crushed in Warren County for use in terrazzo.

**Sulfur.**—Shipments of byproduct sulfur declined 11 percent to 49,000 long tons. The total value was substantially lower because the average per long ton decreased to \$27.64 from \$39.18 in 1969. Elemental sulfur was recovered as a byproduct of petroleum, which was refined at four plants, two in Gloucester and one each in Union and Middlesex Counties.

**Vermiculite.**—Exfoliated vermiculite was produced by one plant each in Essex, Mercer, and Middlesex Counties; the crude material was shipped from other states or imported. The exfoliated vermiculite was used mainly as loose-fill insulation, plaster and lightweight concrete aggregate, and for agricultural purposes.

#### METALS

**Ferroalloys.**—Shieldalloy Corp., Newfield, Gloucester County, produced ferroalloys of vanadium, titanium, boron, columbium, and columbium-nickel.

**Titanium.**—Both quantity and value of ilmenite concentrate production were lower than in 1969, but the average unit value was higher. Glidden-Durkee Division of SMC Corp. recovered ilmenite from a sand deposit about 3 miles north of Lakehurst, Ocean County. The material was concentrated and shipped to a company-owned plant at Baltimore, Md., for conversion to titanium dioxide pigment.

**Zinc.**—The quantity of manganiferous zinc ore mined at Sterling Hill, Sussex County, increased 14 percent over that of 1969. The ore was treated, and the concentrates shipped to a company-owned smelter at Palmerton, Pa., where zinc and manganiferous residuum were recovered.

#### MINERAL FUELS

**Coke and Coal Chemicals.**—Koppers Co., Inc, produced coke and coal chemicals at its merchant oven coke plant at Kearney, Hudson County. Coal chemicals recovered included crude coal tar and crude light oil.

**Peat.**—Production and sales of peat declined for the second year, but the average value increased from 1969. Peat was recovered from bogs near Newton, Stanhope, and Sussex in Sussex County and from Great Meadows in Warren County. Most of the output was used for soil improvement. A small quantity was used in mushroom beds.

**Petroleum.**—Six petroleum refineries active in the State reported a total crude oil capacity of about 520,000 barrels per day. Products recovered included gasoline, asphalt, coke, lubricants, and paraffin.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Clays:</b>			
<b>Fire clay:</b>			
Crossman Co.-----	P.O. Box 38 South Amboy, N.J. 08879	Pit.-----	Middlesex.
Daniel Goff Division, Jesse S. Morie & Son, Inc.	P.O. Box 35 Mauricetown, N.J. 08329	Pit.-----	Cumberland.
A. P. Green Refractories Co., U.S. Gypsum Co.	Pennval Road Woodbridge, N.J. 07095	Pit.-----	Middlesex.
<b>Miscellaneous clay:</b>			
Church Brick Co.-----	P.O. Box 129 Bordentown, N.J. 08505	Pit.-----	Burlington.
Glen-Gery Corp.-----	P.O. Box 1656 East Canton, Ohio 44730	Pit.-----	Camden, Somerset.
New Jersey Shale Brick & Tile Corp.	P.O. Box 490 Somerville, N.J. 08876	Pit.-----	Somerset.
The Rosehill Corp. t/a Osch- wald Brick Works.	Cliffwood, N.J. 07721-----	Pit.-----	Middlesex.
Greensand marl: Inversand Co.-----	226 Atlantic Avenue Clayton, N.J. 08312	Pit.-----	Gloucester.

Table 6.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Gypsum, calcined:			
The Celotex Corp.	1500 North Dale Mabry Tampa, Fla. 33607	Plant	Bergen.
The Flintkote Co., Building Products Group-East.	480 Central Ave. East Rutherford, N.J. 07073	do	Camden.
Kaiser Gypsum Co., Inc.	Delanco, N.J. 08075	do	Burlington.
National Gypsum Co.	325 Delaware Ave. Buffalo, N.Y. 14202	do	Do.
Ilmenite: Glidden-Durkee, Division of SCM Corp.	P.O. Box 5 Lakehurst, N.J. 08733	Pit	Ocean.
Iron oxide pigments (manufactured):			
Cities Service Co.	380 Madison Ave. New York, N.Y. 10017	Plant	Mercer, Middlesex.
E. I. du Pont de Nemours & Co., Inc.	Du Pont Building Wilmington, Del. 19898	do	Essex.
Lime: Limestone Products Corp. of America.	122 Main St. Newton, N.J. 07860	do	Sussex.
Magnesium compounds:			
J. T. Baker Chemical Co.	600 North Broad St. Phillipsburg, N.J. 08865	do	Warren.
Northwest Magnesite Co.	2 Gateway Center Pittsburgh, Pa. 15222	do	Cape May.
Peat:			
Hyper-Humus Co.	Lafayette Rd. Newton, N.J. 07860	Bog	Sussex.
Kelsey Humus Co., Partac Peat Co.	Kelsey Park Great Meadows, N.J. 07838	Bog	Warren.
Mt. Bethel Humus Co., Inc.	1270 Broadway New York, N.Y. 10001	Bog	Sussex.
Netcong Natural Products	Lackawanna Drive Stanhope, N.J. 07874	Bog	Do.
Perlite (expanded):			
Coralux Perlite Corp. of New Jersey.	P.O. Box 251 Metuchen, N.J. 08840	Plant	Middlesex.
Grefco, Inc.	630 Shatto Place Los Angeles, Calif. 90005	do	Do.
Zonolite Division, W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 02140	do	Mercer.
Petroleum refineries:			
Chevron Oil Co.	1200 State St. Perth Amboy, N.J. 08861	do	Middlesex.
Hess Oil & Chemical Corp.	State St. Perth Amboy, N.J. 08861	do	Do.
Humble Oil and Refining Co.	Box 22, Linden, N.J. 07036	do	Union, <sup>1</sup> Hudson.
Mobile Oil Corp. <sup>1</sup>	P.O. Box 927 Philadelphia, Pa. 19105	do	Gloucester.
Texaco Inc.	135 East 42d St. New York, N.Y. 10017	do	Do.
Sand and gravel:			
Amico Sand & Gravel Co.	Norman Ave. Riverside, N.J. 08075	Pit	Burlington.
Bennett Sand & Gravel Co., Inc.	Box 517 Manasquan, N.J. 08736	Pit	Monmouth.
Braen Sand & Gravel Co.	Brookside Ave. Wyckoff, N.J. 07481	Pit	Bergen.
Brick-Wall Corp.	Route 70 Lakehurst, N.J. 08733	Pit	Ocean.
Buck Brothers, Inc.	Edison, N.J. 08817	Pit	Middlesex.
Conklyn Brothers	Montville, N.J. 07045	Pit	Morris.
Crossman Co.	P.O. Box 38 South Amboy, N.J. 08879	Pit	Middlesex.
Fisher Bros. Sand & Gravel Co.	115 Hickory Lane Bayville, N.Y. 08721	Pit	Ocean.
Houdaille Construction Materials, Inc.	10 Park Place Morristown, N.J. 07960	Pit	Morris, Ocean, Warren.
Lacey Materials, Inc.	Forked River, N.J. 08731	Pit	Ocean.
National Glass Sand Corp.	P.O. Box 145 Millville, N.J. 08332	Pit	Do.
Pennsylvania Glass Sand Corp.	Berkeley Springs, W. Va. 25411	Pit	Do.
Steckel Concrete Co.	P.O. Box 47 Phillipsburg, N.J. 08865	Pit	Warren.
Tri-Borough Sand & Stone, Inc.	Haddonfield-Berlin Rd. Gibbsboro, N.J. 08026	Pit	Camden.
United States Dredging Corp.	39 Broadway New York, N.Y. 10006	Dredge	Monmouth.
Whitehead Brothers Co.	60 Hanover Rd. Florham Park, N.J. 07932	Pit	Cumberland.

See footnote at end of table.



Table 6.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Smelters (copper):</b>			
American Metal Climax, Inc.....	1270 Avenue of the Americas New York, N.Y. 10020	Plant.....	Middlesex.
American Smelting & Refining Co.	120 Broadway New York, N.Y. 10005	---do.....	Do.
The Anaconda Co.....	25 Broadway New York, N.Y. 10004	---do.....	Do.
<b>Stone:</b>			
<b>Granite, crushed and broken:</b>			
Braen Industries, Inc.....	Box 188, Wyckoff, N.Y. 07481	Quarry.....	Morris.
Glen Gardner Quarry Corp....	Box 344 Glen Gardner, N.J. 08826	---do.....	Hunterdon.
Hamburg Quarry, Inc.....	Route 23, Hamburg, N.J. 07419	---do.....	Sussex.
Shahmoon Industries, Inc.....	R.D. #1, Wharton, N.J. 07885	---do.....	Morris.
Somerset Crushed Stone Division, Anthony Ferrante & Sons, Inc.	Route 202, Mine Brook Rd. Bernardsville, N.J. 07924	---do.....	Hunterdon.
Tri County Asphalt Corp.....	Beaufort Ave. Roseland, N.J. 07068	---do.....	Sussex.
<b>Limestone, crushed:</b>			
Farber White Limestone Co....	Franklin, N.J. 07416	---do.....	Do.
Limestone Products Corp. of America.	122 Main St. Newton, N.J. 07860	---do.....	Do.
Marble, crushed: Maryland Green Marble Corp.	Cardiff, Md. 21024	---do.....	Warren.
<b>Miscellaneous, crushed and broken:</b>			
Passaic Crushed Stone Co., Inc.	Foot of Broad Pompton Lakes, N.J. 07442	---do.....	Passaic.
<b>Sandstone, dimension:</b>			
Delaware Quarries.....	Lumberville, Pa. 18933	---do.....	Hunterdon.
<b>Traprock (basalt), crushed and broken:</b>			
Samuel Braen's Sons.....	662 Goffle Rd. Hawthorne, N.J. 07500	---do.....	Passaic.
Callanan Trap Rock Corp.....	South Bethlehem, N.Y. 12161	---do.....	Hudson.
Dock Watch Quarry Pit, Inc....	Box 245 Martinsville, N.J. 08836	---do.....	Somerset.
Fanwood Crushed Stone Co....	141 Central Avenue Westfield, N.J. 07090	---do.....	Do.
Houdaille Construction Materials, Inc.	10 Park Place Morristown, N.J. 07960	---do.....	Hunterdon, Passaic, Somerset, Union, Essex.
M. L. Kernan Quarry.....	500 Tillon Rd. South Orange, N.J. 07079	---do.....	Do.
Orange Quarry Co.....	318 Eagle Rock Ave. West Orange, N.J. 07050	---do.....	Do.
Somerset Crushed Stone Division, Anthony Ferrante & Sons, Inc.	Route 202, Mine Brook Rd. Bernardsville, N.J. 07924	---do.....	Somerset.
Trap Rock Industries, Inc....	Laurel Ave. Kingston, N.J. 08528	---do.....	Hunterdon, Mercer, Somerset.
The Union Building & Construction Corp.	315 Howe Ave. Passaic, N.J. 07055	---do.....	Passaic.
Warren Brothers Co., Sowerbutt-Standard District.	Planten Ave., Prospect Park Paterson, N.J. 07502	---do.....	Do.
<b>Sulfur (recovered):</b>			
The Anlin Co. of New Jersey....	1200 State St. Perth Amboy, N.J. 08861	Plant.....	Middlesex.
<b>Vermiculite (exfoliated):</b>			
Coralux Perlite Corp. of New Jersey.	P.O. Box 251 Metuchen, N.J. 08840	---do.....	Do.
Vermiculite Industrial Corp.....	308 Gilligan Ave. Fort Newark, N.J. 07114	---do.....	Essex.
Zonolite Division, W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 02140	---do.....	Mercer.

<sup>1</sup> Also byproduct elemental sulfur.

# The Mineral Industry of New Mexico

By Richard B. Smith <sup>1</sup>

Mineral production in New Mexico topped the \$1 million mark for the first time when it reached \$1,060,358 during 1970. The increase of almost \$125 million over the value of 1969 production is also a record high. Fuels ranked first in value of minerals produced, \$657.3 million; metals second, \$289.2 million; and nonmetals third, \$113.9 million. The value of metal production gained 35 percent over the 1969 level; nonmetals gained 28 percent and fuels 4 percent. Increases in the quan-

ties produced and prices paid for copper and potash account for most of the gain in total value of minerals produced. Copper production exceeded natural gas in value for the first time since 1957. Modest gains occurred in natural gas, natural gas liquids, and petroleum. The principal dollar loss was in the output of zinc. Perlite, gold, and manganese also showed losses in value.

<sup>1</sup> Petroleum engineer, Division of Fossil Fuels.

Table 1.—Mineral production in New Mexico <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Carbon dioxide (natural).....thousand cubic feet..	902,186	\$69	W	W
Clays.....thousand short tons..	70	89	67	\$91
Coal (bituminous).....do.....	4,471	16,376	7,361	21,249
Copper (recoverable content of ores, etc.)				
short tons..	119,956	114,040	166,278	191,885
long tons..	W	W	W	W
Feldspar.....do.....	NA	60	NA	60
Gem stones.....do.....	8,952	372	8,719	317
Gold (recoverable content of ores, etc.)...troy ounces..	141	526	W	W
Gypsum.....thousand short tons..				
Helium:				
Crude.....million cubic feet..	--	--	1	18
Grade A.....do.....	13	260	(?)	6
Lead (recoverable content of ores, etc.)...short tons..	2,368	705	3,550	1,109
Lime.....thousand short tons..	37	W	37	W
Manganese concentrate (35 percent or more Mn)				
short tons, gross weight..	4,855	131	4,225	W
Manganiferous ore (5 to 35 percent Mn).....do.....	49,146	340	46,166	W
Natural gas (marketed).....million cubic feet..	1,138,133	155,924	1,138,980	162,874
Natural gas liquids:				
LP gases.....thousand 42-gallon barrels..	24,920	30,402	25,999	37,179
Natural gasoline and cycle products.....do.....	9,053	24,388	9,606	25,548
Peat.....thousand short tons..	(?)	4	(?)	7
Perlite.....short tons..	397,987	4,493	382,456	4,321
Petroleum (crude).....thousand 42-gallon barrels..	129,227	404,441	128,184	410,320
Potassium salts				
thousand short tons K <sub>2</sub> O equivalent..	2,327	62,034	2,390	85,877
Pumice.....thousand short tons..	226	415	203	442
Sand and gravel.....do.....	8,574	10,422	10,666	10,516
Silver (recoverable content of ores, etc.)				
thousand troy ounces..	466	834	782	1,385
thousand short tons..	2,826	3,236	3,100	4,030
Uranium (recoverable content U <sub>3</sub> O <sub>8</sub> )				
thousand pounds..	11,811	69,887	11,574	69,970
Zinc (recoverable content of ores, etc.)...short tons..	24,308	7,098	16,601	5,086
Value of items that cannot be disclosed: Beryllium concentrate (1969), cement, fluorspar, iron ore (usable), mica (scrap), molybdenum, salt, tin (1969), vanadium, and values indicated by symbol W.....	XX	29,150	XX	28,068
Total.....	XX	935,746	XX	1,060,358
Total 1967 constant dollars.....	XX	883,625	XX	959,624

<sup>2</sup> Preliminary. NA Not available. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not applicable.

<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.

<sup>3</sup> Excludes certain dimension stone, included with "Value of items that cannot be disclosed."

<sup>4</sup> Value estimated based on \$5.86 per pound for sales to the Atomic Energy Commission and an assumed price of \$6.10 per pound for commercial sales; includes value of U<sub>3</sub>O<sub>8</sub> obtained from New Mexico ores processed at an out-of-State mill.

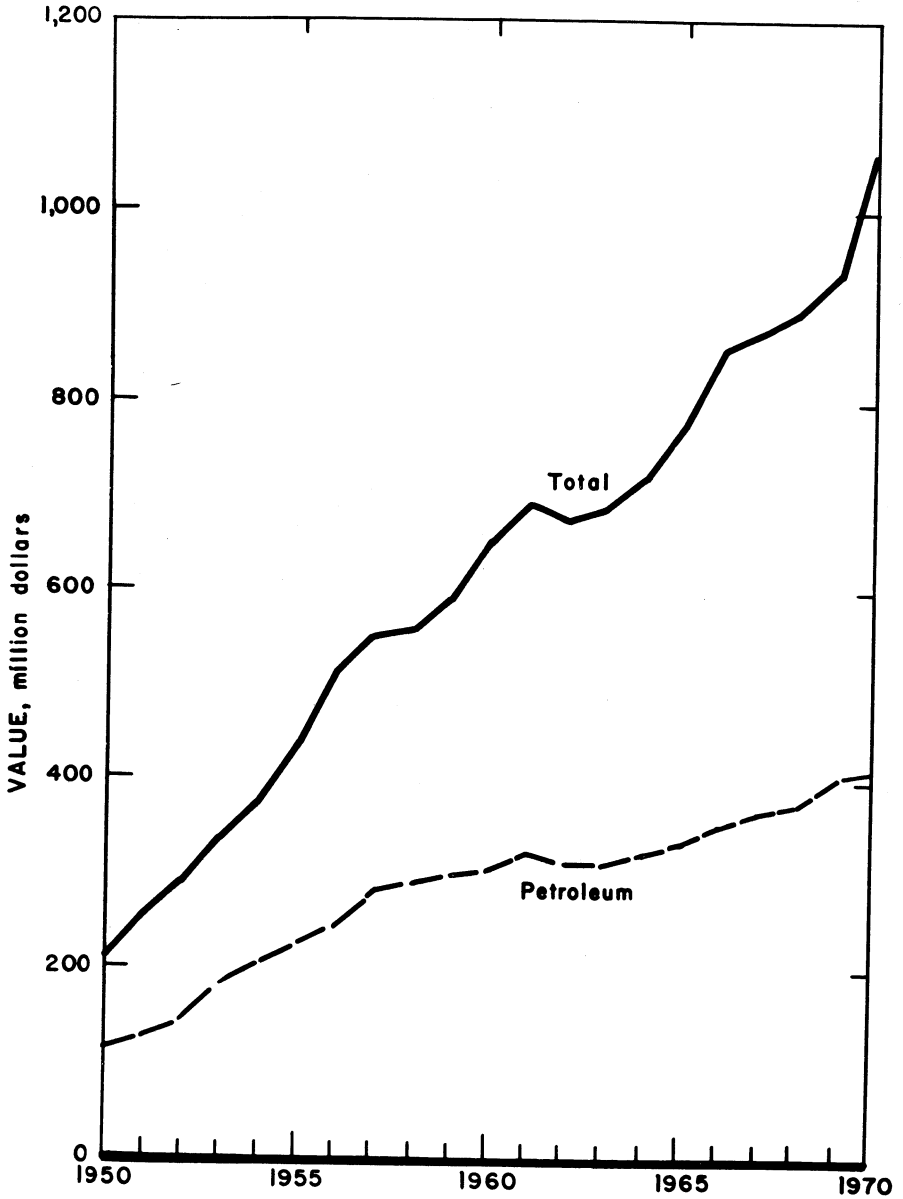


Figure 1.—Value of petroleum and total value of all mineral production in New Mexico.

Table 2.—Value of mineral production in New Mexico, by counties  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Bernalillo	\$8,675	\$8,198	Cement, sand and gravel, stone, clays.
Catron	W	W	Sand and gravel, stone, salt.
Chaves	19,908	16,484	Petroleum, natural gas, sand and gravel, stone.
Colfax	W	W	Coal, sand and gravel, stone.
Curry	W	W	Stone.
De Baca	W	W	Sand and gravel.
Doña Ana	788	416	Sand and gravel, pumice, clays, stone.
Eddy	139,758	168,151	Potassium salts, petroleum, natural gas, natural gas liquids, salt, stone, sand and gravel.
Grant	122,824	199,169	Copper, zinc, molybdenum, silver, lead, lime, manganese ore, gold, stone, fluorspar, sand and gravel.
Guadalupe	13	W	Sand and gravel, copper, silver, gold.
Harding	69	W	Carbon dioxide.
Hidalgo	2,117	2,695	Copper, silver, gold, sand and gravel, clays, zinc.
Lea	381,671	895,329	Petroleum, natural gas, natural gas liquids, stone, sand and gravel.
Lincoln	W	125	Sand and gravel, stone, pumice.
Los Alamos	1	2	Sand and gravel.
Luna	497	578	Sand and gravel, clays, stone.
McKinley	54,785	70,958	Uranium, natural gas, natural gas liquids, stone, sand and gravel.
Mora	734	W	Sand and gravel, stone.
Otero	326	W	Do.
Quay	35	W	Sand and gravel.
Río Arriba	14,164	16,062	Natural gas, petroleum, natural gas liquids, sand and gravel, stone, pumice.
Roosevelt	15,920	21,961	Petroleum, natural gas, natural gas liquids, sand and gravel.
Sandoval	715	829	Gypsum, sand and gravel, petroleum, pumice, natural gas, peat, stone.
San Juan	115,863	102,934	Natural gas, petroleum, coal, natural gas liquids, sand and gravel, stone, helium, uranium, pumice.
San Miguel	328	W	Sand and gravel, stone.
Santa Fe	2,116	1,584	Sand and gravel, copper, stone, gypsum, pumice, gold, silver, zinc, lead.
Sierra	W	W	Sand and gravel, copper, silver, lead, gypsum, gold, zinc.
Socorro	638	225	Manganese concentrate, sand and gravel, iron ore, stone, copper, silver, zinc.
Taos	23,639	21,796	Molybdenum, perlite, sand and gravel, stone, mica.
Torrance	363	W	Sand and gravel, stone.
Union	W	W	Pumice, sand and gravel, stone.
Valencia	20,179	21,826	Uranium, perlite, sand and gravel, stone.
Undistributed <sup>1</sup>	9,627	11,045	
Total <sup>2</sup>	935,746	1,060,358	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."  
<sup>1</sup> Includes gem stones, some sand and gravel, stone, vanadium, silver, copper, lead, and zinc that cannot be assigned to specific counties; and values indicated by symbol W.  
<sup>2</sup> Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of New Mexico business activity

	1969	1970	Change, percent
Employment and labor force, annual average:			
Total labor force..... thousands..	336.6	373.9	+2.0
Employment..... do.....	348.4	350.0	+5
Unemployment..... do.....	18.2	23.7	+30.2
Nonagricultural employment:			
Mining..... do.....	17.3	16.9	-2.3
Construction..... do.....	17.9	15.9	-11.2
Manufacturing..... do.....	20.3	21.2	+4.4
Government..... do.....	86.3	81.6	-5.4
Wholesale and retail trade..... do.....	60.2	60.9	+1.2
Transportation and public utilities..... do.....	20.0	20.1	+5
Services..... do.....	53.6	53.5	-2
Finance, insurance, and real estate..... do.....	12.0	12.4	+3.3
Personal income:			
Total..... millions..	\$2,879	\$3,099	+7.6
Per capita..... do.....	\$2,848	\$3,044	+6.9
Construction activity:			
Total value of construction contracts..... millions..	\$284.7	\$350.3	+23.0
Residential..... do.....	\$83.4	\$85.2	+2.2
Nonresidential..... do.....	\$96.6	\$93.0	-3.7
Nonbuilding..... do.....	\$104.7	\$172.1	+64.4
Highway construction contracts awarded..... do.....	\$61.3	\$47.2	-23.0
Cement shipments to and within the State thousand 376-pound barrels..	2,339.6	2,282.0	-2.5
Farm marketing receipts..... millions..	\$390.3	\$393.8	+0.9
Mineral production..... do.....	\$935.7	\$1,060.4	+13.3

<sup>1</sup> Revised.

Sources: Area Trends in Employment and Unemployment; Survey of Current Business; Employment and Earnings; Farm Income Situation; Roads and Streets Magazine; Construction Review; and U.S. Bureau of Mines.

The area of the State having the highest value of mineral production was in the southeast where Lea, Chaves, Eddy, Roosevelt and Lincoln Counties produce almost 60 percent of the total value of mineral output. Petroleum is the leading mineral in this area. Second highest in value of mineral production were the northwestern counties of San Juan, Rio Arriba, McKinley and Valencia. Oil and gas, uranium, and coal are important minerals in these counties. The leading producers of metals and nonmetals with about 20 percent of the total value of minerals were the southwestern counties of Doña Ana, Grant, Hidalgo, Luna, and Socorro.

**Employment and Injuries.**—Final data for 1969 and preliminary data for 1970, compiled by the Bureau of Mines on employment and injuries in the mineral industries of New Mexico, are reported in table 4. Data on mineral fuels are excluded except for coal.

**Legislation and Government Programs.**—Results of significant studies on certain New Mexico mineral resources were published during the year by State and Federal agencies.<sup>2</sup>

The Interstate Highway system in New Mexico at year-end consisted of 825.36 miles open to traffic, 50.10 miles under construction, and 86.24 miles under preparation of plans and specifications or right-of-way acquisition. Of the 999.19 miles of designated Interstate system, all but 37.49 miles was completed or experienced some progress towards completion. The amount

of Interstate highway open to traffic increased 85.6 miles during the year.

A gun that cuts rock with a high-energy electron beam, offering a potentially safer

<sup>2</sup> Bieberman, Robert A. Index to Samples From Oil and Gas Well Tests in Library at Socorro, New Mexico, July 1, 1966 to June 1, 1970. New Mexico Bur. Mines and Miner. Res. Circ. 109, 1970, 10 pp.

Ericksen, G. E., Helmuth Wedow, Jr., G. P. Eaton, and G. R. Leland. Mineral Resources of the Black Range Primitive Area, Grant, Sierra, and Catron Counties, New Mexico. U.S. Geol. Survey Bull. 1319-E, 1970, 162 pp.

Escalera, Saul J., and Roshan B. Bhappu. Selective Flotation of Molybdenite From Chalcopyrite Concentrates by Potassium Permanganate. New Mexico Bur. Mines and Miner. Res. Circ. 106, 1970, 15 pp.

Goebel, Lorna M. Analysis of Rhenium in Molybdenites. New Mexico Bur. Mines and Miner. Res. Circ. 108, 1970, 17 pp.

Hawks, William L. Test Data for New Mexico Clay Materials, Part 1, Central New Mexico. New Mexico Bur. Mines and Miner. Res. Circ. 110, 1970, 37 pp.

Kottowski, Frank E., and Wendell J. Stewart. The Wolfcampian Joyita Uplift in Central New Mexico. New Mexico Bur. Mines and Miner. Res. Memoirs 23, pt. 1, 1970, 31 pp.

Perhac, Ralph M. Geology and Mineral Deposits of the Gallinas Mountains, Lincoln and Torrance Counties, New Mexico. New Mexico Bur. Mines and Miner. Res. Bull. 95, 1970, 51 pp.

Renault, Jacques, Rena Mae Bonem, and Ronald Riese. Computerization of the New Mexico Bureau of Mines Mineralogical Museum. New Mexico Bur. Mines and Miner. Res. Circ. 111, 1970, 49 pp.

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Stewart, Wendell J. Fusulinids of the Joyita Hills, Socorro County, Central New Mexico. New Mexico Bur. Mines and Miner. Res. Memoirs 23, pt. 2, 1970, 51 pp.

Zeller, Robert A., Jr. Geology of the Little Hatcher Mountains, Hidalgo and Grant Counties, New Mexico. New Mexico Bur. Mines and Miner. Res. Bull. 96, 1970, 22 pp.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours		
					Fatal	Non-fatal	Frequency	Severity	
1969:									
Coal and peat.....	365	248	90	714	--	22	30.83	7,157	
Metal.....	4,370	274	1,198	9,606	10	409	43.62	7,356	
Nonmetal.....	2,112	333	704	5,666	4	161	29.12	5,217	
Sand and gravel.....	911	178	162	1,347	--	31	23.01	1,984	
Stone.....	252	229	58	471	--	7	14.86	289	
Total.....	8,010	276	2,212	17,804	14	630	36.17	6,074	
1970: <sup>p</sup>									
Coal and peat.....	405	252	102	801	--	31	38.72	1,123	
Metal.....	4,515	283	1,276	10,207	5	402	39.87	4,363	
Nonmetal.....	2,165	325	703	5,629	2	183	32.87	3,295	
Sand and gravel.....	920	177	163	1,323	--	35	26.45	358	
Stone.....	245	218	53	453	--	8	17.66	474	
Total.....	8,255	278	2,298	18,413	7	659	36.17	3,512	

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

and cheaper way to dig mines and tunnels, will be field tested in New Mexico by Westinghouse Electric Corp., developer of the gun. The project will be managed by the U.S. Bureau of Mines. Field tests lasting about a month are scheduled for the first half of 1971.

The number of mining and oil and gas leases on Federal lands in New Mexico increased slightly in 1970 to 15,742 leases comprising 10,142,363 acres.<sup>3</sup> This area

amounts to almost one-third of the 33,979,363 acres of Federal lands in the State and 13 percent of the total area of the State.<sup>4</sup> Although mining leases on Federal lands decreased from 1,145 at yearend 1969 to 728 a year later and acreage in these leases decreased by 35 percent from 1,093,887 to 707,240 acres, oil and gas leases more than offset the decline by increasing 6.4 percent to 9,435,123 acres.

## REVIEW BY MINERAL COMMODITIES

### MINERAL FUELS

The value of mineral fuels production increased \$25.4 million, or 4 percent, in 1970. The total value of mineral fuels, \$657.3 million, comprised 62 percent of the value of the State's mineral output.

**Carbon Black.**—Production of carbon black declined, owing partly to the shut-down on May 1, 1970, of the Ashland Chemical Co. plant near Eunice in Lea County. Thereafter, the Continental Carbon Co. plant, also located in Lea County, was the only remaining plant in operation. The companies did not authorize the Bureau of Mines to release output and operational figures.

**Carbon Dioxide.**—Production of carbon dioxide decreased in both quantity and value from 1969 levels. S.E.C. Corporation produced the bulk of the State total. The balance was produced by Schwartz Carbonic Co. All production was in Harding County. Data on quantity produced in 1971 and its value are withheld to avoid disclosing individual company confidential information.

**Coal.**—Bituminous coal output reached 7.4 million tons in 1970, a 65-percent increase from the 1969 figure and more than double the output of 1968. The value of 1970 production, \$21.2 million, reflects a continuation of a long-term trend of decreasing price per ton. The average price of coal dropped from \$6.01 in 1961 to \$2.89 in 1970.

Most of the coal is produced at the Navajo strip mine of Utah Construction & Mining Co., southwest of Fruitland, which supplies low-sulfur, high-ash coal to the Four Corners powerplant of Arizona Public Service Co. To comply with the New Mexico air pollution control standards, Ar-

izona Public Service Co. began installing wet scrubbers on three of its five power-generating units in the Four Corners plant, for which mechanical scrubbers now control 80 percent or more of the fly ash. The new scrubbers will cost about \$11 million. Besides removing 99.2 percent of fly ash they will also take out about 20 percent of the sulfur dioxide. The two newest units of the powerplant were installed in 1970 and are equipped with scrubbers and electrostatic precipitators which have a design capability of 98.4-percent particulate removal. They will require some modification before December 31, 1973, to meet the New Mexico requirement for 99.2-percent control.

Utah Construction & Mining Co. utilizes the bottom ash and fly ash from their coal to help reclaim the strip mine area. The ash is trucked back to the abandoned parts of the mine. Most of the ash is placed in the valleys between the spoil-bank ridges and covered to a depth of about 3 feet with spoil material pushed from the peaks. The result is an undulating topography that has greater resistance to water and wind erosion than the former natural terrain, allowing growth of native vegetation. The remaining ash is dispersed within the active mine area where it is covered by thick spoil during stripping operations.

An increase in the production capacity of the Utah Construction & Mining Co.'s Navajo mine was completed during 1970 to match the rate of fuel consumption of the

<sup>3</sup> U.S. Geological Survey. Oil and Gas and Mineral Leases, Licenses, and Permits; Public, Acquired, Indian, Naval Petroleum Reserve, and Outer Continental Shelf; Under Supervision December 31, 1969 and 1970.

<sup>4</sup> Office of the Commissioner of Public Lands, State of New Mexico. Annual Report, 58th Fiscal Year, July 1, 1969 to June 30, 1970. September 1970, p. 6.

Four Corners powerplant. Coal sales were 5.5 million tons, more than 78 percent over 1969 sales of 3.1 million tons, to meet the first full year's fuel requirements of generating unit No. 4 and a short period of the requirements of generating unit No. 5. Utah Construction & Mining Co. estimates in its annual report that the enlarged plant in normal operation will burn about 8 million tons of coal annually. This tonnage will be supplied from the Navajo mine under long-term contracts containing cost escalation provisions. About one-third of the 1.1-billion-ton Navajo coal reserves is committed to electric power generation, and the remainder is available for future development.

One of the advantages of the San Juan Basin coals is their low sulfur content, which averages about 0.7 percent compared with the average of about 5 percent for midwest and eastern U.S. coals. To test the economics and suitability of using New Mexico's low-sulfur coal in midwestern powerplants, a 100-car train hauled 10,000 tons of low-sulfur coal from the Sundance Coal Co.'s strip mine near Gallup to the Commonwealth Edison Co. of Chicago for testing in their State Line generating station at Hammond, Ind. If haulage of low-sulfur coal to the Midwest proves economically feasible, it would greatly increase the demand for New Mexico's strippable coal.

Public Service Co. of New Mexico and Tucson Gas & Electric Co. began construction on their San Juan powerplant located north of the Four Corners powerplant. The Fruitland coalbeds used in the Four Corners plant will also be strip-mined north of the river, to feed the San Juan powerplant. The San Juan plant will have an eventual capacity of 1,035 million watts, though the first unit will generate only 345 million watts. The pollution-control devices engineered into this new plant are reported to be 99.5 percent effective and will cost about \$2.7 million, which is about 5 percent of the total cost. When running at full capacity, the San Juan powerplant will require more than 9,000 tons per day of low-sulfur coal.

During 1970 much coal-exploratory drilling was carried on in the San Juan Basin region, the Raton field, and in several other coal fields of New Mexico.

The McKinley strip mine of The Pitts-

burg & Midway Coal Mining Co., northwest of Gallup, produced more than 3,000 tons of coal per day to be shipped by unit train to the Arizona Public Service Co.'s Cholla powerplant at Joseph City, Ariz. Production from the Sundance strip mine, south of Gallup, was down in 1970 but it would be substantially increased if contracts were drawn to send its low-sulfur coal to the Midwest by unit train.

Coking coal mined by Kaiser Steel Corp. in its York Canyon underground mine west of Raton is shipped by unit train to Kaiser's Fontana, Calif. steel plant. Approximately 1 million tons of coking coal was mined in 1970 near Raton. Although the major mine is underground, it is a relatively inexpensive operation because the coalbeds are nearly level and are mined through horizontal openings from the canyons that dissect the Raton coalfield.

Geologic work by the U.S. Geological Survey has shown that the reserves of deep Fruitland coal in the San Juan Basin are three to five times greater than previously estimated. Reconnaissance geologic work and core drilling by the New Mexico State Bureau of Mines and Mineral Resources under a matching grant with the Air Pollution Control Office of the Environmental Protection Agency have located strippable reserves of low-sulfur coal in the San Juan Basin which total about 6 billion tons. Much of this quantity is proved reserves drilled by lease holders such as Utah Construction & Mining Co., Public Service Co. of New Mexico, and The Pittsburg & Midway Coal Mining Co.

**Natural Gas.**—Marketed natural gas was up 847 million cubic feet, less than 1 percent, to 1,139 billion cubic feet; value was up almost 5 percent to \$162.9 million. Data compiled by the State Oil Conservation Commission show that San Juan County, the State's leading source, declined in output by almost 5 percent. This loss was offset by production in southeastern New Mexico, where every producing county registered a gain. Roosevelt and Chaves Counties gained 39 and 19 percent, respectively. The highest percentage gain was McKinley County which increased its output 151 percent from 22.5 to 56.4 million cubic feet.

The three leading counties, San Juan, Lea, and Eddy, produced 92 percent of the total natural gas output.

Natural gas reserves at yearend 1970 were estimated by the American Gas Association, Inc. (AGA) <sup>5</sup> at 13,290 billion cubic feet, down 6.9 percent from a year earlier. About 65 percent of this gas reserve is in the San Juan Basin in the northwest quarter of the State, the balance being in four southeastern counties. The 69.5 billion cubic feet of reserves added by new field and pool discoveries were not sufficient to offset the 1.1 trillion cubic feet of production. Reserves declined 10.8 percent in the southeast, compared with a drop of 4.6 percent in the northwest corner of the State.

Royalty received by the State for the production of natural gas was \$4.2 million, up 7.7 percent. Taxes paid to the State for the production of gas, consisting of school tax, severance tax, conservation tax, and ad valorem tax, amounted to \$9.4 million, up 5.6 percent.<sup>6</sup> These figures do not include receipts from the State's share (37.5 percent) of royalties paid on production from public domain, nor bonuses and rentals paid for leases on State lands.

Eight exploratory wells were completed as gas discoveries during 1970, a decrease of three wells from the level of the previous 3 years. A well in southeastern New Mexico that was considered by the American Association of Petroleum Geologists <sup>7</sup> to be significant because of the substantial size of its estimated reserves was Shenandoah Oil Co. well No. 1 Shenandoah-Federal, sec. 21, T 6 S, R 27 E, Chaves County. The well was completed at an initial daily rate of 62.8 million cubic feet producing from the Pennsylvanian age Cisco Formation.

Most significant of the new gas discoveries in Lea County was Union Oil Co. of California No. 1 Pipeline-Federal, which was completed for an initial potential of 26.4 million cubic feet of gas per day producing from the Morrow Formation at a depth of 13,420 to 13,442 feet. The well is in sec. 4, T 19 S, R 34 E, which is about 16 miles west of Hobbs.

In northwestern New Mexico the only gas discovery in 1970 was drilled in San Juan County by Thomas Dugan. The well No. 1 Waw, sec. 32, T 27 W, R 13 W, was completed for an initial potential of 401,000 cubic feet per day from the Pictured Cliffs Formation at 1,325-1,329 feet.

Warren Petroleum Corp. began construc-

tion of a new gas processing plant about 3 miles northeast of Crossroads in Lea County. The facility, designated as the Bough plant, will have an initial capacity of 25 million cubic feet per day. Residue gas will be sold to Natural Gas Pipeline Company of America.

Southern Union Production Co. began work on its gas processing plants at Lybrook and Bloomfield to improve recovery rates at both plants. Capacities are not affected.

El Paso Natural Gas Co. completed two construction projects at their Jal complex of four plants. A 16,800-horsepower turbine compressor installation at one plant and a refrigeration unit at another will result in a net gain in capacity of 50 million cubic feet per day despite the eventual shutdown planned for one of the four plants.

**Natural Gas Liquids.**—Production of natural gas liquids increased 4.8 percent over the 1969 level to 35.6 million barrels. A total of 1,101.4 billion cubic feet of natural gas was processed. After extraction of liquids, 808.4 billion cubic feet was shipped to transmission companies, 170.7 billion delivered directly to customers, and 105.5 billion used for plant fuel and reinjected into producing formations.

Yearend reserves of natural gas liquids were estimated by the AGA <sup>8</sup> at 558.6 million barrels, a decline of 6.8 percent from the 599.7 million barrels of liquids estimated for New Mexico a year earlier. More than 65 percent of the decrease in natural gas liquids reserves occurred in southeastern part of the State, where gas is produced in association with oil. Most of the natural gas and natural gas liquids produced in the northwestern part of the State is from reservoirs that contain no oil. Slightly more than half of the reserves of natural gas liquids are in the San Juan Basin of northwestern New Mexico.

<sup>5</sup> American Gas Association, Inc., American Petroleum Institute, and Canadian Petroleum Association. Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States and Canada and United States Productive Capacity as of December 31, 1970. V. 25, May 1971, p. 114.

<sup>6</sup> New Mexico Oil and Gas Accounting Commission. Oil and Gas Accounting Report, County Summary for the Calendar Year 1970. Mar. 8, 1971, 16 pp.

<sup>7</sup> Sanger, Willard A. and W. L. Saultz. Developments in West Texas and Eastern New Mexico in 1970. Am. Assoc. Petrol. Geol. Bull., v. 55, No. 7, July 1971, p. 1040.

<sup>8</sup> Work cited in footnote 5.



**Peat.**—T. L. Fox continued producing and shipping peat under the new name of Humus Organic Products Co. from a humus deposit near San Ysidro, Sandoval County. Production and shipments were up 12 percent to 500 tons. The peat was used in mixed fertilizers.

**Petroleum.**—Production of crude petroleum decreased less than 1 percent from the record high of 129 million barrels in 1969 to 128 million barrels in 1970. Significant increases in Roosevelt County, up 1.4 million barrels, and Eddy County, up 760,000 barrels, were insufficient to overcome the decreases in output from Chaves County, down 1.4 million, Lea County, down 1.5 million, and San Juan County, down 0.9 million barrels.

According to the State Oil Conservation Commission, 17,314 oil wells in 713 reservoirs were producing oil at yearend, an increase of 226 wells and 10 pools. There were 2,550 injection wells in secondary-recovery or pressure-maintenance projects. The Permian Basin continued to be the principal oil-producing area, with 93 percent of the output and over 90 percent of the wells and oil pools.

Direct revenues to the State from crude oil production totaled \$46.4 million,<sup>9</sup> a decrease of 2.9 percent. Royalties amounted to \$22.6 million, with the balance divided among school, severance, conservation, and ad valorem taxes. The \$46.4 million represents 11.6 percent of the value of crude oil sales during the year.

Proved reserves of crude oil were estimated by the American Petroleum Institute<sup>10</sup> at 760.9 million barrels as of December 31, 1970, a decrease of 9.4 percent. Additions to reserves from new fields and new pools totaled 5.8 million barrels;

extensions and revisions of existing fields added 38.7 million barrels. Depletion of reserves by production of 123.5 million barrels more than offset the additions to reserves.

Overall drilling activity decreased by 486 wells, 40 percent, compared with 1969. Most of the decrease was in development drilling, down 45 percent compared with 14 percent for exploratory drilling. Total drilling in Lea County decreased 50.8 percent; that in San Juan County was down 49.6 percent.

Success ratio for wildcat drilling was 14.7 percent, slightly below the 16.9 percent of 1969. For development drilling the success ratio was 84.2 percent, a slight improvement over the 81.5 percent of 1969. Eddy County, tied for fourth place with Rio Arriba County in total number of wells drilled, was the leading county in the number of discovery wells.

In Lea County the most significant discovery was the West Garrett oilfield in Devonian dolomite. The discovery well, Freeport Oil Co., and The Louisiana Land and Exploration Co. well No. 1 Price, sec. 6, T 17 S, R 38 E, flowed 375 barrels per day from a depth of 12,695 feet.

Another high-producing discovery oil well in Lea County was the Lone Star Producing Co. well No. 1, New Mexico 80 State test, about 15 miles northwest of Lovington, which yielded 450 barrels per day from Pennsylvanian age rock at a depth of 10,708 feet. The field was named Tres Papalotes. The discovery well for the East Morton oilfield in Lea County was Samedan Oil Corp. well No. 1 Gulf-State, sec. 4, T 15 S, R 35 E, which had an ini-

<sup>9</sup> Work cited in footnote 6.

<sup>10</sup> Work cited in footnote 5.

Table 5.—Petroleum production, crude oil and condensate, and natural gas, by counties

County	Crude oil and condensate (thousand 42-gallon barrels)		Natural gas (million cubic feet)	
	1969	1970	1969	1970
Chaves.....	5,848	4,474	9,955	11,822
Eddy.....	17,249	18,009	134,088	139,622
Lea.....	92,679	91,165	422,828	436,252
McKinley.....	822	1,214	22	56
Rio Arriba.....	1,297	1,499	59,817	62,853
Roosevelt.....	4,402	5,848	7,950	11,045
Sandoval.....	43	37	55	53
San Juan.....	6,887	5,938	484,974	462,035
Total.....	129,227	128,184	1,119,689	1,123,738

Source: New Mexico Oil Conservation Commission. 1970 Oil & Gas Statistics.

Table 6.—New Mexico: Oil and gas well drilling, by counties

County	Oil	Gas	Dry	Total	Footage
1969					
Exploratory completions:					
Chaves.....	4	--	26	30	160,390
Colfax.....	--	--	1	1	5,810
De Baca.....	--	--	1	1	4,065
Eddy.....	4	4	21	29	229,757
Harding.....	--	--	1	1	2,108
Lea.....	12	5	53	70	665,637
Lincoln.....	--	--	2	2	9,675
McKinley.....	--	--	11	11	17,840
Mora.....	--	--	2	2	14,730
Quay.....	--	--	2	2	2,887
Roosevelt.....	--	--	12	12	77,561
Sandoval.....	--	--	1	1	1,230
San Juan.....	1	2	22	25	47,699
Santa Fe.....	--	--	1	1	1,058
Torrance.....	--	--	1	1	1,910
Total.....	21	11	157	189	1,242,407
Development completions:					
Chaves.....	43	2	13	58	215,047
Eddy.....	29	4	16	49	198,918
Harding.....	--	1	--	1	2,110
Lea.....	359	10	98	467	3,603,322
McKinley.....	18	4	10	32	41,718
Rio Arriba.....	10	100	3	113	620,650
Roosevelt.....	52	1	13	66	471,166
Sandoval.....	6	11	9	26	80,968
San Juan.....	31	154	28	213	580,673
Total.....	548	287	190	1,025	5,814,572
Total, all drilling.....	569	298	347	1,214	7,056,979
1970					
Exploratory completions:					
Chaves.....	2	1	38	41	136,898
Curry.....	--	--	3	3	10,560
De Baca.....	--	--	1	1	1,100
Eddy.....	4	3	13	20	144,660
Guadalupe.....	--	--	1	1	1,438
Harding.....	--	--	3	3	3,917
Lea.....	4	2	30	36	396,406
McKinley.....	2	--	4	6	21,797
Otero.....	--	--	4	4	22,918
Quay.....	--	--	2	2	13,496
Roosevelt.....	1	--	15	16	71,138
Sandoval.....	2	--	4	6	16,187
San Miguel.....	--	--	1	1	2,856
San Juan.....	1	2	14	17	29,212
Sierra.....	--	--	1	1	7,860
Torrance.....	--	--	2	2	1,130
Union.....	--	--	3	3	10,384
Total.....	16	8	139	163	891,957
Development completions:					
Chaves.....	31	6	14	51	161,096
Eddy.....	22	13	8	43	242,977
Lea.....	182	7	39	223	1,799,416
McKinley.....	24	1	3	28	56,383
Rio Arriba.....	3	57	3	63	404,696
Roosevelt.....	35	--	11	46	334,413
Sandoval.....	1	1	1	3	13,002
San Juan.....	27	66	10	103	315,628
Total.....	325	151	89	565	3,327,611
Total, all drilling.....	341	159	228	728	4,219,568

Sources: 1970 data—American Petroleum Institute.  
1969 data—American Association of Petroleum Geologists, and Petroleum Information Corporation, Résumé and Yearbook.

Table 7.—New Mexico: Principal oil and gas discoveries in 1970

County and field	Well	Operator	Location			Initial production			Month completed	Remarks	
			Section	Township	Range	Producing formation	Total depth (feet)	Barrels of oil per day			Thousand cubic feet of gas per day
Chaves County:											
Round tank	No. 1-A Mullis-State	Elk Oil Co.	30	15 S	29 E	Queen	10,590	1,500	(1)	Flowing. Swabbing.	
Tower	No. 1-A Marley	Phillips Petroleum Co.	3	11 S	31 E	San Andres	9,200	154	Feb.		
Wildcat	No. 1 Shenandoah Federal	Shenandoah Oil Co.	21	6 S	27 E	Cisco	6,585	--	NA	Flowing.	
Do.	No. 1 Terra Federal	Frank Stringer	17	12 S	31 E	Queen	4,060	--	Aug.	Do.	
Eddy County:	No. 1 O'Neill Federal	Pennzoil United, Inc.	11	24 S	26 E	Bone Spring	11,900	--	Aug.	Do.	
Black River	No. 2 Todd Federal	Texas American Oil Corp.	26	23 S	31 E	Cherry Canyon	6,140	173	Feb.	Do.	
Sand Dunes (Cherry C).	No. 1 Avalon Federal	David Fasken	1	21 S	25 E	Morrow	10,583	--	Aug.	Do.	
Wildcat	No. 1-Avalon Federal COM.							2,725	Aug.	Do.	
Do.	No. 1-J Federal	Midwest Oil Corp.	21	18 S	24 E	do.	8,750	--	Nov.	Do.	
Lea County:	No. 1 Mattie Price	Freeport Oil Co.	6	17 S	38 E	Devonian	12,696	375	Aug. (1)	Do.	
Garrett, West	No. 1 Diamond	Elk Oil Co.	16	16 S	34 E	Pennsylvanian	13,028	--	Aug.	Do.	
Kennitz	No. 1 Pipeline Federal	Union Oil Co. of Calif.	4	19 S	34 E	Morrow	14,870	--	NA	Do.	
La Rica	No. 1 Pipeline Federal	Samedan Oil Corp.	4	15 S	35 E	Cisco	10,546	309	Oct.	Do.	
Morton, East	No. 1 Gulf State	Lone Star Producing Co.	33	14 S	34 E	Pennsylvanian	10,708	450	Feb.	Do.	
Tres Papalotes	No. 1 New Mexico '80' State	King Resources Co.	16	19 S	33 E	Wolfcamp	14,700	132	June	Do.	
Wildcat	No. 1 Kimmo Sabe Federal	Union Oil Co. of Calif.	4	19 S	34 E	Morrow	14,870	--	Aug.	Do.	
Do.	No. 1 Pipeline Federal							26,400	Aug.	Do.	
McKinley County:	Lone Pine	Tenneco Oil Co.	18	17 N	8 W	Dakota	2,950	258	June	Do.	
Roosevelt County:	Todd	Texaco, Inc.	22	7 S	35 E	Wolfcamp	7,960	221	Oct.	Pumping.	
Sandoval County:	Wildcat	Refiners Petroleum Co.	25	22 N	3 W	Dakota	7,189	387	Oct.	Flowing.	
San Juan County:	No. 1 Waw	Thomas Dugan	32	27 N	13 W	Pictured Cliff	1,411	--	June	Do.	
Do.	No. 1 Atom	Atom, Inc.	10	29 N	15 W	Mesaverde	4,350	9	June	Pumping.	

NA Not available.

(1) Well completed in December 1969, but data not available until 1970.

tial potential of 309 barrels of oil per day from upper Pennsylvanian rocks at 10,546 feet.

In the San Juan Basin the continuing search for Dakota stratigraphic traps led to the discovery of oil in the Refiners Petroleum Co. well No. 1 Cuba-Union in sec. 25, T 22 N, R 3 W, Sandoval County. The well was completed flowing 387 barrels of oil per day. Another Dakota discovery was the Lone Pine field in McKinley County drilled by Tenneco Oil Co. with their well No. 1 Don Ne Pah, sec. 18, T 17 N, R 8 W, which flowed at the rate of 258 barrels of oil per day. An oil discovery in the Mesaverde Formation was made by Atom, Inc., in their well No. 1 Atom, sec. 10, T 29 N, R 15 W, completed at a pumping rate of 9 barrels of oil per day. Nearest Mesaverde production is about 64 miles away.

Runs of crude oil to stills in the State's five refineries totaled 14.8 million barrels, 1,000 barrels of which was received from Colorado and the balance produced in New Mexico. Out-of-State shipments of crude oil produced in New Mexico totaled 112 million barrels. More than 80 percent of the quantity shipped was destined for Texas, 54.7 million barrels; Indiana, 19.2 million; and Illinois, 18.2 million.

Plateau, Inc., increased the capacity of its Bloomfield refinery from 4,200 to 5,200 barrels per day by the addition of a first-stage fractionator and a crude oil heater. The 275-barrel-per-day increase in crude oil capacity at the Caribou-Four Corners Oil Co. refinery at Kirtland resulted from increases in operating efficiency. No new construction was performed during the year.

## METALS

Metal production was valued at \$289.2 million, up \$74.5 million over 1969. The 35-percent increase in value was attributable principally to the larger output and improved prices paid for copper. Production and total value of zinc decreased despite a 5-percent increase in the average price paid. No beryllium production was reported.

**Copper.**—The increase in the price of copper, from about 48 cents per pound in 1969 to an average of 58 cents in 1970,

contributed to the increase in value of production, but the first full year of operation for the Tyrone open pit mine of Phelps Dodge Corp. was the major factor in both the increased tonnage and increased value.

The tonnage mined during the early part of the 1960's rose slightly each year until the sharp rise in 1965 and 1966. Tonnage then dropped because of the labor strike of 1967-68. Production in 1969 was augmented by the initial output from the Tyrone mine, and 1970 production was boosted by Tyrone's first major tonnage. Value of copper fluctuated with tonnage except during 1969 and 1970 when copper prices rose faster than production.

New Mexico copper production reached 166,278 tons of recoverable copper, 39 percent over the previous alltime high of 119,956 tons produced in 1969. Value of the produced copper was almost \$192 million or 68 percent above the 1969 level.

The Nacimiento mine near Cuba, operated by Earth Resources Co., was preparing to go into operation in 1971. Construction of a 3,000-ton-per-day flotation mill was begun in August 1970, and much preliminary stripping of waste rock above the ore was done in preparation for open pit mining. The low-sulfur, high-copper concentrate will be sold to the El Paso smelter of the American Smelting and Refining Company (Asarco) at an estimated rate of 7,000 tons of copper per year with a possible total value of \$35 million for the 5-year contract.

The Nacimiento ore differs from the copper mined at Santa Rita and Tyrone in that it occurs in "red beds," which are reddish-brown sandstone and shale that contain an average of only a few pounds of copper in each ton of ore-bearing rock, with the copper content being less than 1 percent. The Santa Rita and Tyrone copper is also less than 1 percent, but it occurs in large irregular bodies, not in beds.

In its annual report Earth Resources Co. estimated that total copper-bearing material in the sulfide zone of its Nacimiento project is about 10 million tons containing 0.67 percent copper. Reserves considered by the company to be minable with open pit methods are estimated to be 5 million tons of 0.9 percent copper.

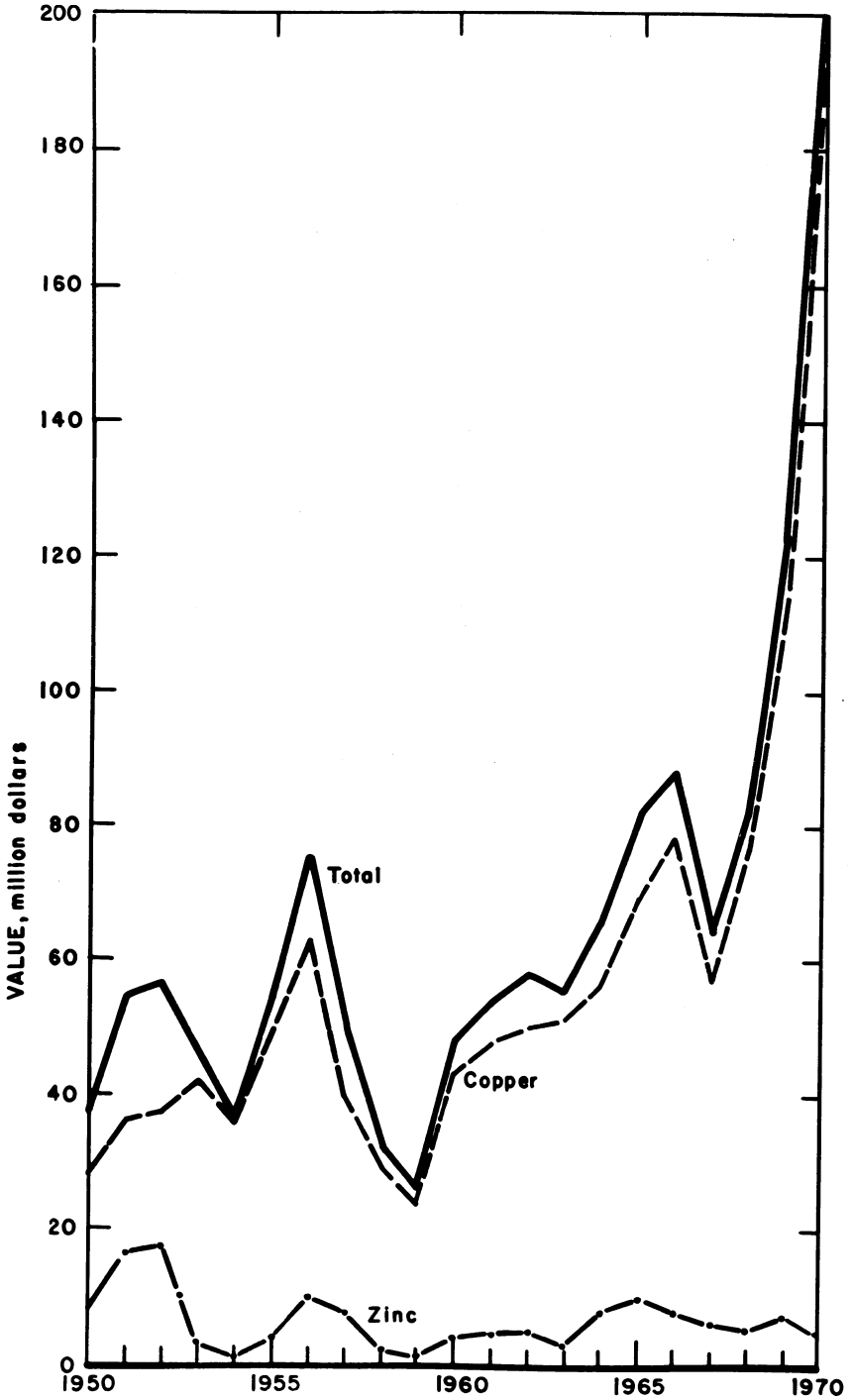


Figure 2.—Value of mine production of copper and zinc, and total value of gold, silver, copper, lead and zinc in New Mexico. The value of gold, silver, and lead produced annually has been relatively small.

**Table 8.—New Mexico: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by counties**

County	Mines producing <sup>1</sup>		Material sold or treated <sup>2</sup> (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1968, total.....	24	2	7,011,421	6,630	\$260,294	224,866	\$482,248
1969, total.....	29	1	12,835,019	8,952	371,598	465,591	833,720
1970:							
Grant.....	11	--	20,645,300	6,174	224,674	731,900	1,296,065
Hidalgo.....	1	--	86,902	1,390	50,582	38,954	68,981
Santa Fe.....	2	--	21,233	1,145	41,666	8,813	15,605
Undistributed.....	5	--	3,455	10	363	2,285	4,046
Total.....	19	--	20,756,890	8,719	317,285	781,952	1,384,697
	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
1968, total.....	90,769	\$75,968,207	1,363	\$360,159	18,686	\$5,045,219	\$82,116,127
1969, total.....	119,956	114,039,770	2,368	705,427	24,308	7,097,936	123,048,451
1970:							
Grant.....	163,706	188,916,550	3,547	1,108,089	16,572	5,077,268	196,622,646
Hidalgo.....	2,223	2,565,573	--	--	1	214	2,685,350
Santa Fe.....	323	372,165	( <sup>3</sup> )	31	( <sup>3</sup> )	107	429,574
Undistributed.....	26	30,696	3	859	28	8,717	44,681
Total.....	166,278	191,884,984	3,550	1,108,979	16,601	5,086,306	199,782,251

<sup>1</sup> Operations at plants leaching runoff water and old mill and miscellaneous cleanups not counted as producing mines.

<sup>2</sup> Does not include tonnage of precipitates shipped.

<sup>3</sup> Less than ½ unit.

**Table 9.—New Mexico: Mine production of gold, silver, copper, lead, and zinc in 1970, by classes of ore or other source materials, in terms of recoverable metals**

Source	Number of mines <sup>1</sup>	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Dry gold-silver.....	1	406	66	1,502	( <sup>2</sup> )	--	( <sup>2</sup> )
Dry silver.....	1	70	8	833	1	2	( <sup>2</sup> )
Total.....	2	476	74	2,335	1	2	( <sup>2</sup> )
Copper.....	10	20,593,414	8,409	606,892	135,756	2	547
Lead-zinc and zinc <sup>3</sup> .....	4	162,190	235	171,547	522	3,545	16,054
Total <sup>4</sup> .....	14	20,755,604	8,644	778,439	136,278	3,548	16,601
Other lode material:							
Copper precipitates <sup>5</sup> .....	4	40,321	--	--	29,997	--	--
Copper tailings.....	1	810	1	1,178	3	--	--
Total.....	5	41,131	1	1,178	30,000	--	--
Total lode material <sup>4</sup> .....	21	20,797,211	8,719	781,952	166,278	3,550	16,601

<sup>1</sup> Detail may not add to total because some mines produce more than 1 class of material.

<sup>2</sup> Less than ½ unit.

<sup>3</sup> Combined to avoid disclosing individual company confidential data.

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

<sup>5</sup> Operations at plants leaching runoff water not counted as producing mines.

**Table 10.—New Mexico: Mine production of gold, silver, copper, lead, and zinc in 1970, by types of material processed and methods of recovery, in terms of recoverable metals**

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
<b>Lode:</b>					
Acid leaching (heap): Ore .....	--	--	1,133	--	--
Smelting of concentrates from—					
Ore .....	8,642	777,699	135,072	3,548	16,601
Tailings .....	1	1,178	3	--	(1)
Total .....	8,643	778,877	135,075	3,548	16,601
Direct smelting of—					
Ore .....	76	3,075	73	2	1
Precipitates .....	--	--	29,997	--	--
Total .....	76	3,075	30,070	2	1
Grand total <sup>2</sup> .....	8,719	781,952	166,278	3,550	16,601

<sup>1</sup> Less than ½ unit.

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

Asarco, with a smelter located in El Paso but less than a mile from the New Mexico State line, announced that it will build a \$15 million sulfuric-acid-manufacturing plant at that smelter to use a substantial part of the sulfur dioxide produced at the smelter.

Early in the year Asarco began a \$1.5 million expansion of the electrostatic precipitator to remove particulate matter from the stack gases, in addition to a new baghouse and afterburner to control low-level particulate emissions. The company also announced a \$2 million pilot plant to test a new process for converting sulfur dioxide into elemental sulfur.

Federal Resources Corp. (FRC) leased the Henry Clay mine, southwest of Lordsburg in the Pyramid Mountains, from Henry Clay Mines, Inc., reporting that it included an extension of the Emerald vein, the producing copper-gold-silver ore vein in FRC's adjacent properties, the "85" and Bonney mines. In April FRC announced discovery, on the 2,000-foot level of the Bonney mines. In April FRC announced taining 5 percent copper.

At Hurlley the Chino Division of Kennecott Copper Corp. continued its program to alleviate air pollution. Installations included a modernized electrostatic precipitator to remove dust before it goes up the stack and a new mechanical collector. An older 500-foot smokestack was put back into operation after receiving extensive repairs. It joins a 626-foot stack that has been in operation for 2 years. The two

smokestacks will handle the same volume of gases as the one had been handling but will do it more efficiently.

Kennecott Copper Corp. announced in its annual report that a magnetite pilot plant installation was completed late in the year to develop data for designing a production plant. Target specifications call for a minimum grade of 60 percent iron and a maximum of 0.03 percent copper. The magnetite to be produced might be sold to the steel industry or used by Kennecott for production of sponge iron for the company's precipitate copper operations.

Phelps Dodge Corp. announced at year-end plans for a \$38 million expansion at its open pit Tyrone mine in Grant County to increase annual copper capacity from the 1970 level of 55,000 tons to about 90,000 tons by late 1972 or early 1973. Payroll at Tyrone is expected to increase by \$2 million to slightly over \$7 million by the addition of about 200 more employees. New facilities will include a third conveyor from the crusher to the mill, plus eight additional ball mill operations, bringing the ball mill total to 20. The primary crusher will be expanded to increase throughput by 20,000 tons per day to a new level of about 48,000 tons per day. New trucks of 110-ton capacity were ordered to supplement the 85-ton-capacity trucks currently used in the haulage fleet.

Phelps Dodge's Tyrone open pit is mine with electric equipment; electric blast hole drills, electric shovels, and elec-

tric trucks are used. Daily production in 1970 was 25,000 tons of ore, 117,000 tons of waste, and 8,000 tons of leach. Both pit and mill operate three shifts per day for 26 days with the next two days being rest days. Normal repair and maintenance are performed during the operating cycle. The two no-work days are not considered repair days, and only about one-tenth of the shop force works at that time.

Phelps Dodge Corp. announced that it has no plans for construction of a smelter at Tyrone. Copper concentrate will continue to be shipped to smelters in Arizona.

Goldfield Mining Co. reported development of the old San Pedro copper mine in the San Pedro Mountains northeast of Albuquerque near the town of Golden. Low-grade ore from the surface dumps and stockpiles was milled, and some development work was done in the mine.

Early in 1970, U.S. Natural Resources, Inc. (USNR) purchased copper mining leases and claims known as Copper Mountain and Copper Leach deposits located adjacent to Phelps Dodge's Tyrone mine properties in Grant County. The USNR properties consist of two open pit mines, each with its own plant for producing cement copper (copper precipitate) through a nonpolluting closed-system heap-leaching process.

According to the stock prospectus of USNR, proved reserves were estimated jointly by Bechtel Corp. and Copper Range Exploration Co. in 1968 to be at least 16 million tons of copper oxide ore, assaying at an average of 0.52 percent copper. Production was reported to have begun in August for one property. The other is still in a development phase. USNR has contracted to sell its entire cement copper output for a 2-year period commencing in August 1970, to the metal brokerage firm of Aaron Ferer and Sons, Co.

United States Smelting, Refining and Mining Co. (USSR & M Co.) expanded its capacity to process copper ore in Bayard, N. Mex. In late 1967 its Continental mill at Fierro was completed with a capacity to process about 3,000 tons of copper ore per day from underground and open pit operations. In August 1970, the company purchased the mill facilities, mining properties, and claims of The New Jersey Zinc Co. (NJZ) contiguous to USSR & M Co.'s

copper properties in Bayard. By the end of 1970 the construction of a second mill designed to more than double USSR & M Co.'s capacity to process copper ores was proceeding on schedule. A stockpile of low-yield ore extracted from the open pit is available for treatment at the new mill. Higher yield ore produced from the underground mine is processed at the Continental mill.

According to the company's annual report for 1970, about 1.02 million tons of copper ore was milled and 587,000 tons of lower grade material was stockpiled for future processing.

**Gold.**—Production of gold decreased 2.6 percent; value decreased 14.6 percent. The drop in value to \$317,285 from \$371,598 in 1969 was due mostly to the decrease in price from \$41.51 to \$36.39 per troy ounce. Gold was recovered mainly as a byproduct from the treatment of copper ores and to some extent from lead, zinc, and silver ores. Principal production came from the Continental and Tyrone mines in Grant County, the Bonney-Miser's Chest and "85" mines in Hidalgo County, and the San Pedro mine in Santa Fe County. Thirteen mines in Grant, Guadalupe, Hidalgo, Santa Fe, and Sierra Counties were sources of gold in the State.

A pamphlet on gold mining in New Mexico, now in its fourth printing, has just been reissued by the New Mexico State Bureau of Mines and Mineral Resources.<sup>11</sup>

**Iron Ore.**—Magnetite ore was shipped directly for use in cement by Dotson Minerals Corp. from the Jones open pit iron mine in Socorro County.

**Lead.**—Lead output increased 50 percent and the value of production gained 57 percent, owing mainly to the first full year's production after reopening the Groundhog mine of Asarco at Vanadium.

According to the company 1970 annual report 122,417 tons of ore was mined and milled, producing 31,540 tons of concentrates from which 3,174 tons of lead in lead concentrates, 14,179 tons of zinc in zinc concentrates, and 161,204 ounces of silver were produced. This production by Asarco represents gains over 1969 of 174

<sup>11</sup> Wells, E. H., and T. P. Wootton. Gold Mining and Gold Deposits in New Mexico. New Mexico Bur. Mines and Min. Res. Circ. 5, 1932 (reissued 1970), 26 pp.



percent in quantity mined and milled, 122 percent in quantity of concentrates and 90 percent in quantity of lead contained in the concentrates.

NJZ, a subsidiary of Gulf & Western Industries, Inc., formerly operated or leased, among other properties, two lead mines in Grant County. The company announced that as of August 21, 1970, its assets at the Hanover property were sold to USSR & M Co. and the leased Oswaldo mine was returned to Kennecott Copper Corp. Lead was produced at seven mines in Grant, Santa Fe, and Sierra Counties.

**Manganese Concentrate and Manganiferous Ores.**—The quantity of manganiferous ore containing from 5 to 35 percent manganese decreased 6 percent from 49,146 tons in 1969 to 46,166 tons in 1970. Manganese concentrates containing 35 percent or more manganese dropped in output by 13 percent from 4,855 tons to 4,225 tons.

With the closing of the Nancy-Tower mine in Socorro County in October 1970, the last underground manganese mine in the United States became inactive. Shipments continued to be made from stock.

**Molybdenum.**—Production of molybdenum decreased almost 11 percent, owing mostly to reduced output at the Questa mine of the Molybdenum Corporation of America (Molycorp). Molybdenum output as a byproduct of copper production decreased also at the Kennecott Copper Corp. Chino mine in Grant County. Kerr-McGee Corp. produced about 3 percent more molybdenum in 1970 as a byproduct of its uranium operations in McKinley County.

According to the 1970 annual report of Molycorp, production at the Questa molybdenum mine totaled 10.1 million pounds in 1970; this was below the company's expectations primarily because lower than anticipated ore grade was encountered in the eastern fringe of the deposit. This resulted in some loss of molybdenum production in the second quarter of 1970 and a larger loss in the third quarter. In the fourth quarter when ore was mined partly from the main pit, production totaled 3.3 million pounds of molybdenum. In 1970 plant and equipment additions and land purchases at Questa cost \$1.9 million. Ore reserves at yearend were 150 million tons with an average grade of 0.173 percent molybdenum disulfide, according to the company annual report for 1970.

**Silver.**—Silver production reached 781,952 troy ounces, a 68-percent gain over that of 1969 and the highest level since 1941. The value of silver produced reached an alltime high of \$1,384,697. The largest increase was at the Tyrone mine of Phelps Dodge Corp. where silver is produced as a byproduct of copper. Gains in silver output among major producers occurred also at the Groundhog mine of Asarco and the Continental mine of USSR & M Co. in Grant County, and the Bonney-Miser's Chest and "85" mines of FRC in Hidalgo County. Output of silver was from 15 mines in six counties, a decrease from the 27 mines in eight counties producing during 1969.

**Tin.**—Production of tin, obtained in small quantities from a placer in the Black Range-Taylor Creek area in 1969, was not reported in 1970.

**Uranium.**—New Mexico continued to lead the States in uranium output by producing 47 percent of the U.S. total. Twelve New Mexico shippers produced 11,574,000 pounds of recoverable uranium oxide in uranium concentrates from 38 operations in three counties. Output was down 2 percent from the 11,811,000 pounds produced in 1969 but value of production gained slightly to \$69,970,000.

Yearend 1970 marked the termination of the Atomic Energy Commission's (AEC) domestic uranium procurement program, which had been in effect since 1947. In recent years AEC purchases decreased as private purchases, mainly by utility companies as fuel for nuclear power reactors, have decreased. New Mexico's contribution to uranium concentrate purchases by AEC dropped from 4,104 tons in 1969 to 828 tons in 1970, which resulted in a decrease in value of concentrate purchased in the State by AEC from \$47 million to \$7.9 million.

According to the AEC,<sup>12</sup> at the end of 1970, New Mexico had more uranium reserves than any other State with 108,380 tons of uranium recoverable at \$8 per pound in 45 million tons of ore averaging 0.24 percent U<sub>3</sub>O<sub>8</sub>.

Surface exploration and development drilling decreased slightly from 5.6 million feet in 1969 to 5.2 million feet in 1970, maintaining a third place ranking among States after Wyoming and Texas. Explora-

<sup>12</sup> Atomic Energy Commission. Statistical Data of the Uranium Industry. Jan. 1, 1971, 54 pp.

tory drilling was performed in some marginal areas, many of which are far from producing mines. Depths of individual drill holes increased. In the Mount Taylor-San Mateo-Seboyeta Mesa area some exploratory holes reportedly were drilled to depths of more than 5,000 feet. Of the 5.2 million feet drilled in 1970, about 3 million feet was exploratory and 2.2 million was development drilling.

Lands acquired for uranium mining and exploration decreased from an alltime peak of 8.1 million acres in 1969 to 4.7 million acres in 1970, a reduction of 42 percent.<sup>13</sup>

The AEC reported three uranium ore processing mills in New Mexico having a total nominal capacity of 13,500 tons of ore per day. These mills comprise 42 percent of the U.S. capacity of 31,900 tons per day for mills in operation or under construction.

According to its annual report The Anaconda Company's Paguate mine and Blue-water mill increased production of uranium oxide to 3,534,000 pounds from 3,042,000 pounds in 1969. The Jackpile mine, which has not been active for several years, will be reopened by Anaconda. The contract between Anaconda and the AEC for the sale of uranium expired at the end of 1970. Full production from the company's operation has been sold through 1975 to private customers. The Anaconda Company's Paguate uranium mine continued its long safety record by winning first place in the 1969-70 National Safety Council open pit mining safety contest with no lost-time accidents.

Two companies formed a new joint venture operation to explore for uranium in the Ambrosia Lake area of McKinley and Valencia Counties. Bokum Corp. of Santa Fe, has a one-half interest in the venture. The remaining interest is owned jointly by a group of companies for which Keradamex Inc., a subsidiary of Kerr Addison Mines, Ltd., is the operating company. Exploratory drilling was done on 13,000 acres of unpatented lode mining claims. Hole depths of 3,200 to 4,200 feet were reported to have penetrated uranium-bearing material.

Test hole drilling by several companies proceeded during 1970 to evaluate potential uranium-producing properties. Hydro Nuclear Corp. appraised test hole results on a 580-acre property northwest of Grants

where it was reported to have found uranium mineralization at a depth of about 260 feet. Commercial-grade uranium reported by Enerdyne Corp. of Albuquerque at its properties on the eastern end of the Ambrosia Lake ore trend was being evaluated for justification of further development. Reserve Oil and Minerals Corp., in a joint venture with Sohio Petroleum Co., reportedly developed commercial quantities of uranium oxide ore at depths of 250 to 700 feet on its South L-Bar lease in the Laguna mining district, north of The Anaconda Company's Jackpile mine.

An operating uranium mine in the Ambrosia Lake area was purchased by Kerr-McGee Corp. This mine is adjacent to the company's Section 1 ore body which is also being mined from the Section 36 mine shaft. Two new mines, Section 30 West and Section 35, were under development by Kerr-McGee Corp. throughout 1970. The Section 30 West mine progressed from the development stage to the production stage by yearend. The Section 35 mine is expected to begin production late in 1971. At that time Kerr-McGee will have eight operating uranium mines at Ambrosia Lake. Construction of the shaft and surface plant for the Section 19 mine was completed, but development was temporarily suspended.

Kerr-McGee's Ambrosia Lake mill operated at a rate slightly in excess of 5,000 tons of ore per day. The mill's capacity is sufficient to accommodate initial ore production from the company's reserves in the northeast Church Rock area where development drilling was done during the year. The first mine shaft is scheduled for completion by mid-1971 and ore production by 1974. A development drilling program is expected to be initiated in 1971 to further delineate minable ore reserves in Kerr-McGee properties in the Rio Puerco area.

Kerr-McGee Corp. made its first shipments of natural uranium hexafluoride from the company's new Sequoyah facility in eastern Oklahoma, the first deliveries of mixed plutonium and uranium dioxide fuel rods from its Cimarron plutonium plant in central Oklahoma, and the first enriched uranium fuel assembly fabricated at the company's Cimarron uranium fuels plant.

The largest diameter vertical mine shaft

<sup>13</sup> Work cited in footnote 12.

ever successfully drilled to completion by rotary drilling techniques on the North American continent was completed by Kerr-McGee Corp. in the Ambrosia Lake area. The 16-1/2-foot-diameter mine shaft hole was drilled to a depth of 784 feet. A steel liner with external reinforcement members and an outside diameter of 14 feet was lowered into the hole to a depth of 784 feet and cemented in place. Drilling of the shaft was completed in less than 6 months.

Exploration in the Ambrosia Lake area was continued by Ranchers Exploration and Development Corp. for the final year of a 3-year joint venture exploration program with its partners, Houston Natural Gas Corp. and Combustion Engineering, Inc. According to the company's annual report, reserves on their Section 7 property were increased by 67 percent above the 1969 levels as a result of the 185,000 feet of drilling that was done on the property. Most of the remaining 305,000 feet of drilling done by the joint venture was on prospective areas of northwestern New Mexico.

United Nuclear Corp. (UNC) operated four mines, all in the Ambrosia Lake area, and owned a 70-percent interest in six additional mines which were partner operated. United Nuclear-Homestake Partners, managed by Homestake Mining Co., operated four mines at Ambrosia Lake and two mines at Smith Lake. Mining operations were curtailed by UNC late in 1970 at one mine because production from it was no longer profitable at existing uranium prices. UNC announced the discovery of more than a million tons of uranium ore in the Laguna-Rio Puerco area at depths that will allow open pit mining. The ore was estimated to contain more than 3 million pounds of uranium oxide equivalent. The location of the discovery is within 50 miles of the United Nuclear-Homestake Partners' mill at Ambrosia Lake. UNC acquired about 80,000 acres of additional land in the United States for uranium exploration, most of which is in the Laguna-Rio Puerco area east of Grants.

According to the annual report of Homestake Mining Co., production from the United Nuclear-Homestake Partners mines near Grants was 510,647 tons of ore in 1970 compared with 579,878 tons in 1969. There were 665,155 tons of partner-

ship ore processed by the mill in 1970 from which 1,972,106 pounds of  $U_3O_8$  were recovered, compared with 692,000 tons processed in 1969 returning 2,200,400 pounds of  $U_3O_8$ . In addition 382,030 tons of ore were processed under toll milling arrangements for the individual partners. Uranium concentrates produced from ore mined by the partnership are distributed to the partners in kind, and the partners reimburse the partnership for their respective shares of the operating expense.

**Vanadium.**—Vanadium produced in connection with uranium is no longer recovered by mills in New Mexico. The vanadium-containing sludge from uranium mills is shipped to Colorado for extraction and recovery of vanadium. The quantity produced in 1970 was 70 percent less than in 1969 and the value of production was down 59 percent.

**Zinc.**—Production of zinc was down 32 percent in quantity to 16,601 tons from 24,308 tons a year earlier; value of production decreased 28 percent to \$5.1 million. The reduced output resulted principally from the closing of the Princess mine in Grant County by USSR & M Co., and the Hanover and Oswaldo mines NJZ.

NJZ, the largest zinc producer in the State in 1969, ceased active operations in Grant County. The Hanover mine, flotation mill, and claims were sold to USSR & M Co., owner of a copper mine at Fierro adjacent to the newly acquired properties. The Oswaldo mine was returned by NJZ to Kennecott Copper Corp. The Hanover ore bodies have been mined since the early part of this century by NJZ and its predecessors.

## NONMETALS

Nonmetals increased 28 percent in value of production to \$113.9 million, representing almost 11 percent of the State's total mineral production. Potassium salts, the most valuable nonmetal, gained 38 percent in value while increasing only 3 percent in quantity. Sand and gravel, in second place, increased production enough to offset lower prices and ended the year with a 1-percent gain in total value.

**Cement.**—Shipments of portland and masonry cement increased in amount and value. The value of portland cement shipments increased \$578,000. Consumption of portland cement, 2,282,000 barrels was

within less than 1 percent of the previous year. Finished portland cement was used by ready-mix concrete companies, concrete-product manufacturers, highway contractors, building-material dealers, and other contractors; small amounts were used by Federal, State, and local government agencies. The State's only cement plant is located at Tijeras, east of Albuquerque, Bernalillo County, and is operated by Ideal Cement Co., a division of Ideal Basic Industries, Inc.

**Clays.**—Shipments of clay decreased about 4 percent, but value remained about the same despite the closing of two mines. U.S. Mining Corp. and Gallup Brick & Tile Co., both with mines in McKinley County, were not in operation in 1970. Bernalillo County was the principal producer. Output came from Ideal Cement Co. at Tijeras, where clay is used in the preparation of cement; Kinney Brick Co., Inc., near Albuquerque, mined clay and shale for building brick. El Paso Brick Co., in Doña Ana County, also mined clay and shale for building brick. Mathis & Mathis, in Luna County, continued production of clays.

The first of a series of five reports on the clays and shales of New Mexico was published by the State Bureau of Mines and Mineral Resources.<sup>14</sup>

**Fluorspar.**—Shipments of fluorspar increased substantially in quantity and value over 1969. The sole producer reporting to the Bureau of Mines was Southwest Fluorspar Co. in Grant County.

The State Inspector of Mines listed<sup>15</sup> two mines under development—the Bishops Cap mine of North Star Mining & Milling Corp. in Doña Ana County, and the Mirabal mine of Aluminum Company of America in Valencia County. New registrations were reported for the Hayner mine of Pegasus Fluorspar Corp. in Doña Ana County and the Red Star No. 1 mine of Joe Ordóñez in Grant County.

**Gypsum.**—Gypsum output from four mines in three counties increased in quantity almost 10 percent while value of production dropped 5 percent.

White Mesa Gypsum Co. continued to mine gypsum from its White Mesa open pit mine near San Ysidro, Sandoval County. The material was calcined for use in manufacturing wallboard at the American Gypsum Division plant of the Susque-

hanna Corp., Albuquerque. Duke City Gravel Products Co. obtained gypsum from an open pit at San Felipe near Bernalillo, Sandoval County, for use as a portland cement retarder by Ideal Cement Co. A small amount of gypsum was produced in Sierra County for agricultural purposes by Associated Materials Co. of Las Cruces.

Kaiser Gypsum Co., Inc., closed its gypsum wallboard plant at Rosario, south of Santa Fe. Production ceased at yearend and the plant was phased into a caretaker status. The company attributed the closing to increasing operating losses resulting from reduced sales and poor gypsum wallboard prices in the marketing area served by the Rosario plant. The Kaiser plant, constructed in 1960, has an annual productive capacity of 125 million square feet of gypsum board products.

**Lime.**—Lime is calcined by the Chino Division of Kennecott Copper Corp. at Hurley for use in its copper smelter. The limestone ore is quarried from Lone Mountain west of Hurley. Production remained at 37,000 tons during 1970.

**Mica.**—The value of scrap mica sold or used increased substantially from the 1969 figure, although output remained the same. Mineral Industrial Commodities of America, Inc., the sole producer, continued to mine scrap mica from its Tojos open pit in Taos County.

**Perlite.**—For the first time since perlite production started in New Mexico more than 2 decades ago, the annual output dipped slightly in 1970. Despite this decrease the State continued to lead the Nation with 84 percent of the total production. The State produced 382,000 tons of crude perlite valued at \$4.3 million. Output came from the open pit mines of United States Gypsum Co. in Valencia County, and three northern Taos County operations—El Grande mine of Grecco, Inc., No Agua mine of Johns-Manville Perlite Corp., and the open pit mine of Silbrico Corp. of Antonito, Colo.

**Potash.**—Production of marketable potassium salts in New Mexico increased

<sup>14</sup> Hawks, William L. Test Data for New Mexico Clay Materials, Part 1, Central New Mexico (Bernalillo, Los Alamos, Sandoval, and Santa Fe Counties). New Mexico Bur. Mines and Miner. Res., Circ. 110, 1970, 37 pp.

<sup>15</sup> Hays, William H. Fifty-eighth Annual Report by the State Inspector of Mines to the Governor of the State of New Mexico, Year Ending Dec. 31, 1970. 70 pp.

almost 3 percent to 2.4 million tons  $K_2O$  equivalent, or 88 percent of the Nation's total. Of more significance was the increase in prices. The value of production increased 38 percent to \$85.6 million.

The U.S. Tariff Commission in 1969 found that large quantities of potassium chloride were being dumped in U.S. markets by Canada, France, and West Germany, resulting in a drastic deterioration in prices. As a result of the findings, the Tariff Commission ruled that potassium muriate imports from the three countries would be subject to special dumping duties. The Provincial Government of Saskatchewan, Canada, announced late in 1969 a plan to curb overproduction and help stabilize prices. Beginning in 1970 the Saskatchewan Potash Conservation Board set quarterly production rates to limit Canadian plants to a fixed percentage of their capacities and require exporters to obtain a license to ship potash from the Province. New price schedules set a minimum of \$18.75 per ton. These regulations contributed to an upturn of prices in 1970. The value of potassium salts increased for all New Mexico producers despite reduced output at some plants. Average grade of crude potassium salts mined dipped from 18.4 percent in 1969 to 18.1 percent.

Duval Corp., a subsidiary of Pennzoil United, Inc., mined langbeinite and sylvite ore bodies for the production of specialty fertilizer products and for muriate of potash from its Saunders mine, which was closed at yearend, and from its Nash Draw

mine and the new Wells Weaver mine. Production of total potassium salts was up nearly 6 percent over that of 1969.

Southwest Potash Corp.'s production of muriate of potash totaled 835,000 tons, down slightly from 1969 according to the company's annual report. Sales revenues increased 30 percent over 1969 because of improved prices. An accelerated mine modernization program completed during the year improved operating efficiencies according to the annual report. Southwest Potash Corp. is a subsidiary of American Metal Climax, Inc.

During 1970 all chemical fertilizer and nonfuel minerals activities of Kerr-McGee Corp. were consolidated into a single subsidiary, Kerr-McGee Chemical Corp. This new subsidiary encompasses operations formerly conducted by three chemical subsidiaries of Kerr-McGee Corp., and operates Kerr-McGee's potash mine at Hobbs.

Freeport Sulphur Co., of which National Potash Co. is a subsidiary, changed its name during 1970 to Freeport Minerals Co. Value of production of total potassium salts from National Potash Co.'s Eddy mine, 15 miles east of Carlsbad, was up 44 percent over its 1969 output.

Potash Company of America, a division of Ideal Basic Industries, Inc., increased its output of total potassium salts by more than 18 percent over 1969. Value of production was up 44 percent.

**Pumice.**—New Mexico ranked fifth in the Nation in the production of pumice. Shipments of pumice and pumiceous mate-

Table 11.—New Mexico: Crude potassium salts produced, and marketable salts produced and sold or used

(Thousand short 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		
			Gross weight	K <sub>2</sub> O equivalent	Value <sup>2</sup>	Gross weight	K <sub>2</sub> O equivalent	Value
1969:								
January–June.....	7,962	1,472	2,117	1,194	\$31,742	2,591	1,466	\$37,641
July–December.....	7,558	1,389	2,014	1,133	30,293	1,842	1,055	27,222
Total <sup>3</sup> .....	15,519	2,861	4,131	2,327	62,034	4,433	2,521	64,863
1970:								
January–June.....	8,096	1,476	2,164	1,198	42,260	2,192	1,224	42,377
July–December.....	8,150	1,459	2,123	1,192	43,617	1,774	1,008	35,922
Total <sup>3</sup> .....	16,246	2,935	4,286	2,390	85,877	3,966	2,227	78,299

<sup>1</sup> Sylvite and langbeinite.

<sup>2</sup> Derived from reported value of "Sold or used."

<sup>3</sup> Data may not add to totals shown because of independent rounding.

rials decreased 10 percent, but value increased almost 7 percent to \$442,000. There were 10 operations, a decrease of two, in seven counties. Statistics designated "pumice" include such volcanic material as scoria, volcanic cinders, and pumice.

Pumice operations included the General Pumice Corp. Cullum mine near Espanola, Rio Arriba County; Utility Block Co., Inc., Esquire claims near Ponderosa, Sandoval County; and Copar Pumice Co., Inc., Santa Fe County near Espanola. Volcanic cinder was mined in San Juan County by Garcia & Son near Farmington; Associated Materials Co., Black Bear Mountain mine near Berino; Morton Bros. Volcano 1 mine and Volcanic Cinder Co. Klinker claim, both near Las Cruces. Scoria output came from Twin Peaks Products Co. Lava Pit mine, near Carrizozo, Lincoln County; Crego Block Co., Inc., La Cienega mine near Santa Fe, Santa Fe County; and Twin Mountain Rock Co. Twin Mountain Rock mine near Des Moines, Union County.

Pumice and volcanic cinders are used mainly in concrete aggregate. Additional uses include pumice in cleaning com-

pounds, for roofing, for landscaping, and as an insulating medium. Volcanic cinders are utilized in concrete admixtures, landscaping, roofing, and driveway gravel. The main uses for scoria are in roofing, ballast, concrete aggregate, landscaping, and running-track material.

**Salt.**—Salt shipments were down 5 percent, or 5,600 tons, from the alltime high reached in 1969. Value of shipments decreased by 32 percent. Output came from Eddy and Catron Counties where salt was recovered as a byproduct of potash operations. Leading shippers of rock salt and pressed blocks were The Salt Supply Co., Inc., and New Mexico Salt Co., both of Carlsbad. Pioneer Water Co., Inc., of Eunice recovered brine from potash operations. Principal markets for rock salt were feed dealers, city and State highway departments for use on icy roads, oil refiners, water-softener manufacturers, and oilfield service companies. Some brines were used in oil and gas well drilling. Rock salt, used mainly in New Mexico and Texas, was shipped also to Arizona, Alabama, Arkansas, Colorado, and Oklahoma.

Table 12.—New Mexico: Sand and gravel sold or used by producers, by counties  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Bernalillo.....	16	1,666	\$2,239	15	1,318	\$1,023
Catron.....	2	105	129	5	285	557
Chaves.....	7	183	215	8	514	431
Colfax.....	6	1,340	1,675	7	1,655	1,981
Doña Ana.....	15	622	623	10	493	269
Eddy.....	2	84	106	3	W	W
Grant.....	4	174	206	5	123	W
Guadalupe.....	1	5	6	1	W	W
Hidalgo.....	1	3	4	1	4	6
Lea.....	3	40	72	3	W	W
Lincoln.....	4	70	84	3	W	W
Los Alamos.....	1	1	1	1	1	2
Luna.....	4	715	490	6	W	W
McKinley.....	4	86	127	4	145	77
Mora.....	5	374	466	7	626	519
Otero.....	9	238	225	8	235	165
Quay.....	3	29	35	3	W	W
Rio Arriba.....	11	419	554	13	641	700
San Juan.....	11	564	725	10	572	734
San Miguel.....	5	160	220	4	173	241
Sandoval.....	3	155	191	5	387	W
Santa Fe.....	10	630	865	10	566	641
Sierra.....	2	11	10	4	W	34
Socorro.....	4	48	69	3	W	W
Taos.....	8	126	160	9	177	294
Torrance.....	1	290	363	2	W	W
Union.....	3	35	47	3	W	W
Valencia.....	7	283	313	6	W	W
Undistributed <sup>1</sup> .....	3	118	202	5	2,751	2,842
Total <sup>2</sup> .....	155	8,574	10,422	164	10,666	10,516

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed".  
<sup>1</sup> Includes De Baca and Roosevelt Counties, and some sand and gravel that cannot be assigned to specific "counties".

**Table 13.—New Mexico: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building .....	729	\$1,005	511	\$597
Fill .....	76	42	76	76
Paving .....	429	464	276	305
Railroad ballast .....	13	13	--	--
Other uses <sup>1</sup> .....	( <sup>2</sup> )	( <sup>2</sup> )	43	50
Total <sup>3</sup> .....	1,247	1,524	906	1,028
<b>Gravel:</b>				
Building .....	860	1,429	676	867
Fill .....	45	29	123	112
Paving .....	1,076	1,376	3,906	2,776
Miscellaneous .....	17	44	96	205
Other uses .....	--	--	3	5
Total <sup>3</sup> .....	1,999	2,877	4,803	3,965
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Building .....	227	294	--	--
Fill .....	25	12	26	21
Paving .....	280	364	254	324
Other uses .....	2	2	2	2
Total <sup>3</sup> .....	533	673	282	348
<b>Gravel:</b>				
Building .....	197	248	4	9
Fill .....	201	134	98	45
Paving .....	4,374	4,943	4,539	5,092
Other uses .....	23	22	33	29
Total <sup>3</sup> .....	4,795	5,347	4,674	5,175
Total sand and gravel <sup>3</sup> .....	8,574	10,422	10,666	10,516

<sup>1</sup> Includes blast (1969), and other sands.

<sup>2</sup> Less than ½ unit.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

**Sand and Gravel.**—Shipments of sand and gravel increased 24 percent while value increased less than 1 percent, from 8.6 million tons valued at \$10.4 million in 1969 to 10.7 million tons valued at \$10.5 million. Sand and gravel operations in 30 counties totaled 164, up from 155 in 1969. Government-and-contractor operations accounted for 5.0 million tons, 47 percent of the 10.7-million-ton output; commercial operators shipped the remainder.

Of the 9.5 million tons of gravel, 8.4 million tons were used by commercial and Government-and-contractor operations for road construction and about 876,000 tons for building construction. The remainder was used for fill and other purposes. Of the 1.2 million tons of sand, a total of 511,000 tons was used by all operations for building, 530,000 tons for road construction, and 102,000 tons for fill. Small amounts were used for railroad ballast and other uses.

The 10-year trend in production of sand and gravel shows great variance: a drop of almost 50 percent in 1962, a steady rise to the peak high of 15.5 million tons in 1966, a slacking-off to 12.3 million tons in 1968, and a drop to 8.6 million tons in 1969. Values have fluctuated even more than tonnage.

**Stone.**—Stone shipments increased 10 percent in tonnage and 23 percent in value. The number of quarries in operation increased from 57 to 67.

Traprock was produced in Catron, Colfax, McKinley, Mora, Rio Arriba, and Valencia Counties. Quarries in the following counties sold or used limestone: Chaves, Doña Ana, Eddy, Grant, Lincoln, Luna, Otero, Rio Arriba, San Miguel, Santa Fe, Torrance, and Valencia. Quartz or quartzite was produced in Colfax and Rio Arriba Counties. Sandstone sold or used by producers was quarried in Colfax, Mora, San Miguel, Sandoval, Santa Fe, Socorro, Taos, and Valencia Counties.

**Table 14.—New Mexico: Stone sold or used by producers, by counties**  
(Thousand short tons and thousand dollars)

County	1969			1970			Kind of stone produced in 1970
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value	
Catron.....	1	42	\$46	1	W	W	Traprock.
Chaves.....	1	( <sup>1</sup> )	( <sup>1</sup> )	2	W	W	Limestone.
Colfax.....	4	7	9	5	W	W	Quartz, sandstone, traprock.
Dña Ana.....	1	1	1	1	W	W	Limestone.
Eddy.....	1	W	W	3	128	\$213	Do.
Grant.....	2	94	W	1	89	W	Do.
Lea.....	6	249	313	6	807	1,236	Other stone.
Lincoln.....	3	192	253	1	W	W	Limestone.
Luna.....	2	1	3	1	W	W	Do.
McKinley.....	1	80	160	1	54	108	Traprock.
Mora.....	2	206	268	3	W	W	Sandstone, traprock.
Otero.....	2	95	101	2	W	W	Limestone.
Rio Arriba.....	6	50	79	7	W	W	Limestone, other stone, quartzite, traprock.
Roosevelt.....	1	68	70	--	--	--	Other stone.
San Juan.....	2	26	57	2	33	65	Do.
San Miguel.....	4	76	108	5	W	W	Granite, limestone, other stone, sandstone.
Sandoval.....	3	1	1	1	W	W	Sandstone.
Santa Fe.....	2	1,095	776	2	W	W	Limestone, sandstone.
Socorro.....	2	1	11	3	W	W	Other stone, sandstone.
Taos.....	3	47	59	3	W	W	Other stone, sandstone.
Torrance.....	1	( <sup>1</sup> )	( <sup>1</sup> )	2	W	W	Limestone.
Valencia.....	2	2	3	4	W	W	Limestone, other stone, sandstone, traprock.
Undistributed <sup>2</sup> .....	5	494	969	11	1,990	2,407	
Total <sup>3</sup> .....	57	2,826	3,286	67	3,100	4,030	

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

<sup>1</sup> Less than ½ unit.

<sup>2</sup> Includes Bernalillo, Curry (1970), and Union (1970) Counties and counties for which no county breakdown is available.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

**Table 15.—New Mexico: Stone sold or used by producers, by kinds**  
(Thousand short tons and thousand dollars)

Kind of Stone	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Dolomite.....	( <sup>1</sup> )	( <sup>1</sup> )	--	--
Granite.....	( <sup>1</sup> )	\$17	( <sup>1</sup> )	( <sup>1</sup> )
Marble.....	--	--	( <sup>1</sup> )	( <sup>1</sup> )
Sandstone.....	( <sup>1</sup> )	W	( <sup>1</sup> )	W
Other stone.....	W	W	W	W
<b>Crushed and broken:</b>				
Limestone.....	956	1,443	1,282	\$1,675
Granite.....	9	11	9	11
Sandstone.....	W	W	W	318
Quartz.....	--	--	( <sup>1</sup> )	( <sup>1</sup> )
Quartzite.....	( <sup>1</sup> )	W	( <sup>1</sup> )	W
Traprock.....	340	490	351	522
Other stone.....	421	534	994	1,501
Undistributed.....	1,099	791	464	2
Total <sup>2</sup> .....	2,826	3,286	3,100	4,030

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

<sup>1</sup> Less than ½ unit; included with "Undistributed".

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

**Sulfur.**—All sulfur production came as a byproduct in the liquid purification of gas at four natural gas processing plants in two counties. Of the 26,127 long tons of "recovered" sulfur produced, 25,457 long tons were shipped at a total value of \$357,959. Shipments in 1969 were 19,702 long tons with a total value of \$518,214.

Because of the difficulty in determining the State of origin of byproduct sulfur recovered at natural gas plants and petro-

leum refineries, particularly on the eastern seaboard and at gulf ports, the quantity and value of sulfur recovered from these sources are not included in mineral production statistics in table 1.

The modified Claus process was used to recover the high-purity sulfur at the Indian Basin plant of Marathon Oil Co. and the Empire Abo plant of Pan American Petroleum Corp., both of Artesia, Eddy County. The Artesia plant of Phillips Petroleum



Co. used the standard Claus process, as did the Cities Service Oil Co. in its Bluit plant near Milnesand, Roosevelt County.

**Vermiculite.**—Vermiculite exfoliated at

the Southwest Vermiculite Co. Albuquerque plant was used in concrete aggregate, block insulation, loose-fill insulation, and plaster aggregate.

**Table 16.—Principal producers**

Commodity and company	Address	Type of activity	County
<b>Carbon dioxide (natural):</b>			
Schwartz Carbonic Co. ....	Box 9737 El Paso, Tex. 79987	Well and extraction plant.	Harding.
S.E.C. Corp. ....	.....do.....	.....do.....	Do.
<b>Cement:</b>			
Ideal Cement Co., a divi- sion of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	Dry process, 2-rotary- kiln plant.	Bernalillo.
<b>Clays:</b>			
El Paso Brick Co. ....	Box 12336 El Paso, Tex. 79912	Open pit mine. ....	Doña Ana.
Ideal Cement Co., a divi- sion of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	.....do.....	Bernalillo.
Kinney Brick Co., Inc. ....	Box 1804 Albuquerque, N. Mex. 87103	.....do.....	Do.
<b>Coal:</b>			
Kaiser Steel Corp. ....	Box 1107 Raton, N. Mex. 87740	Underground mine, crushing plant, dense media-froth flotation cleaning plant.	Colfax.
The Pittsburg & Midway Coal Mining Co.	10 Main Center Kansas City, Mo. 64105	Strip mine, crushing plant, chemical and water treatment plant.	McKinley.
Utah Construction & Mining Co.	Box 155 Fruitland, N. Mex. 87416	Strip mine, crushing plant, dust sup- pression detergent treatment plant.	San Juan.
<b>Copper:</b>			
Federal Resources Corp. <sup>1</sup> ..	1370 South Third West Salt Lake City, Utah 84115.	3 underground mines and mill.	Hidalgo.
Kennecott Copper Corp., Chino Mines Division. <sup>1</sup>	Hurley, N. Mex. 88043.....	Open pit mine, flota- tion mill, precipita- tion plant, smelter, and refinery.	Grant.
Phelps Dodge Corp., Tyrone Branch.	Tyrone, N. Mex. 88065.....	Open pit mine and mill.	Do.
United States Smelting Refining and Mining Company. <sup>1</sup>	136 East South Temple St. Salt Lake City, Utah 84111	Underground mine, open pit-under- ground mine, and flotation mill.	Do.
<b>Fluorspar:</b>			
Southwest Fluorspar Co. ....	Box 1158 Demming, N. Mex. 88001	Open pit mine. ....	Doña Ana.
<b>Gypsum:</b>			
White Mesa Gypsum Co. ..	124 Jackson NE Albuquerque, N. Mex. 87108	.....do.....	Sandoval.
<b>Iron ore:</b>			
Dotson Minerals Corp. ....	Box 115 Socorro, N. Mex. 87801	.....do.....	Socorro.
<b>Lime:</b>			
Kennecott Copper Corp., Chino Mines Division.	Hurley, N. Mex. 88043.....	Rotary-kiln plant. ....	Grant.
<b>Manganese concentrates:</b>			
Goret & Aguilar, Inc. ....	Box 282 Socorro, N. Mex. 87801	Underground mine and jigging plant.	Socorro.
<b>Manganiferous ore:</b>			
Luck Mining Co. ....	215 Market St. San Francisco, Calif. 94105	Open pit mine. ....	Grant.
<b>Mica:</b>			
Mineral Industries Com- modities of America, Inc.	Box 2408 Santa Fe, N. Mex. 87501	.....do.....	Taos. Santa Fe.
<b>Molybdenum:</b>			
Kennecott Copper Corp., Chino Mines Division.	Hurley, N. Mex. 88043.....	See Copper.....	Grant.
Kerr-McGee Corp. ....	Kerr-McGee Bldg. Oklahoma City, Okla. 73102 280 Park Ave. New York, N.Y. 10017	Byproduct of uranium mining.	McKinley.
Molybdenum Corporation of America, Questa Division.		Open pit mine and flotation mill.	Taos.
<b>Natural gas and petroleum: <sup>2</sup></b>			
Peat: Humus Organic Products.	506 Rosemont NE Albuquerque, N. Mex. 87107	Humus bog.....	Sandoval.

See footnotes at end of table.

Table 16.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Perlite:</b>			
Grefco, Inc., Dicalite Division.	333 North Michigan Ave. Chicago, Ill. 60601	Open pit mine; crushing screening, and air-separation plant.	Taos.
Johns-Manville Perlite Corp.	2500 Miguelito Road Lompoc, Calif. 93436	-----do-----	Do.
<b>Potash:</b>			
AMAX Chemical Corp.----	Box 279 Carlsbad, N. Mex. 88220	Underground mine and refinery.	Eddy.
Duval Corp., Potash Division.	Box 511 Carlsbad, N. Mex. 88220	2 underground mines and refinery.	Do.
International Minerals & Chemical Corp.	Box 71 Carlsbad, N. Mex. 88220	Underground mine and refinery.	Do.
Kerr-McGee Chemical Corp.	Kerr-McGee Bldg. Oklahoma City, Okla. 73102	-----do-----	Lea.
National Potash Co.-----	Box 731 Carlsbad, N. Mex. 88220	-----do-----	Eddy.
Potash Company of America, a division of Ideal Basic Industries, Inc.	Box 31 Carlsbad, N. Mex. 88220	-----do-----	Do.
<b>Pumice:</b>			
General Pumice Corp.-----	Box 449 Santa Fe, N. Mex. 87501	Open pit mine and crushing and screening plant.	Rio Arriba.
Twin Mountain Rock Co..	Box 1009 Sheridan, Wyo. 82801	-----do-----	Union.
Volcanic Cinder Co.-----	Box 9977 El Paso, Tex. 79990	-----do-----	Doña Ana.
<b>Salt:</b>			
New Mexico Salt Co.-----	Box 303 Carlsbad, N. Mex. 88220	Potash tailing recovery and plant.	Eddy.
The Salt Supply Co., Inc..	Drawer SS Carlsbad, N. Mex. 88220	-----do-----	Do.
<b>Sand and gravel (commercial):</b>			
Armstrong & Armstrong---	Box 1873 Roswell, N. Mex. 88201	Pit and portable plant.	Chaves.
Wayne A. Lowdermilk, Inc.	1950 West Dartmouth Ave. Englewood, Colo. 80110	-----do-----	Colfax, Rio Arriba, and Taos.
Springer Corp.-----	Box 572 Albuquerque, N. Mex. 87103	Pit and stationary crushing and screening plant.	Bernalillo.
Universal Constructors, Inc.	Box 6008, Station B Albuquerque, N. Mex. 87107	Pits and portable plants.	Bernalillo, Colfax, Mora, Rio Arriba.
<b>Silver:</b>			
American Smelting and Refining Co.	120 Broadway New York, N.Y. 10005	See Zinc.-----	Grant.
The New Jersey Zinc Co..	2045 City Line Road Bethlehem, Pa. 18017	-----do-----	Socorro.
Thomas Consolidated Mines, Inc.	637 Peyton Bldg. Spokane, Wash. 99201	Underground mine----	Catron.
<b>Stone:</b>			
Ideal Cement Co., a division of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	Quarry and plant.----	Bernalillo.
J.W. Jones Construction Co.	Box 8038, Station C Albuquerque, N. Mex. 87108	Quarries and plants---	Colfax, Mora, Torrance.
Lea County Highway Department.	Lovington, N. Mex. 88260----	Quarry and plant.----	Lea.
List & Clark Construction Co.	6811 West 63d St. Kansas City, Kans. 66103	-----do-----	Santa Fe.
<b>Uranium:</b>			
The Anaconda Company, New Mexico Operations.	Box 638 Grants, N. Mex. 87020	Open pit mine and acid-leach process mill.	Valencia.
Kerr-McGee Corp.-----	Box 218 Grants, N. Mex. 87020	6 underground mines and acid-leach process mill.	McKinley.
United Nuclear Corp.-----	Box 199 Grants, N. Mex. 87020	4 underground mines----	Do.
United Nuclear-Homestake Partners.	Box 98 Grants, N. Mex. 87020	Underground mine----	Valencia.
		6 underground mines and alkaline-leach process mill.	McKinley.
<b>Zinc:</b>			
American Smelting and Refining Co. <sup>1</sup>	120 Boradway New York, N.Y. 10005	Underground mine and mill.	Grant.
The New Jersey Zinc Co. <sup>2</sup>	2045 City Line Road Bethlehem, Pa. 18017	Open pit-underground mine, underground mine, flotation mill.	Do.
United States Smelting Refining and Mining Co. <sup>3</sup>	136 East South Temple St. Salt Lake City, Utah 84111	See Copper.-----	Do.

<sup>1</sup> Also gold and silver.<sup>2</sup> Most of the major oil and gas companies and many smaller companies operate in New Mexico and several commercial directories contain complete lists of them.<sup>3</sup> Also lead.



# The Mineral Industry of New York

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the New York State Museum and Science Service for collecting information on all minerals except fuels.

By E. Chin <sup>1</sup>

The value of New York's mineral production decreased 1 percent, mainly because of decreases in natural gas, and sand and gravel production. Other commodities declining substantially in quantity and value were emery, lead, lime, mercury, and silver. The quantity and value of petroleum, talc, and wollastonite also decreased. The quantity of zinc and garnet decreased but the value of each increased. Salt and ilmenite increased in both quantity and value. The State ranks first nationally in production of emery, garnet, talc, and wollastonite, and continues to be a major producer of zinc, cement, gypsum, salt, sand and gravel, and stone.

## Legislation and Government Programs.

—In 1970, New York created a new agency, the Department of Environmental Conservation, to integrate all State activities for the control and abatement of environmental pollution. Additionally, the State's Pure Waters Authority was converted into the Environmental Facilities Corporation with expanded powers to assist communities in all phases of pollution control, water supply, management, and solid waste disposal. The State also stiffened civil and criminal penalties against violators of the Water Pollution Control Law

<sup>1</sup> Chemist, Division of Nonferrous Metals.

Table 1.—Mineral production in New York <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays..... thousand short tons..	1,623	\$1,783	1,707	\$1,897
Gem stones.....	NA	10	NA	10
Gypsum..... thousand short tons..	492	2,945	425	2,737
Lead (recoverable content of ores, etc.)..... short tons..	1,686	502	1,280	400
Lime..... thousand short tons..	1,055	10,224	W	W
Mercury..... 76-pound flasks	r 280	r 141	28	11
Natural gas..... million cubic feet..	4,861	1,458	3,858	1,017
Peat..... thousand short tons..	14	178	15	145
Petroleum (crude)..... thousand 42-gallon barrels..	1,256	5,683	1,194	5,397
Salt..... thousand short tons..	5,582	45,561	5,990	47,254
Sand and gravel..... do.....	39,806	42,518	35,537	38,839
Silver (recoverable content of ores, etc.)..... thousand troy ounces..	32	57	24	42
Stone..... thousand short tons..	37,561	66,839	37,616	68,118
Zinc (recoverable content of ores, etc.)..... short tons..	58,728	17,149	58,577	17,947
Value of items that cannot be disclosed:				
Abrasive garnet, cement, emery, iron ore, talc, titanium concentrate, wollastonite, and value indicated by symbol W.....	XX	107,432	XX	115,750
Total.....	XX	r 302,480	XX	299,564
Total 1967 constant dollars.....	XX	285,632	XX	p 271,105

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

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

and has forbidden the construction or operation of steam-electric generating facilities without a State permit for thermal discharge. Under cooperative programs with the U.S. Geological Survey and the U.S. Army Corps of Engineers, the ten regional water resources planning boards continued studies on water resources, drainage, and pollution abatement.

The Office of Recovery, Recycling and Reuse of the Department of Environmental Conservation was investigating technological, economic, and social systems to prevent damage to the environment and loss of valuable resource materials through recovery, recycling, and reuse of wastes that might otherwise become a source of pollution in the State's waters, air, and land.

**Employment and Injuries.**—In 1970, the total labor force in the State was 8.36 million. Total employment was 7.99 million, a

decrease of 0.3 percent compared with total employment in 1969. Employment in the manufacturing, contract construction, and mining sectors totaled 2.05 million. In the mining industry, employment was 8,000, a decrease of 1.2 percent compared with 1969 figures. Unemployment was 0.37 million in 1970, an increase of 27 percent compared with 1969 figures.

The following companies received certificates of achievement from the National Safety Competition for having an outstanding safety record in 1970: Alpha Portland Cement Co.; Buffalo Slag Co., Inc.; Eastern Rock Products, Inc.; Cayuga Crushed Stone, Inc.; Dewitt Concrete Corp.; Georgia-Pacific Corp., Gypsum Div.; Marquette Cement Mfg. Co.; New York Trap Rock Corp.; Penn-Dixie Cement Corp.; Rhinehart Sand and Gravel, Inc.; United States Gypsum Co.; U.S. Steel Corp., Universal Atlas Cement Division.

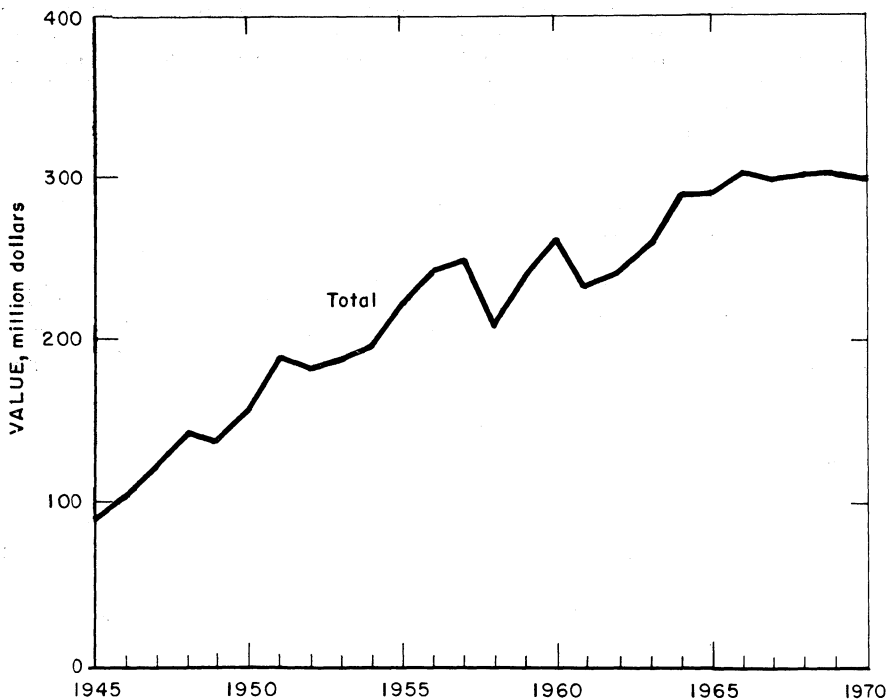


Figure 1.—Total value of mineral production in New York.

Table 2.—Value of mineral production in New York, by counties <sup>1 2</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Albany.....	W	W	Cement, stone, clays, sand and gravel.
Allegany.....	W	\$756	Sand and gravel.
Broome.....	\$1,616	1,210	Sand and gravel, stone, clays.
Cattaraugus.....	2,675	W	Sand and gravel, peat.
Cayuga.....	W	W	Stone, sand and gravel.
Chautauqua.....	W	327	Sand and gravel.
Chemung.....	W	1,494	Do.
Chenango.....	W	299	Do.
Clinton.....	W	W	Stone, sand and gravel.
Columbia.....	W	W	Cement, stone, sand and gravel, clays.
Cortland.....	W	W	Sand and gravel.
Delaware.....	1,390	1,503	Stone, sand and gravel.
Dutchess.....	W	W	Do.
Erie.....	13,850	13,241	Stone, cement, lime, gypsum, sand and gravel, clays.
Essex.....	W	W	Iron ore, ilmenite, sand and gravel, wollastonite, stone, garnet.
Franklin.....	W	W	Sand and gravel, stone.
Fulton.....	192	228	Sand and gravel, stone.
Genesee.....	3,339	W	Stone, gypsum, sand and gravel.
Greene.....	21,553	19,994	Cement, stone.
Herkimer.....	W	W	Stone, sand and gravel.
Jefferson.....	W	W	Do.
Lewis.....	947	W	Sand and gravel, stone.
Livingston.....	W	W	Salt, sand and gravel, stone.
Madison.....	838	W	Stone, sand and gravel.
Monroe.....	4,272	W	Do.
Montgomery.....	W	W	Do.
Nassau.....	4,768	W	Sand and gravel, clays.
Niagara.....	4,663	W	Stone, lime.
Oneida.....	2,439	W	Stone, sand and gravel.
Onondaga.....	20,190	16,702	Stone, lime, cement, salt, sand and gravel, clays.
Ontario.....	1,919	W	Sand and gravel, stone, peat.
Orange.....	1,963	W	Do.
Orleans.....	W	W	Sand and gravel, stone.
Oswego.....	W	419	Sand and gravel.
Otsego.....	W	152	Do.
Putnam.....	W	W	Do.
Rensselaer.....	1,158	W	Sand and gravel, stone.
Richmond.....	W	---	---
Rockland.....	9,452	9,701	Stone, sand and gravel.
St. Lawrence.....	36,432	33,671	Zinc, iron ore, talc, stone, sand and gravel, lead, silver, mercury.
Saratoga.....	1,857	W	Stone, sand and gravel.
Schenectady.....	545	478	Sand and gravel.
Schoharie.....	W	W	Cement, stone, clays, sand and gravel.
Schuyler.....	W	W	Salt, sand and gravel.
Seneca.....	279	246	Stone, peat.
Steuben.....	1,080	W	Sand and gravel, stone.
Suffolk.....	4,153	2,143	Sand and gravel.
Sullivan.....	W	W	Stone, sand and gravel.
Tioga.....	442	604	Sand and gravel.
Tompkins.....	W	W	Salt, stone, sand and gravel.
Ulster.....	W	W	Cement, stone, clays, sand and gravel.
Warren.....	W	W	Cement, garnet, stone.
Washington.....	1,302	W	Stone, sand and gravel.
Wayne.....	W	W	Do.
Westchester.....	809	W	Stone, sand and gravel, emery, peat.
Wyoming.....	W	W	Salt.
Yates.....	3	W	Sand and gravel.
Undistributed <sup>3</sup> .....	158,853	196,394	
Total <sup>4</sup> .....	302,480	299,564	

<sup>2</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

<sup>1</sup> Bronx, Hamilton, Kings, New York, and Queens Counties are not listed because no production was reported.

<sup>2</sup> Natural gas and petroleum not listed by counties; value included with "Undistributed."

<sup>3</sup> Includes natural gas, petroleum, sand and gravel, and gem stones that cannot be assigned to specific counties, and values indicated by symbol W.

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

Table 3.—Indicators of New York business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average: <sup>1</sup></b>			
Total labor force..... thousands.....	8,305.0	8,360.0	+ .6
Unemployment..... percent of labor force.....	3.5	4.4	+25.7
<b>Employment:</b>			
Manufacturing..... thousands.....	1,871.0	1,769.0	-5.5
Durable goods..... do.....	831.1	833.0	-5.5
Nondurable goods..... do.....	989.9	937.0	-5.3
Mining..... do.....	8.1	8.0	-1.2
Contract construction..... do.....	262.2	268.0	+2.2
<b>Earnings—average weekly: <sup>1</sup></b>			
Manufacturing.....	\$123.90	\$133.71	+4.2
Durable goods.....	\$141.66	\$147.83	+4.4
Nondurable goods.....	\$117.66	\$124.79	+6.1
<b>Personal income: <sup>2</sup></b>			
Total..... millions.....	\$81,384	\$87,452	+7.6
Per capita.....	\$4,495	\$4,797	+6.7
<b>Construction activity: <sup>3</sup></b>			
Portland cement shipments to and within New York thousand 376-pound barrels.....	17,626	17,868	+1.4
Mineral production <sup>3</sup> ..... thousands.....	\$302,480	\$299,564	- .9

<sup>1</sup> Revised.<sup>1</sup> New York State Department of Labor.<sup>2</sup> Survey of Current Business.<sup>3</sup> United States Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Peat.....	13	169	2	17	-----	1	57.53	805
Metal.....	1,303	275	358	2,862	-----	57	19.92	1,947
Nonmetal.....	2,049	266	545	4,429	1	146	33.19	2,390
Sand and gravel.....	2,219	215	477	3,969	-----	79	19.90	559
Stone.....	3,210	269	863	7,070	1	80	11.46	1,264
Total <sup>1</sup> .....	8,794	255	2,244	18,347	2	363	19.89	1,490
<b>1970:<sup>p</sup></b>								
Peat.....	14	183	3	20	-----	-----	-----	-----
Metal.....	1,345	269	362	2,898	1	50	17.60	2,709
Nonmetal.....	2,085	266	555	4,440	1	130	29.50	2,149
Sand and gravel.....	2,115	217	459	3,918	-----	69	17.61	588
Stone.....	3,075	273	840	6,869	3	131	19.51	3,654
Total <sup>1</sup> .....	8,635	257	2,219	18,146	5	380	21.22	2,468

<sup>p</sup> Preliminary.<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Abrasives, Manufactured.**—The Carborundum Co. and General Abrasives Co. in Niagara County operated electric furnaces for fused aluminum oxide and silicon carbide manufacture. The finished products were used in abrasives and in refractories and other nonabrasives.

Metallic abrasives consisting of chilled iron shot and grit, annealed iron shot and grit, and cut wire shot, were produced by Fanner Mfg. Co. and Pellets, Inc., in Erie County.

**Cement.**—Shipments of all types of cement decreased 4 percent in quantity but increased 3 percent in value. Cement ranked first in value among the State's mineral industries. Portland cement accounted for 98 percent of the cement value; the average price of portland cement was \$2.80 per barrel. Shipments of masonry cement decreased in quantity and the average price increased to \$2.54 per barrel.

Eleven plants were in operation of which nine were in eastern and two in western New York. Four plants produced

portland cement exclusively; six produced portland and masonry; and one produced masonry only. Cement production was reported from eight counties; in quantity, Albany County ranked first, followed by Greene, Ulster, and Columbia Counties.

Cement rock and limestone totaling more than 7 million tons were the principal raw materials for manufacturing portland cement. Other raw materials included clay and shale (413,130 tons); gypsum (219,405); sand (28,030 tons); and iron-bearing materials (17,307 tons). A total of 668 million kilowatt-hours of electrical energy were consumed, all of which were purchased.

**Emery.**—Production for the entire United States was from one open-pit mine, DeLuca Emery Mine, Inc., in Westchester County. With the closing of the DiRubbo American Emery Co. in 1969, total emery output in 1970 decreased substantially. Uses were mainly as aggregate for heavy-duty nonslip floors and pavements and for general abrasive purposes.

**Garnet.**—The total quantity of abrasive garnet produced decreased 3 percent and the value increased 5 percent. Garnet from an open-pit mine in Warren County operated by Barton Mines Corp. was sold for precision uses in coated abrasives, glass grinding and polishing, and metal lapping. Garnet recovered as a byproduct of wollastonite mining by Interpace Corp. in Essex County was sold for use in sandblasting and for general abrasive purposes. New York State ranked first in the Nation in the production of garnet in 1970.

**Gem Stones.**—The collection of gem stones and mineral specimens was principally by amateurs. The value of gem stone production was estimated to be \$10,000. Based on value, New York ranked 21st in the United States in gem stone production.

**Graphite (Manufactured).**—Graphite, manufactured from petroleum coke and other materials was produced by Great Lakes Carbon Corp., Airco Speer Electronics, Carborundum Metals Co., and Union Carbide Corp. The principal uses were shapes: Anodes, electrodes, electric motor brushes, crucibles, and other refractories. Synthetic graphite powder was used as a carbon raiser in steelmaking, an additive in nonferrous metallurgy, foundry facings, and lubricants (alone and in greases).

**Gypsum.**—Output of gypsum decreased 14 percent in quantity and 7 percent in

value. Production came from three underground mines, two in Erie County and one in Genesee County. Most of the crude gypsum was calcined at company-owned plants for use in manufacturing building materials. Seven calcining plants located in Bronx, Erie (2), Genesee, Richmond, Rockland, and Westchester Counties were in operation. Uses for calcined gypsum other than in building materials included manufacturing plate glass, pottery, molding, and art coating plasters. Some crude gypsum was used as a retarder in portland cement.

**Ilmenite.**—Ilmenite concentrate was produced by the National Lead Co. from an open-cut titaniferous-magnetite deposit near Tahawus, Essex County. Shipments and value were 9 percent more than those of 1969. The output was used principally in the manufacture of titanium dioxide pigment.

**Lime.**—Production of lime in New York decreased both in quantity and value in 1970. In order of output, lime was produced by Allied Chemical Corp. (Onondaga County), Bethlehem Steel Corp. (Erie County), and Union Carbide Corp. (Niagara County). The lime plant of the Bethlehem Steel Corp. was operated to supply quicklime for the basic oxygen furnaces at Lackawanna. All other quicklime was captive production by chemical companies. Quicklime accounted for about 90 percent of the lime output. Most hydrated lime was used for chemical processing; some was used for construction.

**Perlite.**—Crude perlite mined in Western States was expanded at seven plants of four companies. National Gypsum Co. operated plants in Bronx and Erie Counties, Georgia-Pacific Corp. in Erie County, United States Gypsum Co. in Genesee, Richmond, and Rockland Counties, and Buffalo Perlite Corp. in Erie County. The most important use was in acoustical building plaster. Other uses included loose fill insulation, soil conditioning, lightweight concrete aggregate, and filtering.

**Salt.**—The output of salt increased 7 percent in quantity and 4 percent in value. Rock salt and brine salt increased in quantity and value whereas evaporated salt remained constant. The overall value per ton increased slightly. By tonnage, most evaporated salt was used for food processing and seasoning. Another large



use for evaporated salt was for manufacturing chlorine and other chemicals. The principal use for rock salt was for ice control on highways in the Northeastern States. Other important uses for rock salt were in the chemical and food industries. Salt in brine was used mainly for the manufacture of soda ash; some salt in brine was used for the manufacture of chlorine and other chemicals. Most of the salt consumed for chemical manufacture was used within New York State. Rock salt was produced from one mine each in Livingston and Tompkins Counties. Salt was produced from two well operations in Schuyler County and from one each in Onondaga and Wyoming Counties. The State ranked third in quantity and fourth in value among the salt-producing States.

**Sand and Gravel.**—Production of sand and gravel decreased 11 percent in quantity and 9 percent in value. The average value per ton increased by 2.5 cents to

\$1.09. There were 330 sand and gravel mines, a decrease of 66 mines compared with 1969 figures. These mines were operated by construction companies and government operators working on various Federal, State, County, and local government contracts. More than 1 million tons each was reported from Nassau, Cattaraugus, Essex, Dutchess, Rensselaer, Suffolk, Livingston, and Ontario Counties, in decreasing order of tonnage.

**Stone.**—Total stone production increased 1 percent in quantity and 2 percent in value. Stone was the second most valuable mineral commodity produced in the State. Dutchess County ranked first in value among the State's 39 stone-producing counties, followed by Rockland, Ulster, and Onondaga. Sixteen counties had stone industries with output valued in excess of \$1 million. Crushed limestone and dolomite, considered together as carbonate rock, were predominant in the State, accounting for

**Table 5.—New York: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	9,786	\$12,637	9,582	\$12,608
Fill.....	1,522	1,059	704	327
Molding.....	166	764	139	687
Paving.....	3,143	4,279	3,740	4,414
Other uses <sup>1</sup> .....	882	1,039	457	581
Total <sup>2</sup> .....	15,499	19,778	14,622	18,618
<b>Gravel:</b>				
Building.....	4,787	7,238	4,763	7,591
Fill.....	1,845	1,163	1,789	910
Paving.....	3,832	4,599	4,093	4,675
Other uses <sup>3</sup> .....	657	832	862	965
Total <sup>2</sup> .....	11,121	13,832	11,507	14,141
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Building.....	43	65	43	65
Fill.....	3,171	1,539	1,692	561
Paving.....	290	202	905	501
Other uses.....	721	332	67	37
Total <sup>2</sup> .....	4,225	2,188	2,707	1,164
<b>Gravel:</b>				
Fill.....	3,364	1,820	2,329	1,354
Paving.....	5,530	4,837	4,346	3,559
Other uses.....	63	63	26	2
Total <sup>2</sup> .....	8,961	6,720	6,701	4,915
Total sand and gravel <sup>2</sup> .....	39,806	42,518	35,537	38,839

<sup>1</sup> Includes engine, filtration, foundry, and other sands.

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

<sup>3</sup> Includes miscellaneous, railroad ballast (1969), and other gravel.

Table 6.—New York: Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Albany	9	W	W	9	320	\$272
Allegany	4	331	\$501	4	507	756
Broome	13	913	1,283	11	604	929
Cattaraugus	11	1,918	2,650	11	2,399	3,111
Cayuga	4	264	301	3	206	273
Chautauqua	5	435	323	5	397	327
Chemung	5	602	841	4	621	1,494
Chenango	4	227	298	4	221	299
Delaware	1	W	W	2	24	3
Dutchess	19	1,773	1,976	17	1,526	1,683
Erie	7	1,020	1,937	7	645	1,078
Essex	6	224	178	6	1,554	1,187
Franklin	5	218	156	5	447	110
Fulton	7	247	193	8	342	228
Genesee	5	388	490	3	312	382
Jefferson	13	536	426	14	522	270
Lewis	4	W	W	6	410	327
Livingston	5	866	839	6	1,102	972
Madison	1	W	W	1	W	W
Monroe	7	874	1,386	10	871	1,351
Montgomery	4	330	490	2	W	W
Nassau	6	4,510	4,568	5	4,529	5,281
Niagara	3	(1)	W	-----	-----	-----
Oneida	11	1,081	1,339	9	741	922
Onondaga	7	867	637	7	880	635
Ontario	14	1,095	1,274	14	1,043	1,022
Orange	10	813	1,021	8	582	892
Orleans	4	152	217	4	265	296
Oswego	4	335	457	4	259	419
Otsego	3	143	132	4	112	152
Rensselaer	15	776	627	15	1,295	978
Richmond	1	43	32	-----	-----	-----
Saratoga	12	292	460	7	257	369
Schenectady	6	379	545	6	340	478
St. Lawrence	13	628	466	12	701	426
Steuben	5	537	821	5	751	1,290
Suffolk	16	3,684	4,153	13	1,819	2,143
Sullivan	6	139	238	7	147	228
Tioga	5	367	443	5	432	604
Wayne	7	141	72	6	145	69
Westchester	1	W	W	1	55	93
Undistributed <sup>2</sup>	108	12,654	10,747	60	8,152	7,490
Total <sup>3</sup>	396	89,806	42,518	330	35,537	38,839

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

<sup>1</sup> Less than ½ unit.

<sup>2</sup> Includes Clinton, Columbia, Cortland, Herkimer, Putnam, Rockland, Schoharie, Schuyler, Tompkins, Ulster, Warren (1969), Washington and Yates Counties, and some sand and gravel that cannot be assigned to specific "counties."

<sup>3</sup> Data may not add to totals shown because of independent rounding.

89 percent of the tonnage and 83 percent of the value of all stone produced.

The chief uses for crushed dolomite and limestone were as an aggregate material in various construction applications and for the manufacture of cement and lime. Other uses were agricultural stone, railroad ballast, riprap, asphalt filler, and fluxing stone.

Basalt (traprock), ranked second in quantity of stone production within the State. All output came from Rockland County. The chief uses were for concrete aggregate and road metal.

Sandstone, which includes quartzite, was quarried as dimension stone and as

crushed stone. Sandstone ranked third in tonnage and value in the State. The chief uses of dimension sandstone were for curbing and flagging and for architectural applications. Crushed sandstone was used for concrete aggregate and road metal. Production was reported from seven counties, led in value by Delaware and Sullivan.

Slate was quarried in Washington County and prepared for uses as flagstone, roofing, structural, and sanitation stone. Granite was quarried and dressed in Essex and Westchester Counties mostly for building stone. Crushed granite from Essex, Warren, and Westchester Counties was used for concrete aggregate, road metal, and railroad ballast.

**Table 7.—New York: Crushed and broken limestone and dolomite sold or used by producers, by uses**

(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Bituminous aggregate.....	2,086	\$4,139	2,527	\$5,577
Concrete aggregate.....	8,363	15,718	10,795	20,140
Dense graded road base stone.....	2,120	3,763	1,444	2,503
Macadam aggregate.....	380	640	381	736
Surface treatment aggregates.....	623	1,269	562	1,245
Unspecified aggregate and roadstone.....	10,254	17,942	8,051	14,556
Agricultural limestone.....	306	1,139	500	1,747
Cement.....	6,980	6,969	7,172	6,929
Railroad ballast.....	412	681	198	362
Riprap and jetty stone.....	137	451	144	330
Other uses <sup>1</sup> .....	1,745	3,053	1,758	2,593
<b>Total<sup>2</sup>.....</b>	<b>33,456</b>	<b>55,744</b>	<b>33,535</b>	<b>56,718</b>

<sup>1</sup> Data includes fluxing stone, sand stone (1970), chemical stone (1970), fill (1970), stucco (1970), drain fields (1970), lime (1969), and other uses in smaller quantities.

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

**Talc.**—The output of talc decreased 12 percent and the value decreased 6 percent. New York continued to be the leading talc-producing State. Gouverneur Talc Co. and International Talc Co. mined talc from two underground mines and one open-cut mine in St. Lawrence County. Crude talc was ground in company-owned mills and marketed principally for use in ceramics and as a mineral filler in paints. Small quantities were used as a mineral filler in floor and wall tiles, rubber, and miscellaneous products.

**Vermiculite.**—Crude vermiculite mined in other States was exfoliated at the Zonolite Div. plant of W. R. Grace Co., Weedsport, Cayuga County. The expanded vermiculite was used for loose fill insulation, soil conditioning, ultra-lightweight concrete aggregate, and building plaster aggregate.

**Wollastonite.**—Crude wollastonite was mined and beneficiated at the Willsboro Mine in Essex County now operated by Interpace Corp. The refined wollastonite was used as a filler in paints and plastics and as an ingredient in ceramic products.

#### METALS

**Aluminum.**—Production of primary aluminum from the Massena plants, St. Lawrence County, of Aluminum Company of America and Reynolds Metals Co. increased in both tonnage and value. The State ranked third in aluminum production.

**Iron Ore.**—The decreased mine production of magnetite iron ore came from an underground mine operated by Republic

Steel Corp. in Essex County, and two open-pit mines, one operated by National Lead Co. in Essex County and one by Jones & Laughlin Steel Corp. in St. Lawrence County. All of the ore was beneficiated and most of the concentrates were agglomerated before shipment. Principal uses for shipments were in the manufacture of pig iron and steel and some in the manufacture of cement, for heavy media separation, and for ballast.

**Lead.**—Lead was recovered as a byproduct of zinc mining at the Balmat mine of St. Joe Minerals Corp. in St. Lawrence County. Quantity decreased 24 percent and the value decreased 20 percent. Lead recovery varies from year to year, depending on the proportion of ore coming from that section of the Balmat mine where the vein has a higher lead content. The lead concentrate was shipped to the company lead smelter at Herculaneum, Mo.

**Silver.**—The quantity of silver recovered from lead concentrates shipped from the Balmat mine, St. Joe Minerals Corp., in St. Lawrence County was 25 percent less than that of 1969 and the value decreased 26 percent. Silver recovery usually reflects the demands for silver-free lead rather than the silver content of the concentrate.

**Zinc.**—New York continued to rank second to Tennessee in U.S. zinc production for both quantity and value. Production, all from the Balmat and Edwards mines of the St. Joe Minerals Corp. in St. Lawrence County, decreased less than 1 percent in quantity and increased 5 percent in value from 1969.

Table 8.—New York: Mine production (recoverable) of silver, lead, and zinc

	1968	1969	1970
Mines producing:			
Lode.....	2	2	2
Material sold or treated:			
Ore..... thousand short tons..	785	741	742
Lead-zinc..... do.....	---	---	566
Zinc..... do.....	785	741	176
Production (recoverable):			
Quantity:			
Silver..... troy ounces..	27,615	31,755	23,830
Lead..... short tons.....	1,396	1,686	1,280
Zinc..... do.....	66,194	53,728	58,577
Value:			
Silver..... thousands..	\$59	\$57	\$42
Lead..... do.....	369	502	400
Zinc..... do.....	17,872	17,149	17,947
Total..... do.....	18,300	17,708	18,389

## MINERAL FUELS

**Natural Gas.**—According to the Geological Survey, New York State Museum and Science Service, the production of natural gas decreased 31 percent, to 3.4 billion cubic feet. Estimated crude recoverable reserves of natural gas at yearend, according to the American Gas Association, were 126 billion cubic feet, of which 103 billion cubic feet was in underground storage reservoirs. Reserves were 4 percent more than at yearend 1969.

**Peat.**—Sales of peat increased 7 percent in quantity but decreased 19 percent in value. Peat use was mainly in general soil improvement although some peat was used for potting. Orange County was the leading producing area; output was also re-

ported from Cattaraugus, Ontario, Seneca, and Westchester Counties.

**Petroleum.**—Crude oil production was 1,193,501 barrels compared with 1,255,660 barrels in 1969, a decrease of 62,159 barrels. The Allegany field produced 416,687 barrels; the Cattaraugus field produced 673,099 barrels; and the Busti oil pool, Chautauqua County, produced 103,715 barrels. On January 1, 1970, the posted prices for New York crude oil per barrel were \$4.37 in Allegany County, \$4.63 in Cattaraugus County, and \$4.19-4.35 in Chautauqua County. There were no price changes during the year. The estimated 1970 value of crude oil produced was \$5,387,073, a decrease in value of \$296,066 from 1969.

Table 9.—Oil and gas well drilling in 1970, by counties

County	Oil	Gas	Dry	Total	Footage
<b>Exploratory completions:</b>					
Allegany.....		1	4	5	23,757
Erie.....		1	---	1	1,513
Madison.....		---	1	1	3,463
Steuben.....		---	3	3	12,119
Wyoming.....		---	1	1	4,944
Total.....		2	9	11	45,796
<b>Development completions:</b>					
Allegany.....	27	4	1	32	53,252
Broome.....	---	---	1	1	5,910
Cattaraugus.....	18	---	1	19	30,410
Chautauqua.....	24	---	---	24	16,696
Erie.....	---	10	1	11	15,857
Genesee.....	---	1	---	1	1,533
Total.....	69	15	4	88	123,658
Total all drilling.....	69	17	13	99	169,454

Source: American Association of Petroleum Geologists.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Abrasives:</b>			
<b>Artificial:</b>			
The Carborundum Co., Electro Mineral Div.	P.O. Box 423 Niagara Falls, N.Y. 14302	Plant	Niagara.
General Abrasive Co., Div. of U.S. Industries, Inc.	Niagara Falls, N.Y. 14302	do	Do.
<b>Metalllic:</b>			
Cleveland Metal Abrasive Co., Div. of Fanner Mfg. Co.	Brookside Park Cleveland, Ohio 44109	do	Erie.
Pellets, Inc.	533 S. Niagara St. Tonawanda, N.Y. 14150	do	Do.
<b>Cement:</b>			
Alpha Portland Cement Co. <sup>1</sup>	15 South Third St. Easton, Pa. 18043	do	Greene.
Alpha Portland Cement Co.	do	do	Onondaga.
Atlantic Cement Co., Inc. <sup>1</sup>	P.O. Box 3 Ravena, N.Y. 12143	do	Albany.
Century Cement Mfg. Co., Inc.	Rosendale, N.Y. 12472	do	Ulster.
Glens Falls Portland Cement Co., <sup>2</sup> Div. of Flintkote Co.	313 Warren St. Glens Falls, N.Y. 12801	do	Warren.
Hudson Cement Division, <sup>2</sup>	1740 Broadway New York, N.Y. 10019	do	Ulster.
Colonial Sand & Stone Co., Inc.	1718 Hamilton St. Allentown, Pa. 18105	do	Erie.
Lehigh Portland Cement Co. <sup>2</sup>	do	do	Greene.
Marquette Cement Mfg. Co. <sup>3</sup>	20 N. Wacker Dr. Chicago, Ill. 60606	do	Do.
Penn Dixie Cement Corp. <sup>1</sup>	P.O. Box 152 Nazareth, Pa. 18064	do	Schoharie.
Universal Atlas Cement Div., <sup>1</sup> U.S. Steel Corp.	Chatham Center Pittsburgh, Pa. 15230	do	Columbia.
<b>Clays (miscellaneous):</b>			
Binghamton Brick Co., Inc.	P.O. Box 1256 Binghamton, N.Y. 13902	Pit.	Broome.
Hudson Lightweight Stone Div., Colonial Sand & Stone Co., Inc.	1740 Broadway New York, N.Y. 10019	Pit.	Ulster.
Hudson Valley Lightweight Aggregate Corp.	P.O. Box 9138 Richmond, Va. 23227	Pit.	Do.
Jova Brick Mfg. Corp.	Kingston, N.Y. 12401	Pit.	Do.
Nassau Brick Co., Inc.	635 Round Swamp Rd. Old Bethpage, L.I., N.Y. 11804	Pit.	Nassau.
New York Trap Rock Corp.	162 Old Mill Rd. W. Nyack, N.Y. 10994	Pit.	Ulster.
Powell & Minnock Brick Works, Inc.	Coeymans, N.Y. 12046	Pit.	Albany.
<b>Emery:</b>			
DeLuca Emery Mine, Inc.	926 Constant Ave. Peekskill, N.Y. 10566	Pit.	Westchester.
<b>Garnet:</b>			
Barton Mines Corp.	North Creek, N.Y. 12853	Pit.	Warren.
<b>Graphite (synthetic):</b>			
Airco Speer Electrodes & Anodes, Div. of Air Reduction Co., Inc.	Packard Rd. Niagara Falls, N.Y. 14302	Plant	Niagara.
The Carborundum Co., Graphite Products Div.	2050 Cory Dr. Sanborn, N.Y. 14132	do	Do.
Great Lakes Carbon Corp., Graphite Products Div.	299 Park Ave. New York, N.Y. 10017	do	Do.
Union Carbide Corp., Carbon Products Div.	270 Park Ave. New York, N.Y. 10017	do	Do.
<b>Gypsum:</b>			
Georgia-Pacific Corp., Gypsum Div. <sup>4</sup>	P.O. Box 311 Portland, Ore. 97207	Underground mine and calcining plant.	Erie.
National Gypsum Co. <sup>4</sup>	325 Delaware Ave. Buffalo, N.Y. 14202	Calcining plant. Underground mine and calcining plant.	Westchester. Erie.
United States Gypsum Co. <sup>4</sup>	101 S. Wacker Dr. Chicago, Ill. 60606	Calcining plant. Underground mine and calcining plant.	Bronx. Genesee.
		Calcining plants	Richmond, Rockland.
<b>Iron ore:</b>			
Jones & Laughlin Steel Corp.	Star Lake, N.Y. 13690	Pit.	St. Lawrence.
Republic Steel Corp. <sup>5</sup>	1629 Republic Bldg. Cleveland, Ohio 44101	Underground	Essex.

See footnotes at end of table.

Table 10.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Lime:</b>			
Bethlehem Steel Corp.....	701 E. Third St. Bethlehem, Pa. 18016	Plant.....	Erie.
Industrial Chemicals Div., Allied Chemical Corp.	P.O. Box 70 Morristown, N.J. 07960	---do.....	Onondaga.
<b>Peat:</b>			
George Dobbs.....	Clifton Springs, N.Y. 14432	Bog.....	Ontario.
Sterling Forest Peat Co., Inc.....	P.O. Box 608 Tuxedo, N.Y. 10987	Bog.....	Orange.
Stone Age Humus Corp.....	Armonk, N.Y. 10504	Bog.....	Westchester.
Sue Peat Co.....	Allegany, N.Y. 14706	Bog.....	Cattaraugus.
<b>Perlite (expanded):</b>			
Buffalo Perlite Corp.....	100 Sugg Rd. Buffalo, N.Y. 14225	Plant.....	Erie.
<b>Petroleum:</b>			
Mobil Oil Corp.....	Buffalo, N.Y. 14221	Refineries.....	Do.
Frontier Oil & Refining Co., Div. of Ashland Oil & Refining Co.	Tonawanda, N.Y. 14150	---do.....	Do.
<b>Salt:</b>			
<b>Evaporated:</b>			
International Salt Co.....	Clarks Summit, Pa. 18411	Well.....	Schuyler.
Morton Salt Co.....	110 N. Wacker Dr. Chicago, Ill. 60606	---do.....	Wyoming.
The Watkins Salt Co., Inc. <sup>6</sup> ...	Box 150 Watkins Glen, N.Y. 14891	---do.....	Schuyler.
<b>Rock:</b>			
Cayuga Rock Salt Co., Inc.....	191 Portland Pt. Rd. Myers, N.Y. 14866	Underground.....	Tompkins.
International Salt Co.....	Clarks Summit, Pa. 18411	---do.....	Livingston.
<b>Brine:</b>			
Industrial Chemicals Div., <sup>7</sup> Allied Chemical Corp.	P.O. Box 70 Morristown, N.J. 07960	Well.....	Onondaga.
<b>Sand and gravel:</b>			
Albany Gravel Co., Inc.....	N. Pearl St. & Loudonville Rd., Albany, N.Y. 12201	Pit.....	Albany, Rensselaer.
Allegany Aggregates, Inc.....	P.O. Box 543 Olean, N.Y. 14760	Pit.....	Cattaraugus.
Colonial Sand & Stone Co., Inc.....	1740 Broadway New York, N.Y. 10019	Pit.....	Nassau, Dutchess.
Country Side Sand & Gravel, Inc.....	South Dayton, N.Y. 14138	Pit.....	Cattaraugus.
Elmira Transit Mix, Inc.....	Box 231, Easton, Pa. 18042	Pit.....	Cattaraugus, Chemung.
Penn Industries, Inc.....	136 East 57th St. New York, N.Y. 10022	Pit.....	Nassau.
Roanoke Marbro Sand & Gravel Corp.	P.O. Box 172 Riverhead, L.I., N.Y. 11901	Pit.....	Suffolk.
Don C. Russo Sand & Gravel Co.....	Bushnell's Basin, N.Y. 14534	Pit.....	Monroe.
Torrington Construction Co., Inc.....	Keeseville, N.Y. 12944	Pit.....	Essex.
Valley Sand & Gravel Corp.....	788 Ridge Rd. West Rochester, N.Y. 14615	Pit.....	Livingston, Sullivan.
<b>Smelters (aluminum):</b>			
Aluminum Co. of America.....	1501 Alcoa Bldg. Pittsburgh, Pa. 15222	Plant.....	St. Lawrence.
Reynolds Metals Co.....	6601 Broad Street Rd. Richmond, Va. 23215	---do.....	Do.
<b>Stone:</b>			
<b>Basalt (crushed):</b>			
Appalachian Stone Div., Martin Marietta Corp.	Box 120 Mercersburg, Pa. 17236	Quarry.....	Rockland.
New York Trap Rock Corp.....	162 Old Mill Rd. W. Nyack, N.Y. 10994	---do.....	Do.
Rockland Materials Corp.....	P.O. Box 57, Suffern, N.Y. 10901	---do.....	Do.
<b>Granite (dimension):</b>			
Di Rienzo Brothers.....	107 Main St. Tuckahoe, N.Y. 10707	---do.....	Westchester.
Frank Baratta, P. D'Amato & Angelo Cucchiella, T/A Dunwoodie Stone Quarry, Inc.	941 Midland Ave. Yonkers, N.Y. 10787	---do.....	Do.
Lake Street Granite Quarry, Inc.	Lake Street E. White Plains, N.Y. 10600	---do.....	Do.
<b>Granite (crushed):</b>			
Northern Materials, Inc.....	Route 9 Chestertown, N.Y. 12817	---do.....	Warren.

See footnotes at end of table.

Table 10.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Stone—Continued</b>			
<b>Limestone (dimension):</b>			
Brickyard Falls Farm.....	R.D. 2 Manlius, N.Y. 13104	Quarry.....	Onondaga.
<b>Limestone and dolomite (crushed and broken):</b>			
Appalachian Stone Division, Martin Marietta Corp.	Box 120 Mercersburg, Pa. 17236	---do.....	Rockland.
Buffalo Crushed Stone Co....	10 Park Place Morristown, N.J. 07960	---do.....	Erie.
The Buffalo Slag Co., Inc., Federal Crushed Stone Div.	111 Great Arrow Ave. Buffalo, N.Y. 14216	---do.....	Do.
The Callanan Road Improve- ment Co.	So. Bethlehem, N.Y. 12161	---do.....	Albany, Ulster.
Dolomite Products Co. <sup>s</sup> .....	1150 Penfield Rd. Rochester, N.Y. 14625	---do.....	Monroe.
Eastern Rock Products, Inc. <sup>s</sup> ..	404 Court St. Utica, N.Y. 13504	---do.....	Oneida.
Frontier Stone Products, Inc..	Box 376, Lockport, N.Y. 14094	---do.....	Niagara.
The General Crushed Stone Co.	712 Drake Bldg. Easton, Pa. 18042	---do.....	Cayuga, Genesee, Herkimer, Jefferson, Livingston, Onondaga, Ontario, Wayne.
Industrial Chemicals Div., Allied Chemical Corp.	P.O. Box 70 Morristown, N.J. 07960	---do.....	Onondaga.
Niagara Stone Div. of Great Lakes Color Printing Corp.	Quarry Road Niagara Falls, N.Y. 14304	---do.....	Niagara.
<b>Marble (crushed):</b>			
Balducci Crushed Stone Co....	Box 158 Gouverneur, N.Y. 13642	---do.....	St. Lawrence.
Universal Marble Products Corp.	Thornwood, N.Y. 10594	---do.....	Westchester.
<b>Miscellaneous (crushed):</b>			
Fitzgerald Bros. Construction Co., Inc.	504 Broadway Troy, N.Y. 12180	---do.....	Rensselaer.
<b>Sandstone (dimension):</b>			
Adirondak Stone Quarries, Inc.	P.O. Box 184 Malone, N.Y. 12953	---do.....	Franklin.
Downsville Stone Co., c/o MSR, Inc.	1 Dock Street Stamford, Conn. 06902	Processor.....	Delaware.
Finger Lakes Stone Co., Inc..	Box 401 Ithaca, N.Y. 14850	Quarry.....	Tompkins.
Willis Hankins.....	Hancock, N.Y. 13783	---do.....	Delaware.
Heldeberg Bluestone & Marble, Inc.	East Berne, N.Y. 12059	---do.....	Albany, Delaware.
Johnston & Rhodes Bluestone Co.	East Branch, N.Y. 13756	---do.....	Delaware.
W. R. Strong & Son.....	43 Wheeler St. Deposit, N.Y. 13754	Processor.....	Broome, Delaware.
Paul Tompkins Estate.....	Hancock, N.Y. 13783	---do.....	Do.
<b>Sandstone (crushed and broken):</b>			
Steuben Crushed Div., A. L. Blades & Sons, Inc.	County Route #10 Bath, N.Y. 14810	Quarry.....	Steuben.
Sullivan Highway Products Corp.	P.O. Box 392 Monticello, N.Y. 12701	---do.....	Sullivan.
<b>Slate (dimension):</b>			
Darius Slate Products.....	Middle Granville, N.Y. 12849	---do.....	Washington.
A. A. Hadeka Quarry.....	49 South St. Poultney, Vt. 05764	---do.....	Do.
McCullen Slate Co.....	R.D. 1 Granville, N.Y. 12832	---do.....	Do.
The A. B. Potter Slate Co., Inc.	Poultney, Vt. 05764	---do.....	Do.
Ritchie Brothers Slate Co....	Middle Granville, N.Y. 12849	---do.....	Do.
Sheldon Slate Products Co....	Prospect St. Fair Haven, Vt. 05743	---do.....	Do.
Vermont Structural Slate Co., Inc.	Box 104 Granville, N.Y. 12832	---do.....	Do.
Western Slate Co.....	Middle Granville, N.Y. 12849	---do.....	Do.
Williams Bros. Slate Co.....	Middle Granville, N.Y. 12849	---do.....	Do.
<b>Talc:</b>			
Gouverneur Talc Co., Inc.....	Gouverneur, N.Y. 13642	Underground	St. Lawrence.
International Talc Co., Inc.....	420 Lexington Ave. New York, N.Y. 10006	---do.....	Do.

See footnotes at end of table.

Table 10.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Titanium concentrate: Ilmenite: N. L. Industries, Inc. <sup>9</sup> -----	100 Chevalier Ave. So. Amboy, N.J. 08879	Pit.....	Essex.
Vermiculite (exfoliated): Zonolite Division, W. R. Grace and Co.	62 Whittemore Ave. Cambridge, Mass. 02140	Plant.....	Cayuga.
Wollastonite: Interpace Corp. <sup>10</sup> -----	Willsboro, N.Y. 12996-----	Underground.....	Essex.

<sup>1</sup> Also crushed limestone and shale.<sup>2</sup> Also crushed limestone.<sup>3</sup> Also crushed limestone and clay.<sup>4</sup> Also expanded perlite.<sup>5</sup> Also crushed granite.<sup>6</sup> Also brine.<sup>7</sup> Also evaporated salt and crushed limestone.<sup>8</sup> Also sand and gravel.<sup>9</sup> Also iron ore.<sup>10</sup> Also garnet.





# The Mineral Industry of North Carolina

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Division of Mineral Resources, North Carolina Department of Conservation and Development for collecting information on all minerals except fuels.

By Roland W. Merwin<sup>1</sup> and Stephen G. Conrad<sup>2</sup>

In 1970, the mineral industry of North Carolina contributed \$98.4 million to the State's economy, an increase of approximately \$7.9 million, or 9 percent above that of the previous year.

Stone was the leading mineral commodity produced, contributing 55 percent of the total mineral production value, followed by sand and gravel, which accounted for 14 percent. Cement, clays, feldspar, lithium minerals, and phosphate rock were also

produced. Together, they accounted for 28 percent of the State's 1970 mineral production. The remaining 3 percent was derived from the production of asbestos, gem stones, iron ore, kaolin, mica, olivine, talc and pyrophyllite, and tungsten.

<sup>1</sup> Mining engineer, Division of Nonmetallic Minerals.

<sup>2</sup> State geologist, Division of Mineral Resources, North Carolina Department of Conservation and Development.

North Carolina MYB 1970 Vol. III Fig. 1 folio 1a 28 x 14 picas

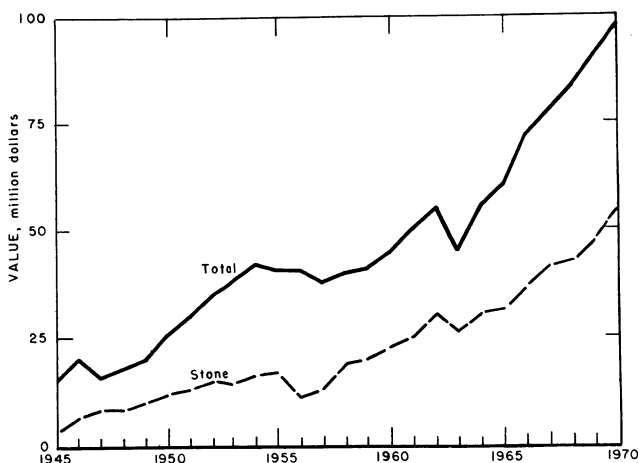


Figure 1.—Value of stone and total value of mineral production in North Carolina.

Table 1.—Mineral production in North Carolina <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays <sup>2</sup> .....thousand short tons.....	3,342	\$2,610	3,318	\$3,102
Feldspar.....long tons.....	338,149	4,615	345,186	5,173
Gem stones.....	NA	20	NA	20
Mica:				
Scrap.....thousand short tons.....	67	1,513	64	1,457
Sheet.....pounds.....	W	3		
Sand and gravel.....thousand short tons.....	10,562	11,437	12,772	13,277
Stone.....do.....	26,812	47,829	30,363	54,121
Talc and pyrophyllite.....short tons.....	105,728	586	92,639	544
Value of items that cannot be disclosed:				
Asbestos, cement, clays (kaolin), iron ore, lithium minerals, olivine, phosphate rock, tungsten (1970),-	XX	21,843	XX	20,671
Total.....	XX	90,456	XX	98,365
Total 1967 constant dollars.....	XX	85,418	XX	p 89,020

<sup>p</sup> Preliminary. 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 kaolin; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in North Carolina, by counties <sup>1</sup>  
(Thousand dollars)

County	1969	1970	Minerals produced in 1970 in order of value
Alamance.....	W	W	Granite, miscellaneous clay, sand and gravel, pyrophyllite.
Alexander.....	\$18	\$13	Sand and gravel.
Alleghany.....	W	W	Granite.
Anson.....	W	W	Sand and gravel.
Ashe.....	W	W	Sand and gravel, granite.
Avery.....	1,178	757	Mica, sand and gravel, kaolin, iron ore, granite.
Beaufort.....	W	W	Phosphate rock, sand and gravel.
Bertie.....	W	W	Sand and gravel.
Bladen.....	101	226	Do.
Brunswick.....	16	42	Do.
Buncombe.....	W	W	Granite, sand and gravel.
Burke.....	W	W	Do.
Cabarrus.....	W	W	Traprock, granite, miscellaneous clay, sand and gravel.
Caldwell.....	815	408	Granite, sand and gravel.
Camden.....	4	4	Sand and gravel.
Carteret.....	3	3	Do.
Caswell.....	W	W	Granite.
Catawba.....	W	W	Granite, sand and gravel, miscellaneous clay.
Chatham.....	W	W	Miscellaneous clay, granite.
Cherokee.....	W	W	Marble, sand and gravel, talc.
Chowan.....	5	5	Sand and gravel.
Clay.....	178	W	Granite, sand and gravel.
Cleveland.....	W	W	Limestone, lithium minerals, granite, feldspar, mica, sand and gravel.
Columbus.....	60	72	Sand and gravel.
Craven.....	W	W	Limestone, sand and gravel.
Cumberland.....	W	W	Sand and gravel, miscellaneous clay.
Currituck.....	11	15	Sand and gravel.
Dare.....	16	8	Do.
Davidson.....	1,239	1,295	Granite, slate, sand and gravel, miscellaneous clay.
Davie.....	W	W	Granite, sand and gravel.
Duplin.....	19	48	Sand and gravel.
Durham.....	W	W	Traprock, miscellaneous clay.
Edgecombe.....	173	237	Sand and gravel.
Forsyth.....	W	W	Granite, sand and gravel.
Franklin.....	12	W	Sand and gravel.
Gaston.....	W	W	Lithium minerals, sand and gravel.
Gates.....	7	20	Sand and gravel.
Graham.....	W	W	Do.
Granville.....	W	W	Granite, pyrophyllite, sand and gravel.
Greene.....	W	W	Sand and gravel.
Guilford.....	W	4,770	Granite, miscellaneous clay, sand and gravel.
Halifax.....	W	W	Do.
Harnett.....	W	W	Sand and gravel, miscellaneous clay.

See footnotes at end of table.

Table 2.—Value of mineral production in North Carolina, by counties <sup>1</sup>—Continued  
(Thousand dollars)

County	1969	1970	Minerals produced in 1970 in order of value
Haywood	W	W	Sand and gravel, granite.
Henderson	W	\$545	Limestone, granite, miscellaneous clay.
Hertford	W	W	Sand and gravel.
Hoke	\$30	52	Do.
Hyde	2	5	Do.
Iredell	W	W	Granite, miscellaneous clay, sand and gravel.
Jackson	W	464	Sand and gravel, granite, asbestos.
Johnston	W	W	Granite, sand and gravel, miscellaneous clay.
Jones	W	W	Limestone, sand and gravel.
Lee	W	W	Miscellaneous clay, sand and gravel.
Lenoir	W	172	Sand and gravel.
Lincoln	W	W	Granite, sand and gravel.
McDowell	113	W	Sand and gravel.
Macon	233	223	Granite.
Madison	42	W	Granite, feldspar.
Martin	W	W	Sand and gravel.
Mecklenburg	W	1	Granite.
Mitchell	4,161	4,549	Feldspar, mica, sandstone, granite.
Montgomery	W	W	Quartz, sandstone, miscellaneous clay, sand and gravel, slate.
Moore	883	1,413	Granite, sand and gravel, pyrophyllite, miscellaneous clay.
Nash	W	W	Granite, sand and gravel.
New Hanover	W	W	Cement, limestone, shell, miscellaneous clay, sand and gravel.
Northampton	6	W	Sand and gravel.
Onslow	W	W	Shell, sand and gravel.
Orange	W	W	Granite, pyrophyllite.
Pamlico	(2)	7	Sand and gravel.
Pasquotank	24	W	Do.
Pender	47	4	Do.
Perquimans	3	4	Do.
Person	1	-----	-----
Pitt	W	W	Granite, sand and gravel.
Polk	7	W	Do.
Randolph	W	W	Granite.
Richmond	107	W	Granite, sand and gravel.
Robeson	123	153	Sand and gravel.
Rockingham	W	1,303	Granite, miscellaneous clay, sand and gravel.
Rowan	W	W	Do.
Rutherford	W	W	Granite, sand and gravel.
Sampson	40	86	Sand and gravel, miscellaneous clay.
Scotland	43	33	Sand and gravel.
Stanly	W	W	Miscellaneous clay.
Stokes	181	75	Sand and gravel, quartzite, miscellaneous clay.
Surry	3,185	W	Granite, traprock, sand and gravel.
Swain	W	W	Limestone.
Transylvania	123	255	Granite, sand and gravel.
Union	W	W	Granite, miscellaneous clay, sand and gravel.
Vance	W	W	Granite, tungsten, sand and gravel.
Wake	W	W	Granite, sand and gravel.
Washington	6	8	Sand and gravel.
Watauga	W	W	Do.
Wayne	139	178	Do.
Wilkes	W	W	Granite, sand and gravel.
Wilson	W	W	Do.
Yadkin	7	7	Sand and gravel.
Yancey	W	W	Mica, olivine, sand and gravel, asbestos.
Undistributed	77,093	80,912	
Total <sup>3</sup>	90,456	98,365	

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

<sup>1</sup> The following counties are not listed because no production was reported: Tyrrell and Warren.

<sup>2</sup> Less than  $\frac{1}{2}$  unit.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

The leading mineral producers were Ideal Cement Co., Superior Stone Co., Nello L. Teer Co., Texas Gulf Sulphur Co., and Vulcan Materials Co. Together they accounted for 60 percent of the State's mineral production.

North Carolina ranked first among the States in the production of feldspar, lithium minerals, and mica; second in the pro-

duction of olivine; and fourth in the production of asbestos, clays and phosphate rock.

**Employment and Injuries.**—In the mineral industries, 4,545 men worked 9,707,000 man-hours, compared with 4,628 men and 9,859,000 man-hours in 1969, a decrease of 2 percent. Employment expanded tenfold at metal mines, owing to the reopening of

the Tungsten Queen mine, and increased 2 percent at stone quarries, but decreased 2 percent at sand and gravel mines and 13 percent at other nonmetal mines.

There were 249 lost-time injuries and two fatalities in the mineral industries, compared with 208 injuries and six fatalities in 1969.

**Legislation and Government Programs.**—Pursuant to a directive from the 1969 General Assembly, the North Carolina Mining Council continued its efforts to develop a mined land reclamation bill for consideration by the 1971 General Assembly. Public hearings on a preliminary draft of the pro-

posed bill were held; the final form of the bill was to be completed by the end of 1970.

The U.S. Bureau of Mines established a liaison office at Raleigh to provide surveillance of mineral supply and mineral-related environmental issues in the State and to develop closer Federal Government cooperation with State and local agencies in discerning and attacking mineral problems.

The State Division of Mineral Resources was actively engaged in geological and other mineral-related investigations concerning North Carolina's mineral potential and industry development. One of their publications reviewed the mineral industry's de-

Table 3.—Selected indicators of North Carolina business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total labor force.....	2,225	2,281	+2.5
Unemployment.....	65	85	+30.8
Employment.....	2,160	2,196	+1.7
Construction.....	97	97	-----
All manufacturing.....	713	699	-2.0
Total nonfarm wage and salary.....	1,735	1,746	+6
<b>Personal income:</b>			
Total.....	\$15,030	\$16,244	+8.1
Per capita.....	\$2,987	\$3,188	+6.7
<b>Construction activity:</b>			
Value of private nonresidential construction.....	\$277	\$192	-30.7
State Highway Commission:			
Value of contracts awarded.....	\$116	\$173	+49.1
Cement shipments to and within North Carolina thousand 376-pound barrels.....	8,526	8,099	-5.0
Farm marketing receipts.....	\$1,406	\$1,522	+8.2
Mineral production.....	\$90	\$98	+8.9
Export trade.....	\$193	\$229	+18.7
Import trade.....	\$203	\$245	+20.7

Sources: U.S. Department of Commerce, Survey of Current Business, Highlights of U.S. Export and Import Trade, Construction Review; U.S. Department of Labor, Employment and Earnings; U.S. Department of Agriculture, Farm Income Situation; Roads and Streets; Area Trends in Employment and Unemployment; U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Metal.....	16	290	5	37	2	53.77	2,016	
Nonmetal.....	1,924	261	503	4,060	2	103	25.86	3,737
Sand and gravel.....	761	232	177	1,646	2	33	21.26	7,690
Stone.....	1,927	251	484	4,116	2	64	16.03	3,754
Total <sup>1</sup> .....	4,628	252	1,168	9,859	6	202	21.10	4,398
<b>1970: <sup>p</sup></b>								
Metal.....	165	276	46	369	53	143.53	3,512	
Nonmetal.....	1,685	261	439	3,531	1	105	30.02	5,518
Sand and gravel.....	745	235	174	1,614	31	19.20	363	
Stone.....	1,950	256	499	4,192	58	14.07	1,862	
Total <sup>1</sup> .....	4,545	255	1,159	9,707	2	247	25.65	3,006

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

velopment.<sup>3</sup> Another report described the State's topography and geology.<sup>4</sup>

The Asheville Minerals Research Laboratory of North Carolina State University continued an active program of metallurgical research related to processing problems

encountered by the State's mineral industry. A large portion of the research was conducted in cooperation with industry groups. A paper was prepared that covered the research leading to the initiation of phosphate rock production in North Carolina.<sup>5</sup>

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Asbestos.**—Amphibole asbestos was mined by Powhatan Mining Co. in Jackson and Yancey Counties. Output increased slightly above that of 1969.

**Cement.**—Production of portland cement at the Castle Hayne plant of Ideal Cement Co., New Hanover County, decreased slightly below that of 1969. Three types of portland cement were produced; general use, moderate heat, and high-early strength. Shipments to ultimate consumers from plant and terminals were predominantly by truck (69 percent) and rail (31 percent), and only nominal quantities were shipped directly by waterways. Sales of portland cement were to building materials dealers, concrete products and ready-mix concrete manufacturers (88 percent), highway contractors and Federal, State, and other government agencies (10 percent), and miscellaneous users (2 percent). Apparent consumption of cement in North Carolina was 9,200,000 barrels.

**Clays.**—Miscellaneous clay was mined by 29 companies from 45 mines in 23 counties for use in manufacturing brick, cement, lightweight aggregate, and other heavy clay products. Production decreased about 1 percent in quantity. The total 18 mines in

Chatham, Lee, Rockingham, and Stanly Counties accounted for 60 percent of the State's production in quantity and 52 percent in value. Leading producers were Sanford Brick Corp. and Carolina Solite Corp.

North Carolina continued as the Nation's leading brick producer, a position held since 1962. In 1970 it manufactured 835.9 million bricks valued at \$28.6 million, or approximately 12.9 percent of the total U.S. production.

Following the trend to modern tunnel kilns and automation, Pine Hall Brick and Pipe Co. completed a \$1.8 million brick-making facility near Madison in mid-1970. At the same time this company phased out two of its plants and now produces all of its bricks from two others, including the new facility. One of the plants closed was

<sup>3</sup> Stuckey, Jasper L. Mineral Industry of North Carolina From 1960 Through 1967. Div. of Miner. Res., North Carolina Dept. of Conservation and Development, Econ. Paper 68, 1970, 25 pp.

<sup>4</sup> Allen, Eldon P. An Introduction to the Topography, Geology, and Mineral Resources of North Carolina. Div. of Miner. Res., North Carolina Dept. of Conservation and Development, Educational Ser. 2, 1970 revision, 20 pp.

<sup>5</sup> Redeker, Immo H. North Carolina Phosphate Concentration. The Texas Gulf Sulphur Company Project at the Asheville Minerals Research Laboratory. Ann. Meeting, Soc. of Min. Eng., American Institute of Mining, Metallurgical, and Petroleum Engineers, Preprint 71-H-23, 1971, 29 pp.

Table 5.—Miscellaneous clay sold or used by producers, by counties

County	1969			1970		
	Number of mines	Short tons	Value	Number of mines	Short tons	Value
Chatham.....	3	405,519	\$298,524	5	550,261	\$477,313
Davidson.....	1	60,000	24,000	1	72,000	29,000
Guilford.....	3	92,034	59,823	2	95,921	76,700
Harnett.....	1	14,000	9,100	2	W	W
Lee.....	4	513,868	345,264	5	462,190	423,727
Montgomery.....	1	W	W	1	14,000	17,500
Rowan.....	3	282,031	183,320	3	189,349	147,820
Sampson.....	1	28,313	18,403	1	27,781	22,200
Stokes.....	1	212,706	104,226	1	4,432	2,216
Union.....	1	185,748	371,496	1	163,996	327,992
Undistributed.....	16	1,548,247	1,195,705	23	1,737,851	1,577,046
Total.....	35	3,342,466	2,609,861	45	3,317,781	3,101,514

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

<sup>1</sup> Includes Alamance, Avery (1969), Cabarrus, Catawba (1970), Cumberland, Durham, Halifax, Henderson (1970), Iredell, Johnston, Moore, New Hanover, Rockingham, and Stanly Counties, and data indicated by symbol W.

the last beehive kiln operation in the State, and its closing marked the end of a major era in the brick industry.

Harris Mining Co., Avery County, was the sole producer of kaolin. The quantity produced was less than that of 1969, but the value was approximately the same. The kaolin was used for pottery and whiteware.

**Feldspar.**—North Carolina ranked first in the production of feldspar, accounting for 53 percent of U.S. production in quantity and 54 percent in value. State production increased 2 percent in quantity and 12 percent in value over that of 1969. Seven companies operated 14 mines in Cleveland, Madison, Mitchell, and Yancey Counties. Leading companies were International Minerals & Chemical Corp. and The Feldspar Corp. Production was mainly in the form of flotation concentrate and feldspar silica mix, in that order; there was only minor production of hand-cobbed feldspar.

Ground feldspar shipments decreased 9 percent in quantity and 4 percent in value below those of 1969. The major demand for feldspar was in the glass industry, followed by pottery manufacturing. The main destinations of ground feldspar shipments were Ohio (22 percent), Illinois (11 percent), and Tennessee, Texas, and West Virginia (7 percent each). The remaining 46 percent of the shipments went to numerous States, none of which accounted for more than 4 percent each.

Significant progress was accomplished in production and pollution control facilities during the year. Early in 1970 International Minerals & Chemical Corp. started work on a new plant near Spruce Pine, which was estimated to cost about \$1 million.

**Gem Stones.**—Amateur collectors of gems and minerals were responsible for the production of rubies, sapphires, emeralds, and semiprecious gem stones in several areas in

the State. In 1970, an emerald crystal found near Hiddenite, Alexander County, was reported to be the largest ever recovered in North America.

**Lithium Minerals.**—Two producing mines in North Carolina accounted for the major portion of U.S. lithium ore production in 1970. State production was substantially more than in 1969, both in quantity and value. Foote Mineral Co. operated a mine and mill at Kings Mountain, Cleveland County. The concentrate was shipped outside the State for further processing. Lithium Corp. of America, Inc., operated a mine and lithium chemicals plant near Bessemer City, Gaston County.

**Mica.**—The State accounted for 54 percent of the domestic production of scrap mica by quantity and 58 percent by value. State production decreased 4 percent, both in quantity and value. There was no production of sheet mica. Eight companies reported production of scrap mica from 12 mines in Avery, Cleveland, Mitchell, and Yancey Counties. Leading producers were Deneen Mica Co., Inc., and Harris Mining Co. Ground mica was produced by seven companies with nine plants in Buncombe, Cleveland, Macon, Mitchell, and Yancey Counties. Six plants used dry methods, two used wet methods, and one used both methods. There was no significant change from the 1969 quantity of ground mica produced, but the value decreased 4 percent. The major uses, in descending order, for ground mica were for roofing, well drilling, paint, and rubber.

**Olivine.**—Production of olivine decreased moderately, both in quantity and in value. Harbison-Walker Refractories Co. and Northwest Carolina Olivine Inc., operated one mine each in Jackson and Yancey Counties. The material was used for molding sand and refractory products.

Table 6.—Ground mica sold or used by producers, by uses

Use	1969			1970		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Paint.....	9,490	\$1,439,585	\$151.69	8,966	\$1,372,275	\$153.05
Rubber.....	4,955	761,103	153.60	4,581	690,124	150.65
Wallpaper.....	W	W	W	488	66,188	151.11
Plastics.....	460	W	W	360	58,480	162.44
Other uses <sup>1</sup> .....	40,631	1,784,414	43.92	41,224	1,622,369	39.35
Total.....	55,536	3,985,102	71.76	55,569	3,809,436	68.55

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

<sup>1</sup> Includes roofing, textile coating, and well drilling.

**Perlite.**—Carolina Perlite Co., Inc., expanded perlite at Gold Hill, Rowan County, using crude material imported from other States. Quantity increased slightly and value increased substantially over that of 1969.

**Phosphate Rock.**—Production of phosphate rock at the fertilizer complex of Texas Gulf Sulphur Co., Beaufort County, decreased moderately from that of 1969, both in quantity and in value. The major portion of the output was used for the production of phosphoric acid. A substantial quantity was also exported as phosphate rock.

**Sand and Gravel.**—Sand and gravel continued to be the second leading mineral commodity produced in the State. Tonnage increased 21 percent and value, 16 percent

over that of the previous year. Production was reported by 120 commercial and 74 Government-and-contractor operations located in 86 counties. Twenty-eight operations in Anson, Cumberland, Harnett, Moore and Pitt Counties accounted for 47 percent of the total production. Commercial sand and gravel comprised 71 percent of the total; the remainder was Government-and-contractor production. Five leading producers accounted for 52 percent of the commercial sand and gravel production. Commercial operations provided all of the sand and gravel used for building purposes and 60 percent of that used for paving. Transportation of commercial sand and gravel was 71 percent by truck and 29 percent by railroad.

**Table 7.—North Carolina: Sand and gravel sold or used by producers, by counties**

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Alexander.....	1	39	\$18	1	28	\$13
Ashe.....	1	W	W	3	161	221
Beaufort.....	1	142	105	3	W	W
Bladen.....	1	135	101	2	270	226
Brunswick.....	1	22	16	1	57	42
Cabarrus.....	3	W	W	1	4	2
Caldwell.....	4	198	W	4	W	W
Camden.....	1	5	4	1	6	4
Carteret.....	1	10	3	1	12	3
Caswell.....	1	8	8	1	W	W
Catawba.....	2	W	W	5	205	184
Cherokee.....	1	W	22	1	W	W
Chowan.....	1	21	5	1	19	5
Clay.....	1	100	60	1	W	W
Columbus.....	1	81	60	1	97	72
Cumberland.....	2	W	W	5	610	573
Currituck.....	1	15	11	1	21	15
Dare.....	1	21	16	1	12	8
Davidson.....	1	342	171	2	W	W
Davie.....	1	25	20	3	98	96
Duplin.....	2	25	19	5	68	48
Edgecombe.....	3	190	173	9	269	237
Forsyth.....	2	W	W	1	56	39
Franklin.....	1	12	12	2	W	W
Gaston.....	2	W	33	9	75	52
Gates.....	1	10	7	1	28	20
Granville.....	1	5	7	1	2	3
Greene.....	2	53	W	2	W	W
Guilford.....	1	W	W	1	7	4
Halifax.....	1	77	25	1	62	24
Hoke.....	1	40	30	1	70	52
Hyde.....	1	7	2	1	19	5
Iredell.....	1	48	22	4	73	34
Johnston.....	1	109	102	2	W	W
Jones.....	1	20	5	1	21	6
Lenoir.....	2	W	W	4	218	172
Lincoln.....	1	34	20	4	31	22
McDowell.....	4	W	113	3	W	W
Martin.....	1	6	1	3	W	W
Mecklenburg.....	1	W	W	1	1	1
Montgomery.....	1	13	6	1	13	6
Moore.....	5	440	313	8	608	448
Nash.....	1	17	14	1	66	58
New Hanover.....	1	8	6	1	24	10

See footnotes at end of table.



**Table 7.—North Carolina: Sand and gravel sold or used by producers, by counties—Continued**

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Northampton	1	26	\$6	3	W	W
Onslow	1	17	13	3	W	W
Pamlico	1	1	-----	1	9	\$7
Pasquotank	1	32	24	1	W	W
Pender	1	64	47	1	10	4
Perquimans	1	4	3	1	6	4
Person	1	1	1	-----	-----	-----
Pitt	3	W	92	8	754	361
Polk	1	18	7	1	9	4
Richmond	1	14	11	1	13	8
Robeson	1	165	123	1	205	153
Rowan	1	35	18	4	W	W
Rutherford	1	133	50	2	W	W
Sampson	1	30	22	6	78	64
Scotland	1	53	43	2	40	33
Stokes	1	110	77	1	98	69
Surry	1	( <sup>1</sup> )	( <sup>1</sup> )	1	2	3
Transylvania	-----	-----	-----	1	4	5
Union	1	16	12	1	25	23
Vance	-----	-----	-----	1	1	1
Wake	1	2	2	1	3	2
Washington	1	23	6	1	32	8
Wayne	3	144	139	5	223	178
Wilkes	1	3	3	1	8	6
Wilson	2	W	W	2	26	23
Yadkin	1	4	7	1	4	7
Undistributed <sup>2</sup>	33	7,387	9,198	38	7,915	9,619
<b>Total <sup>3</sup></b>	<b>124</b>	<b>10,562</b>	<b>11,437</b>	<b>194</b>	<b>12,772</b>	<b>13,277</b>

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

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

<sup>2</sup> Includes Alamance (1970), Anson, Avery, Bertie, Buncombe, Burke, Cleveland, Craven, Graham, Harnett, Haywood, Hertford, Jackson, Lee, Mitchell (1969), Rockingham, Watauga, and Yancey Counties.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

**Table 8.—North Carolina: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building	3,521	\$3,343	3,267	\$3,494
Fill	189	187	431	278
Paving	837	882	1,946	1,721
<b>Gravel:</b>				
Building	1,223	2,221	1,084	1,792
Paving	1,133	1,379	1,620	1,917
Other sand and gravel <sup>1</sup>	650	1,576	740	1,932
<b>Total</b>	<b>7,553</b>	<b>9,588</b>	<b>9,088</b>	<b>11,134</b>
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Fill	341	256	432	324
Paving	1,759	1,172	1,969	1,335
Other <sup>1</sup>	501	161	830	251
<b>Total <sup>2</sup></b>	<b>2,600</b>	<b>1,589</b>	<b>3,231</b>	<b>1,910</b>
<b>Gravel:</b>				
Paving	409	260	452	233
Other <sup>1</sup>	-----	-----	1	1
<b>Total <sup>2</sup></b>	<b>409</b>	<b>260</b>	<b>453</b>	<b>233</b>
<b>Total sand and gravel</b>	<b>10,562</b>	<b>11,437</b>	<b>12,772</b>	<b>13,277</b>

<sup>1</sup> Includes filtration, railroad ballast and other sands, and railroad ballast and miscellaneous gravel.

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

**Stone.**—Stone was again the principal mineral commodity produced in the State; both quantity and value were 13 percent greater than in 1969. Production was reported from 56 counties by 41 companies with 110 operations and by the State Highway Commission's four quarries. Five companies with 57 operations, accounted for 82 percent of the production in quantity and 81 percent in value. A total of 20 operations in Cleveland, Guilford, Mecklenburg, New Hanover, and Wake Counties, produced 33 percent of the stone by quantity and 31 percent by value.

Production of crushed granite at 82 quarries accounted for 80 percent of the State's stone output by quantity, and 73 percent by value. Both quantity and value were 29 percent greater than in 1969. Major quantities of other types of crushed and broken stone were produced at seven limestone, three shell, and three traprock operations; relatively minor outputs were reported by one marble, eight sandstone, three quartz, and six quartzite operations. Combined, they accounted for 20 percent of the State's stone production in both quantity and value. The production of these categories of stone was 23 percent less in quantity and 22 percent less in value than in 1969.

Production of dimension stone was reported by 16 granite, two slate, and three individual marble, sandstone, and quartzite quarries. The tonnage produced was small, amounting to less than two-tenths of 1 percent of the State's stone production, but the value accounted for 7 per-

cent of the State total for stone. The quantity produced was approximately the same as in 1969, but the value increased 12 percent.

The major uses for crushed stone were as roadbase material, concrete, and bituminous aggregate. Transportation was predominantly by truck (93 percent), railroad (6 percent), and waterway (1 percent). Dimension stone was used for monumental, structural stone, curbing, paving blocks, and flagging.

**Talc and Pyrophyllite.**—Production of talc and pyrophyllite decreased 12 percent in quantity and 7 percent in value from that of 1969. Talc was produced by Hitchcock Corp. in Cherokee County. The main uses were for toilet preparations and in the textile industry. Pyrophyllite was produced by four companies operating seven mines in Alamance, Granville, Moore, and Orange Counties. The major part of the production was used, in descending order, by the refractory, ceramic, and insecticide industries. Leading producers were Piedmont Minerals Co., Inc., and Standard Minerals Co., Inc.

**Vermiculite.**—W. R. Grace & Co. operated an exfoliating plant in Guilford County, and Carolina Wholesale Florist, Inc., operated a plant in Lee County. Both companies used crude vermiculite shipped into the State. The combined output decreased slightly in quantity and increased slightly in value from that of 1969. Principal uses for the finished product were as insulation (61 percent), aggregate (31 percent), and other uses (8 percent).

**Table 9.—Crushed granite sold or used by producers, by counties**  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Cabarrus.....	1	71,015	\$112,900	1	79,310	\$126,896
Clay.....	1	78,914	118,371	1	80,133	W
Guilford.....	4	2,380,569	3,919,614	5	2,840,336	4,689,313
Iredell.....	-----	-----	-----	3	1,293,716	2,060,947
Jackson.....	1	113,400	151,125	2	W	W
Macon.....	1	171,000	223,475	1	171,000	223,475
Mitchell.....	-----	-----	-----	1	3,252	4,065
Richmond.....	1	66,371	96,238	2	W	W
Transylvania.....	1	77,000	123,000	1	155,000	250,000
Undistributed <sup>1</sup> .....	54	15,898,527	26,098,504	65	19,628,285	32,386,357
Total.....	64	18,856,796	30,843,327	82	24,251,032	39,741,053

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

<sup>1</sup> Includes Alamance, Alleghany (1970), Ashe, Buncombe, Burke, Caldwell, Caswell, Catawba, Chatham, Cleveland, Davidson (1970), Davie, Forsyth, Granville, Halifax, Haywood, Henderson, Johnston (1970), Lincoln, Madison (1970), Mecklenburg, Moore, Nash, Orange, Pitt, Polk (1970), Randolph, Rockingham, Rowan, Rutherford, Surry, Union, Vance, Wake, Wilkes, and Wilson Counties, and data for which no county breakdown is available.

**METALS**

**Aluminum.**—Primary aluminum was produced by the Aluminum Co. of America (Alcoa) at a plant near Badin, in Stanly County, using imported alumina. The production decreased slightly in quantity, but increased slightly in value.

**Iron Ore.**—Cranberry Magnetite Corp. operated a mine and concentrator in Avery County. The production was in the form of a high-quality magnetite product for special uses, principally for coal preparation.

**Tungsten.**—Ranchers Exploration and Development Corp. produced tungsten concentrate at a major-size operation in Vance County. Their Tungsten Queen mine, formerly known as the Hamme mine, was reopened in 1969 after being idle since 1963.

Production of tungsten concentrate began in August 1970.

**MINERAL FUELS**

There was no production of mineral fuels in North Carolina during 1970.

**Petroleum and Natural Gas.**—Exploration drilling rights on nearly 400,000 acres of submerged offshore land owned by the State were acquired by Colonial Oil and Gas Corp. from the original owners, North Carolina Gas and Oil Co., which obtained the original concession in 1966. Pursuant to the terms of the State lease, Colonial Oil and Gas Corp. drilled one dry hole in Onslow County and eight dry holes in Brunswick County in 1970. The depths of the holes ranged from 1,222 to 2,009 feet, for a total footage drilled of 11,972 feet.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum: Aluminum Company of America.....	1501 Alcoa Bldg. Pittsburgh, Pa. 15219	Smelter.....	Stanly.
Asbestos: Powhatan Mining Co.....	6721 Windsor Mill Road Baltimore, Md. 21207	Open-pit mine.....	Jackson, Yancey.
Cement: Ideal Cement Co., Div. of Ideal Basic Industries, Inc.....	420 Ideal Cement Bldg. Denver, Colo. 80202	Plant.....	New Hanover.
Clay:			
Kaolin: Harris Mining Co.....	Box 628 Spruce Pine, N.C. 28777	Open-pit mine and plant.....	Avery.
Miscellaneous:			
Boren Clay Products Co.....	Pleasant Garden, N.C. 27813.....	4 open-pit mines and plants.....	Chatham, Guilford, Sampson.
Carolina Solite Corp.....	Box 9138 Richmond, Va. 23227	Open-pit mine and plant.....	Stanly.
Pine Hall Brick and Pipe Co.....	Box 4325, North Station Winston-Salem, N.C. 27105	4 open-pit mines and plants.....	Rockingham, Stokes.
Pomona Corp., Pomona Pipe Products Co.....	Box 7236 Greensboro, N.C. 27407	Open-pit mine and plant.....	Chatham.
Sanford Brick Corp.....	Box 38 Gulf, N.C. 27256	3 open-pit mines and plant.....	Chatham, Lee, Stanly.
Solite Corp.....	Box 9138 Richmond, Va. 23227	Open-pit mine and plant.....	Rockingham.
Feldspar:			
The Feldspar Corp.1.....	Spruce Pine, N.C. 28777.....	3 open-pit mines and 2 plants.....	Mitchell.
Foote Mineral Co.....	Box 792 Kings Mountain, N.C. 28086	Open-pit mine and plant.....	Cleveland.
International Minerals & Chemical Corp.1.....	Old Orchard Road Skokie, Ill. 60079	Open-pit mine and 2 plants.....	Mitchell.
Kings Mountain Silica Co., Inc.....	Box 709 Kings Mountain, N.C. 28086	2 open-pit mines and 2 plants.....	Cleveland.
Lawson-United Feldspar and Mineral Co.1.....	Minpro, N.C. 28777.....	Open-pit mine and plant.....	Mitchell.
Iron ore: Cranberry Magnetite Corp.....	Box 63 Greenback, Tenn. 37742	Underground mine and plant.....	Avery.
Lithium minerals:			
Foote Mineral Co.....	Box 792 Kings Mountain, N.C. 28086	Open-pit mine and plant.....	Cleveland.
Lithium Corp. of America, Inc.....	Box 428 Bessemer City, N.C. 28016	.....do.....	Gaston.
Mica, scrap:			
Deneen Mica Co., Inc.....	Newdale, N.C. 28714.....	Open-pit mine and plant.....	Yancey.
The Feldspar Corp.....	Box 220 Spruce Pine, N.C. 28777	2 open-pit mines and 2 plants.....	Mitchell.
Harris Mining Co.....	Box 628 Spruce Pine, N.C. 28777	3 open-pit mines and 2 plants.....	Avery, Mitchell.
Kings Mountain Mica Co., Inc.....	Box 709 Kings Mountain, N.C. 28086	2 open-pit mines and 2 plants.....	Cleveland.
United States Gypsum Co.....	101 South Wacker Drive Chicago, Ill. 60606	Open-pit mine.....	Do.

See footnotes at end of table.

Table 10.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Mica, grinders:</b>			
Deneen Mica Co.	Newdale, N.C. 28714	Open-pit mine and plant.	Yancey.
Diamond Mica Co.	Box 646	2 plants.	Mitchell, Yancey.
Franklin Mineral Products Co.	Spruce Pine, N.C. 28777	Plant.	Macon.
Harris Mining Co.	Box 0	2 open-pit mines and 2 plants.	Mitchell.
Kings Mountain Mica Co., Inc.	Wilmington, Mass. 01887	Plant.	Cleveland.
	Box 628		
	Spruce Pine, N.C. 28777		
	Box 709		
	Kings Mountain, N.C. 28086		
<b>Olivine:</b>			
Harbison-Walker Refractories Co.	Gateway #2	Open-pit mine.	Jackson.
Northwest Carolina Olivine, Inc.	Pittsburgh, Pa. 15222	Open-pit mine and plant.	Yancey.
Perlite, expanded: Carolina Perlite Co., Inc.	Box 672	Plant.	Rowan.
	Box 741	Open-pit mine and plant.	Beaufort.
Phosphate rock: Texas Gulf Sulphur Co.	Hillside, N.J. 07205		
	200 Park Avenue		
	New York, N.Y. 10017		
<b>Sand and gravel:</b>			
Becker Sand & Gravel Co.	Box 848	3 open-pit mines.	Cumberland, Harnett, Moore.
W. R. Bonsal Co., Inc.	Cheraw, S.C. 29520	Open-pit mine.	Anson.
Grove Stone and Sand, Branch of B. V. Hedrick Gravel and Sand Co.	Box 38	do.	Buncombe.
Lessees of B. V. Hedrick Gravel and Sand Co.	Lilesville, N.C. 28091	do.	Anson.
Nello L. Teer Co.	Swannanoa, N.C. 28778	do.	Harnett.
	Lilesville, N.C. 28091		
	Box 1131		
	Durham, N.C. 27702		
<b>Stone:</b>			
Granite, crushed:			
Central Rock Co., Inc.	Box 510	Quarry.	Guilford.
Foote Mineral Co.	Greensboro, N.C. 27409	Open-pit mine.	Cleveland.
Superior Stone Co.	Box 792	24 quarries.	Alamance, Catawba, Chatham, Cleveland, Davidson, Guilford, Halifax, Iredell, Lincoln, Mecklenburg, Moore, Pitt, Randolph, Rockingham, Rowan, Union, Wake.
	Kings Mountain, N.C. 28086		
	Box 2568		
	Raleigh, N.C. 27602		
Nello L. Teer Co.	Box 1181	5 quarries.	Granville, Nash, Wake, Wilson.
Vulcan Materials Co.	Durham, N.C. 27702	15 quarries.	Buncombe, Caldwell, Caswell, Davie, Forsyth, Granville, Guilford, Haywood, Henderson, Iredell, Rockingham, Surry, Vance, Wilkes.
	Box 7506, Reynolds Station		
	Winston-Salem, N.C. 27106		
Granite, dimension:			
C-molli Granite Co.	Elberton, Ga. 30635	2 quarries.	Rowan.

Crystal Pink Granite Co.	Box 245 Faith, N.C. 28041	Do.
Harris Granite Quarries Co.	P.O. Box 1088 Salisbury, N.C. 28144	Do.
North Carolina Granite Corp.	Box 151 Mt. Airy, N.C. 27080	Surry.
Trotino and Brown, Inc.	Box 5595 Asheville, N.C. 28808	Avery.
Limestone, crushed:		
Fletcher Limestone Co., Inc.	Box 98 Fletcher, N.C. 28732	Henderson.
Ideal Cement Co.	420 Ideal Cement Bldg. Denver, Colo. 80202	New Hanover.
Superior Stone Co.	Box 2568 Raleigh, N.C. 27602	Cleveland.
Marble, crushed and dimension:		
Moretti-Harrah Marble Co.	Box 380 Sylacauga, Ala. 35150	Cherokee.
Quartz, crushed:		
Southern Aggregates, Inc.	Box 1198 Roanoke, Va. 24006	Montgomery.
Slate, dimension: Jacob's Creek Stone Co., Inc.	P.O. Box 608 Denton, N.C. 27239	Davidson, Montgomery.
Sandstone, crushed:		
The Feldspar Corp.	Spruce Pine, N.C. 28777	Mitchell.
Sandstone, dimension: Jacob's Creek Stone Co., Inc.	P.O. Box 608 Denton, N.C. 27239	Montgomery.
Shell, crushed and broken:		
Superior Stone Co.	Box 2568 Raleigh, N.C. 27602	Craven, New Hanover, Onslow.
Traprock, crushed:		
Ararat Rock Products Co.	223 Willow Street Mt. Airy, N.C. 27080	Surry.
Nello L. Teer Co.	Box 1181 Durham, N.C. 27702	Durham.
Young Stone Co.	Box 11424 Charlotte, N.C. 28209	Cabarrus.
Talc and pyrophyllite:		
Pyrophyllite:		
Boren & Harvey, Inc.	Box 7247 Greensboro, N.C. 27407	Granville.
General Minerals Co.	Box 6868 Greensboro, N.C. 27405	Alamance, Moore.
Piedmont Minerals Co., Inc.	P.O. Box 7247 Greensboro, N.C. 27407	Orange.
Standard Minerals Co., Inc.	Box 55 Robbins, N.C. 27825	Moore.
Talc: Hitchcock Corp.	Murphy, N.C. 28906	Cherokee.
Vermiculite, expanded:		
Carolina Wholesale Florists, Inc.	Box 537 Sanford, N.C. 27330	Lee.
W. R. Grace & Co.	62 Whittemore Avenue Cambridge, Mass. 02140	Guilford.

1 Also feldspar grinding.



# The Mineral Industry of North Dakota

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

By Franklin D. Cooper <sup>1</sup>

The total value of mineral production in North Dakota was \$96.0 million, a 5.5 percent increase over that of 1969. The value of all fossil-fuel production was \$88.2 million, \$6.2 million more than in 1969. Value increases in 1970 were in million dollars: crude petroleum, 3.54; lignite, 2.31; natural gas, 0.28; and natural gas liquids, 0.11.

The total value of nonmetallic production was \$7.89 million, or \$1.24 million less than in 1969. Compared with 1969, sand and gravel decreased in value \$938,000; clays, lime, peat, and salt decreased \$329,000. Only stone production showed a gain of \$27,000. No uranium was recovered from lignite ash in 1970.

#### Legislation and Government Programs.

—The Strip Mining Reclamation Act (N.D.C.C. 38-14), effective January 1, 1970, allowed mine operators to have 5

years after the expiration of their surface mining permits to reclaim affected lands. All surface mining requiring overburden removal in excess of 10 feet in depth was subject to this law. This act was administered by the State Coal Mine Inspector.

The State Industrial Commission amended Rule 314, pertaining to the control and disposal of salt water by oil producing companies, by requiring that all surface pits or containers be inspected and approved. Also, the disposal of salt water into unlined surface pits must be discontinued by October 1, 1970. By the spring of 1972, all unapproved salt water handling facilities will have to be removed.

A comprehensive air pollution law, containing air-quality and emission standards which received Federal approval became effective July 1, 1970.

<sup>1</sup> Physical scientist, Division of Fossil Fuels.

Table 1.—Mineral production in North Dakota <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Coal..... thousand short tons..	4,704	\$8,696	5,639	\$11,009
Gem stones.....	NA	1	NA	1
Natural gas (marketed)..... million cubic feet..	33,587	5,441	34,889	5,722
Natural gas liquids:				
LP gases..... thousand 42-gallon barrels..	1,951	2,868	1,840	2,944
Natural gasoline and cycle products..... do.....	508	1,346	504	1,376
Petroleum (crude)..... do.....	22,703	63,568	21,998	67,107
Sand and gravel..... thousand short tons..	7,039	7,274	8,090	6,336
Stone..... do.....	72	99	103	126
Value of items that cannot be disclosed:				
Clays, lime, peat (1970), and salt.....	XX	1,755	XX	1,426
Total.....	XX	91,048	XX	96,047
Total 1967 constant dollars.....	XX	85,977	XX	p 86,923

p Preliminary. 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.—Value of mineral production in North Dakota, by counties  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Adams	-----	\$48	\$18 Coal (lignite).
Barnes	-----	387	227 Sand and gravel.
Benson	-----	291	59 Do.
Billings	-----	5,779	W Petroleum, stone, sand and gravel.
Bottineau	-----	7,678	8,730 Petroleum, sand and gravel.
Bowman	-----	2,129	2,729 Petroleum, coal (lignite), sand and gravel.
Burke	-----	8,122	W Do.
Burleigh	-----	540	439 Sand and gravel.
Cass	-----	94	146 Do.
Cavalier	-----	31	87 Do.
Dickey	-----	128	W Sand and gravel, stone.
Divide	-----	838	W Petroleum, sand and gravel, clays.
Dunn	-----	50	37 Petroleum.
Eddy	-----	383	W Sand and gravel.
Emmons	-----	227	W Do.
Foster	-----	W	W Do.
Golden Valley	-----	268	W Petroleum, sand and gravel, stone.
Grand Forks	-----	451	568 Sand and gravel.
Grant	-----	74	W Sand and gravel, coal (lignite).
Griggs	-----	83	93 Sand and gravel.
Hettinger	-----	5	W Do.
Kidder	-----	30	W Do.
LaMoure	-----	1	W Do.
Logan	-----	24	33 Do.
McHenry	-----	246	224 Sand and gravel, petroleum.
McIntosh	-----	129	27 Sand and gravel.
McKenzie	-----	15,197	12,402 Petroleum, sand and gravel, stone.
McLean	-----	209	273 Sand and gravel, coal (lignite).
Mercer	-----	5,355	6,286 Coal (lignite), sand and gravel.
Morton	-----	160	132 Sand and gravel, stone, clays, coal (lignite).
Mountrail	-----	2,556	2,113 Petroleum, sand and gravel.
Nelson	-----	326	W Sand and gravel.
Oliver	-----	986	1,458 Coal (lignite), sand and gravel.
Pembina	-----	805	W Lime, sand and gravel.
Pierce	-----	92	W Sand and gravel.
Ramsey	-----	39	61 Do.
Ransom	-----	183	195 Do.
Renville	-----	5,114	5,189 Petroleum, sand and gravel.
Richland	-----	200	W Sand and gravel.
Rolette	-----	139	W Do.
Sargent	-----	1	W Sand and gravel, stone.
Sheridan	-----	29	W Sand and gravel.
Sioux	-----	13	W Do.
Slope	-----	224	W Petroleum, sand and gravel.
Stark	-----	4,641	6,656 Petroleum, coal (lignite), sand and gravel, pumice, clays.
Steele	-----	98	W Sand and gravel.
Stutsman	-----	369	W Sand and gravel, stone.
Towner	-----	W	168 Sand and gravel.
Trail	-----	110	242 Do.
Walsh	-----	318	307 Do.
Ward	-----	2,179	2,751 Coal (lignite), petroleum, sand and gravel, stone.
Wells	-----	72	W Sand and gravel.
Williams	-----	23,376	18,264 Petroleum, salt, sand and gravel, coal (lignite).
Undistributed <sup>1</sup>	-----	221	26,134
Total	-----	91,048	96,047

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."  
<sup>1</sup> Includes gem stones, some sand and gravel (1970), natural gas (1970), and natural gas liquids (1970) that cannot be assigned to specific counties and values indicated by symbol W.

Table 3.—Indicators of North Dakota business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total labor force.....	250.0	252.4	+1.0
Employment.....	240.4	241.9	+1.6
Unemployment.....	9.6	10.5	+9.4
Nonagricultural employment.....	157.4	162.7	+3.4
Mining.....	1.9	1.6	-15.8
Construction.....	8.0	9.9	+23.8
Manufacturing.....	9.0	9.8	+8.9
Government.....	48.3	49.4	+2.3
Transportation and public utilities.....	12.2	12.2	—
Wholesale and retail trade.....	42.9	43.9	+2.3
Finance, insurance, and real estate.....	6.8	7.0	+2.9
Services.....	28.2	28.9	+2.5
<b>Personal income:</b>			
Total.....	\$1,852.0	\$1,812.0	-2.2
Per capita.....	\$2,982.0	\$2,937.0	-1.5
<b>Construction activity:</b>			
Highway construction contracts awarded.....	\$41.0	\$32.0	-22.0
Cement shipments to and within the State.....	1,253.0	1,536.0	+22.6
Value of authorized nonresidential construction.....	\$16.4	\$18.5	+12.8
Number of authorized residential units.....	2,572	2,478	-3.7
Farm marketing receipts.....	\$744.3	\$693.1	-6.9
Mineral production.....	\$91.0	\$96.0	+5.5

Sources: Construction Review; Farm Income Situation; Streets and Roads; Area Trends in Employment and Unemployment; Survey of Current Business; Employment and Earnings; U.S. Bureau of Mines.

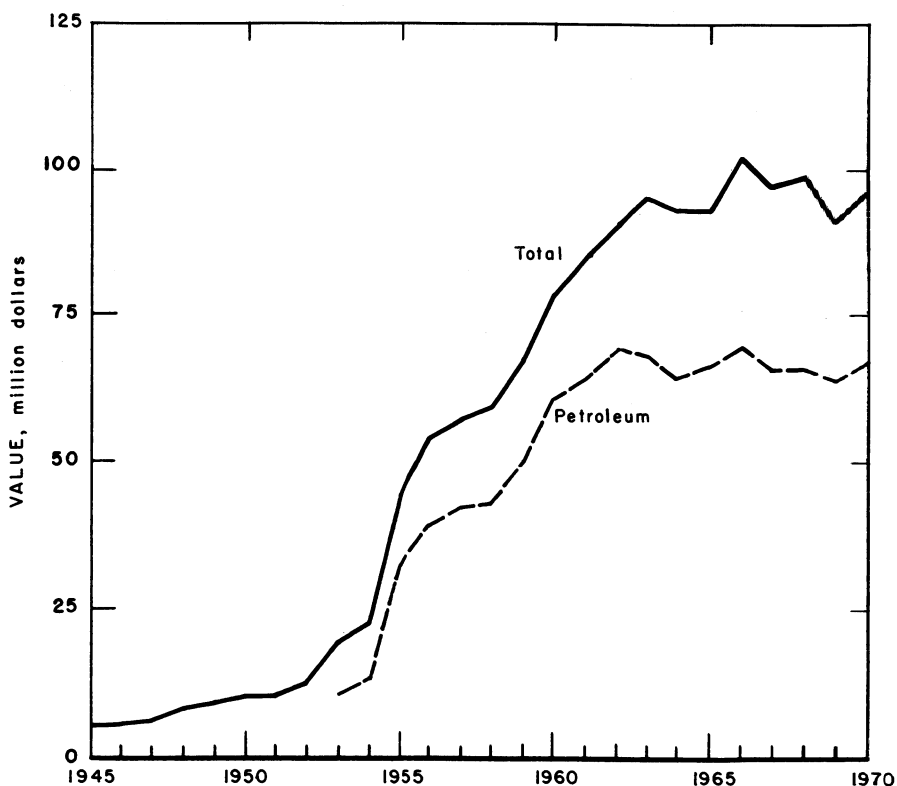


Figure 1.—Value of petroleum and total value of mineral production in North Dakota.

Statewide sulfur oxide control regulations applicable to combustion fuel sources that went into effect July 1, 1970, limited coal to 2.0 percent sulfur content and oil to 2.7 percent sulfur content.

Federal and State Government publications issued during 1970 that could be of interest to the mineral industry include: three Reports of Investigation, one Information Circular and one outside publication by the U.S. Bureau of Mines;<sup>2</sup> one report by the U.S. Geological Survey;<sup>3</sup> four papers prepared cooperatively by the U.S. Geological Survey and the North Dakota Geological Survey;<sup>4</sup> and six publications by the North Dakota Geological Survey.<sup>5</sup>

The total dollar value of highway contracts in 1970 was \$32 million. The State Highway Department's contracting budgets for 1971, in million dollars, included Interstate, 19.5; primary, secondary, and urban highway extensions, 10.2; maintenance by contract, 0.45; and maintenance by State forces. 0.30.<sup>6</sup>

Interstate highways completed during the year totaled 17.07 miles and cost \$22.7 million. Since July 1, 1956 a total of 432.87 miles of Interstate highway have been opened to traffic in North Dakota. At year-end, 75.34 miles were under construction and 14.60 miles were being designed. In December 1970 Interstate highway projects underway or authorized totaled 89.94 miles, 2.47 miles less than at the end of 1969. The Federal-Aid Interstate funds for these projects at yearend totaled \$37.0 million, or \$3.0 million less than 1 year earlier. Primary, secondary, and urban highway extensions completed during the year totaled 824.7 miles and cost \$18.6 million. By year-end, projects underway or authorized for these highways totaled 795.7 miles and cost \$31.0 million compared with 989.8 miles and a \$26.0 million total cost on December 31, 1969.<sup>7</sup>

**Employment and Injuries.**—Statistics of employment and injuries in the mineral industries, exclusive of the petroleum industry, are presented in table 4. Information for 1969 in final data; that for 1970 is preliminary.

<sup>2</sup> Boteler, Daniel C., Wayne R. Kube, and Charles C. Boley. Bench-Scale Carbonization of Lignite From the Northern Great Plains Province: A Statistical Approach. BuMines Rept. of Inv. 7386, 1970, 32 pp.

Gomez, Manuel, Kathleen Hazen, and Everett A. Sondreal. Prediction of Sodium Concentration in Lignite. BuMines Rept. of Inv. 7420, 1970, 18 pp.

Gronhovd, G. H., A. E. Harak, M. M. Fegley, and D. E. Severson. Slagging Fixed-Bed Gasification of North Dakota Lignite at Pressures to 400 Psig. BuMines Rept. of Inv. 7408, 1970, 40 pp.

Elder, James L., and Wayne R. Kube. Technology and Use of Lignite. Proceedings: Bureau of Mines—University of North Dakota Symposium, Grand Forks, N. Dak., May 1–2, 1969. BuMines Inf. Circ. 8471, 1970, 174 pp.

Ellman, R. C., and J. W. Belter. Bigger Markets Mean More Preparation for Lignite and Subbituminous Coal. Min. Eng., v. 22, No. 3, March 1970, pp. 47–50.

<sup>3</sup> Downey, J. S. Ground Water Resources of Nelson County, Northeastern North Dakota. U.S. Geol. Survey Hydrol. Inv. Atlas 428, 1970, 1 p.

<sup>4</sup> Buturla, Frank, Jr. Geology and Ground Water Resources of Wells County, N. D. Part 3, Ground Water Resources. North Dakota Geol. Survey Bull. 51 and North Dakota State Water Comm. County Ground Water Studies 12, 1970, 57 pp.

Croft, M. G. Ground Water Basic Data, Mercer and Oliver Counties, N. D. North Dakota Geol. Survey Bull. 56, pt. 2, and North Dakota State Water Comm. County Ground Water Studies 15, pt. 2, 1970, 268 pp.

Kelly, T. E. and Q. F. Paulson. Geology and Ground Water Resources of Grand Forks County, N.D. Pt. 3, Ground Water Resources: North Dakota Geol. Survey Bull. 53 and North Dakota State Water Comm. County Ground Water Studies 13, 1970, 58 pp.

Naplin, C. E. Ground Water Survey of the Buxton Area, Traill County, N.D. North Dakota State Water Comm. Ground Water Studies 71, 1970, 93 pp.

<sup>5</sup> Folsom, Clarence B. North Dakota Crude Oil Inventory as of January 1, 1970. North Dakota Geol. Survey, Misc. Ser. 41, 1970, 16 pp.

Freers, Theodore F. Geology and Ground Water Resources of Williams County; Pt. 1 Geology. North Dakota Geol. Survey Bull. 48, 1970, 55 pp.

Hanson, D. E., and Jack Kume. Geology and Ground Water Resources of Grand Forks County; Part 1, Geology: North Dakota Geol. Survey Bull. 53 and North Dakota State Water Comm. County Ground Water Studies 13, 1970, 76 pp.

Jensen, H. M., and R. R. Klausung. Geology and Ground Water Resources of Traill County, N.D. North Dakota Geol. Survey Bull. 49, pt. 3, 1970, 40 pp.

North Dakota Geological Survey. Oil Production Statistics—Second Half 1969. 1970, 253 pp.

North Dakota Geological Survey. Oil Production Statistics—First Half 1970. 1970, 260 pp.

<sup>6</sup> State Highway Departments' Contracting Budgets for 1971. Engineering News Record. V. 186, No. 12, Mar. 25, 1971, p. 12.

<sup>7</sup> Federal Highway Administration. Quarterly Reports on the Federal-Aid Highway Program. Dec. 31, 1969, and Dec. 31, 1970. Press Release FHWA-422, Feb. 9, 1970; Press Release FHWA-563, Feb. 17, 1971.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non-fatal	Frequency	Severity
<b>1969:</b>								
Coal.....	258	238	61	488	-----	9	18.43	340
Nonmetal.....	61	189	12	92	1	20	227.18	69,627
Sand and gravel.....	664	170	113	1,032	1	18	18.41	6,139
Stone.....	4	221	1	7	-----	-----	-----	-----
Total <sup>1</sup> .....	987	189	187	1,620	2	47	30.25	7,986
<b>1970: <sup>p</sup></b>								
Coal.....	285	242	69	548	1	13	25.55	11,378
Nonmetal.....	50	189	9	75	-----	1	13.25	225
Sand and gravel.....	670	175	117	1,071	-----	12	11.21	448
Stone.....	5	221	1	7	-----	-----	-----	-----
Total <sup>1</sup> .....	1,010	195	196	1,701	1	26	15.87	3,956

<sup>p</sup> Preliminary.<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### MINERAL FUELS

**Coal (Lignite).**—Production of the States' only underground lignite mine was less than 100 tons in 1970. At the twenty operating strip mines, each producing more than 1,000 salable short tons annually, an estimated 30.0 million cubic yards of overburden was removed. The production of 5.64 million tons of lignite was valued at an average \$1.95 per ton. The overburden ranged from 20 to 70 feet in thickness above 7- to 16-foot-thick coal seams. In 1969, 20 strip mines produced 4.70 million salable tons valued at \$1.85 per ton and stripped 21.2 million cubic yards of overburden. In 1970, two mines, each producing over 1 million tons per year, produced 2.57 million tons. Seven mines, producing more than 100,000 tons but less than 1 million tons annually, collectively produced 2.98 million tons. The 11 other mines in nine counties collectively produced less than 98,000 tons. All production was sold on the open market except the output from a mine in Stark County, which was used to manufacture briquettes, in the only lignite briquetting plant in the United States. Of the total shipments, 3,264,724 tons were by rail or water, including 915,939 tons by unit trains; 568,948 tons by truck; 460,135 tons were used at mine-mouth power plants, and 1,345,933 tons by unreported methods.

Strip mining equipment included 33 power shovels and 15 draglines, of which

42 units were electric-or diesel-powered. Thirty-three units had buckets of under five cubic yard capacity. Four draglines and two shovels each had buckets greater than 16-cubic yard capacity. Carryall scrapers totaled 15, of which five were rated at plus 16 cubic yards. Other equipment included one horizontal power drill, one vertical power drill, 26 bulldozers, 11 front-end loaders, two power brooms, 12 motorgraders, seven coal drills and an unknown number of haulage trucks.

Fourteen plants crushed 5,571,365 tons.

The average productivity for all mining and preparation activities was 83.22 net tons per man day. Mercer County produced about 60 percent of the State's total production.

Demand for lignite was increased when Minnkota Power Cooperative's Milton R. Young plant attained full operation November 20. The mine-mouth plant, located 30 miles northwest of Bismarck in Oliver County, has a 234,500-kilowatt generating capacity, and will annually consume 1.3 million tons of 6,800-Btu, 38 percent moisture, 0.2 percent sulfur lignite. The \$38.7 million plant is claimed to be the world's largest lignite-fueled installation and the first to use a new design of slag-tap cyclone furnace. Reportedly, the lignite used during the early months of operation contained 5 percent ash, having less than 3 percent by weight sodium oxide plus potassium oxide equivalent. Wholesale electric power at 230,000 volts from the plant

was supplied to 12 associated cooperatives in a 35,000-square-mile area in eastern North Dakota and northwestern Minnesota.

Baukol-Noonan, Inc., purchased \$3 million of heavy equipment, including a \$1.3 million, 21-cubic yard walking dragline, and three 120-ton trucks, for use at the mine supplying lignite to the Milton R. Young plant.

Under a cooperative contract with the U.S. Bureau of Mines, a pulse-jet engine releasing 25 million Btu per hour was installed by Baukol-Noonan, Inc., at Noonan, N.D. to provide heat and motive power for the entrained drying of lignite. Because dust produced by the dryer was insufficient to provide fuel for an extended operation of the engine, injection of oil with the lignite-dust fuel was necessary. Slag accumulations were less severe than anticipated and no erosion of the refractory lining occurred during initial tests. The 15-Hertz noise produced by the engine had considerable carrying and penetrating power.

**Table 5.—North Dakota: Lignite coal production, by type of mine and counties**  
(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines	Production	Value
	Strip	(thousand short tons)	(thousands)
Adams.....	1	5	18
Grant.....	2	8	28
McLean.....	1	19	77
Mercer.....	3	3,378	6,262
Morton.....	1	6	19
Williams.....	1	6	15
Other <sup>1</sup> .....	11	2,218	4,589
Total <sup>2</sup> .....	20	5,639	11,009

<sup>1</sup> Bowman, Burke, Oliver, Stark, and Ward Counties combined to avoid disclosing individual county confidential data.

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

The use of North Dakota lignite as a fuel was compared with typical bituminous coals by Duzy and Markley of the Babcock & Wilcox Co.<sup>8</sup>

One fatality occurred in the lignite mining industry in 1970. None occurred in 1969. The fatality rate was 1.8 per million man-hours worked, or 0.18 per million net tons produced.

Leonardite, an oxidized form of lignite was used as a drilling-mud additive, soil conditioner, and for water treatment. It was produced as a byproduct of lignite mining by the Knife River Coal Mining Co. in

Bowman County, and by Baukol-Noonan, Inc., in Burke County. Leonardite was also mined as a primary product in Adams and Williams Counties.

A project sponsored by the Burlington Northern Railway for the past 6 years at the University of North Dakota has been concerned with the direct partial hydrogenation of lignite and subbituminous coals using Pott-Broche technology. The primary objective is to use a refined product from this project as a source of electrode carbon for the aluminum industry.

**Natural Gas.**—Marketed natural gas totaled 34,889 million cubic feet, 3.8 percent more than in 1969. The average value at 16.4 cents per thousand standard cubic feet was 2 mills per thousand standard cubic feet more than in 1969. Of the total marketable gas, 24,294 million cubic feet came from three natural gas processing plants and 141 million cubic feet of dry natural gas came from 28 producing wells, five fewer than in 1969. No new gas discoveries were made in 1970. The Signal Oil & Gas Co. was the principal purchaser of natural gas.

Proved reserves of natural gas totaling 648.5 billion cubic feet at the start of the year decreased to 567.3 billion cubic feet at year end, primarily because of revisions. The State's total gas production was estimated at 39.1 billion cubic feet.<sup>9</sup>

The Federal Power Commission denied the Midwest Natural Gas Co., Denver, Colo., an application for a certificate to provide several cities and towns in North Dakota and South Dakota with natural gas. As a result, Midwest was negotiating with the McCulloch Interstate Gas Co. to deliver 6 million cubic feet per day from Wyoming to the South Dakota border.

**Natural Gas Liquids.**—The production of 2,344,000 barrels of natural gas liquids, comprising 1,840,000 barrels liquid petroleum and 504,000 barrels natural gasoline and cycle products was 4.7 percent less in volume but 2.5 percent more in value than in 1969. Comparing the average values in 1970 per 42-gallon barrel, liquid petroleum gases were sold for \$1.60 per barrel and natural gasoline and cycle products were sold for \$2.73 per barrel. Three natural

<sup>8</sup> Duzy, A. R., and G. R. Markley. Consider Lignite as a Fuel for Your Plant. Power, v. 115, No. 2, February 1971, pp. 53-54.

<sup>9</sup> Breakout By State of Crude-Oil and Natural-Gas Reserves in the United States. Oil and Gas Journal, v. 69, No. 14, Apr. 5, 1971, p. 39.

gas processing plants—Hunt Industries at McGregor, Signal Oil and Gas Co. at Tioga, and Texaco, Inc. at Lignite—continued processing casinghead gas. Sulfur was extracted from the gas at two of these plants.

The estimated proved recoverable reserves of natural gas liquids at the start of 1970 was 51.6 million barrels compared with 49.3 million barrels at yearend.<sup>10</sup> The State's average production of natural gas liquids was 8,208 barrels per day from 106.9 million cubic feet of gas.

**Peat.**—The Peat Products Co. produced reed-sedge peat from bog deposits in Bottineau County and shredded it for use as a soil conditioner. The entire production was shipped in bulk. There was no peat production in 1969 because the bog deposits were too wet to work.

**Petroleum.**—Crude oil production declined for the fourth consecutive year because development failed to offset the normal depletion of reservoirs. However, the value of production was 5.6 percent more than in 1969.

The 0.7-million-barrel decline in production from that of 1969 was estimated to have cost the State \$96,000 in tax revenues and land owners \$227,000 in royalty payments. The average value per barrel increased to \$3.05 from \$2.80 in 1969.

During 1970, 171 drilling permits were issued, two less than in 1969, 15 producing wells were abandoned, and only 30 new producing wells were completed. The drop in production was partly due to the directive of Industrial Commission eliminating earthen pits for salt-water storage. Wells without approved salt-water handling facilities on October 1 were shut in.

The American Petroleum Institute reported<sup>11</sup> that 167 new wells, with a total depth of 1,047,848 feet were drilled in 1970. Of these, 48 were oil wells totaling 303,642 feet, one was a gas well totaling 13,775 feet, and 118 were dry wells totaling 730,431 feet. One 760-foot stratigraphic well was also drilled. Exploratory well drilling, 256,392 feet less than in 1969, totaled 689,223 feet for 109 wells. The drilling was distributed between 7 oil wells totaling 57,728 feet and 102 dry wells totaling 631,495 feet. Development well drilling, 106,952 feet less than in 1969, totaled 358,625 feet for 58 wells, distributed among 41 oil wells totaling 245,914 feet,

one gas well totaling 13,775 feet, and 16 dry wells totaling 98,936 feet.

The total number of exploratory and development wells drilled was 85 less than the 252 drilled in 1969, and the total footage drilled in these wells in 1970 was 363,344 feet less than the 1,411,192 feet drilled in 1969. In late April one rotary drill was active, in late September, 16 were active. Active-rotary-drill weeks totaled 446.

The State's 109 exploratory completions resulted in the discovery of only two new fields, both producing from the Madison Formation of Mississippian age. These two new fields increased the State's reserves by 920,000 barrels. The South Lone Tree field in Ward County was discovered by the No. 1 Felt well, SESE 24-155N-86W, which initially flowed 144 barrels of oil per day and 19 percent water through a 24/64-inch choke at approximately 6,620 feet. At year-end the field had six producers. Among these were one offset well, north of the discovery well, that flowed 249 barrels of oil per day through a 24/64-inch choke, and a northwest offset well that gauged 128 barrels of oil per day through a 20/64-inch choke. The other new field, Lake Darling in Renville County, by year-end had three wells producing from the Sherwood zone, at 5,400 feet. The Madison discoveries were found jointly by Depco, Inc., and Texas Pacific Oil Co.

Exploration and development activity in the Nesson Anticline area was at the lowest level since 1951, at which time North Dakota first produced oil. The area received little attention except for one successful outpost 1 mile northeast of the Keene field.

Development work, in southwest North Dakota, in the Medicine Pole Hills, Zenith, Dickinson, and Rocky Ridge fields was fairly successful.

Several previously untested areas in south central North Dakota were explored. Helmerick & Payne drilled 10 wells, in depths up to 5,500 feet and totaling 51,089 feet, in the Mississippian Formations in Grant County. General American Oil of Texas drilled six wells totaling 40,309 feet

<sup>10</sup> Breakout By State of Crude-Oil and Natural Gas Reserves in the United States. *Oil and Gas Journal*, v. 69, No. 4, Apr. 5, 1971, p. 40.

<sup>11</sup> American Petroleum Institute. *Review of Drilling Statistics—Annual Survey, 1969*, v. 3, No. 4, March 1970, p. 19. *Annual Survey, 1970*, v. 4, No. 4, March 1971, pp. 14-17.

in Oliver County. All 16 wells were unsuccessful.

A scattering of Cretaceous tests completed along the eastern portion of the Williston basin resulted in no significant shows.

The Amarillo Oil Co., at its extension to the Medicine Pole Hills field in Bowman County, recovered oil from three zones of the Red River (Ordovician) sand. The well, 24-130N-104W, produced free oil on drill-stem tests at 9,471; 9,558; and 9,653 feet; covering the Red River A, B, and C zones. After pipe was set, the well produced 496 barrels of oil per day at 9,620 feet. This producer was located off the flank of the Cedar Creek anticline, nearly 2 miles southeast of the four-well Medicine Pole Hills field.

In Stark County, North American Royalties' well No. 1 Wolfe, SWNW 22-140N-96W, was completed early in the year for 595 barrels of oil per day at 8,038 feet.

A McKenzie County well, 24-1 FLB, SENW 24-151-N-101W, was drilled to 13,775 feet by Consolidated Oil and Gas for testing. This well was an eastern offset to the firm's 1969 Red River discovery, 23-1 FLB, SENE 23-151-N-101W, which flowed 518 barrels of oil per day.

Two wells in the Spearfish Sandstone Formation, producing 240 barrels of oil per day from a 16-foot-thick pay zone at 1,280 pounds per square inch, produced 590 barrels of oil per day at the same

pressure after micellar-dispersion treatment.

The continued decline in exploration and development was related to several factors. First, the major companies had significant capital tied up in Alaskan North Slope and offshore developments. Secondly, the lowering of the oil-depletion allowance reduced the tax advantage of oil investments at the same time the supply of money was tightened.

According to the North Dakota Geological Survey, counties reporting more footage of exploratory drilling than in 1969 were as follows: Divide, Grant, Slope, Towner, and Ward. For development drilling, Billings, Bowman, and Stark Counties reported more footage. Only Bottineau, Bowman, Divide, Golden Valley, and Stark Counties produced more crude oil than in 1969. Collectively, their production increased 829,000 barrels. Wells capable of oil production and producing at capacity at the start of the year totaled 2,006, including 609 stripper wells (those wells producing less than 10 barrels of oil per day), which collectively produced about 4,000 barrels of oil per day. At yearend there were 2,031 wells capable of producing oil, of which 679 were stripper wells. It is estimated that about 47 percent of the reserves could be recovered from 126 producing pools. Energy supplementation was underway in 29 of these pools. On January 1, 1970, primary plus secondary reserves, considered to be re-

Table 6.—North Dakota: Crude petroleum production by counties

(Thousand 42-gallon barrels and thousand dollars)

County	Quantity		Value		Principal fields in 1970, in order of production
	1969	1970	1969	1970	
Billings.....	1,958	1,798	\$5,482	\$5,485	Fryburg, Medora, Rocky Ridge.
Bottineau.....	2,645	2,803	7,406	8,551	Newburgh, South Westhope, Wiley.
Bowman.....	632	749	1,770	2,284	Cedar Creek, Medicine Pole Hills.
Burke.....	1,992	1,867	5,578	5,695	Rival, North Tioga, Northeast Foothills, Black Slough.
Divide.....	272	290	762	885	North Tioga, Stoneview.
Dunn.....	18	12	50	37	Lost Bridge.
Golden Valley.....	37	58	104	177	Square Butte.
McHenry.....	24	21	67	64	Pratt.
McKenzie.....	4,658	4,038	13,042	12,318	Antelope, Charlson, Hawkeye, Blue Buttes.
Mountrail.....	848	678	2,374	2,068	Tioga.
Renville.....	1,801	1,675	5,043	5,110	Sherwood, Glenburn.
Slope.....	63	45	190	137	Eleven Bar.
Stark.....	1,451	1,966	4,063	5,998	Dickinson, West Dickinson, Zenith.
Ward.....	371	359	1,039	1,095	Lone Tree.
Williams.....	5,928	5,639	16,598	17,203	Beaver Lodge, Tioga, Capa, Grenora.
Total.....	22,703	21,998	63,568	67,107	

<sup>1</sup> 10,690 from primary recovery units; 11,308 from secondary recovery units.

Source: North Dakota Geological Survey.

Table 7.—North Dakota: Oil and gas well drilling completions, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
Adams.....				0	0	1	1	4,304
Billings.....	1	0	1	0	0	2	4	37,771
Bottineau.....	16	0	4	0	0	12	32	129,096
Bowman.....	3	0	0	1	0	4	8	73,639
Burke.....	1	0	2	0	0	1	4	26,730
Cavalier.....				0	0	1	1	3,127
Divide.....				0	0	6	6	53,168
Dunn.....				0	0	3	3	33,630
Emmons.....				0	0	3	3	7,419
Golden Valley.....				0	0	1	1	5,500
Grant.....				0	0	10	10	51,089
McKenzie.....	1	0	0	1	0	1	3	33,870
McLean.....				0	0	6	6	25,337
Mercer.....				0	0	8	8	39,246
Morton.....				0	0	2	2	9,893
Oliver.....				0	0	6	6	40,309
Ramsey.....				0	0	3	3	6,055
Renville.....	5	0	1	1	0	3	15	77,237
Slope.....				0	0	5	5	40,590
Stark.....	10	0	5	1	0	5	21	170,531
Towner.....				0	0	3	3	5,924
Ward.....	3	0	2	2	0	7	14	90,815
Williams.....	1	1	1	1	0	4	8	82,418
Total.....	41	1	16	7	0	102	167	1,047,848

Source: American Petroleum Institute.

coverable with present equipment and techniques, totaled 653.5 million stock-tank barrels. At yearend, the total recoverable reserves were 670.4 million barrels, of which 354.7 million barrels were classed as primary and 315.7 million barrels as secondary.<sup>12</sup>

At yearend, proved reserves of crude oil totaled 192.4 million barrels. Indicated reserves of crude oil economically available by fluid injection totaled 32.7 million barrels.<sup>13</sup>

The Mandan refinery of the American Oil Co. completed its 16th year of operation in October. This refinery is the principal processor of North Dakota crude. In October 1970, it processed 47,000 barrels per day, 5,000 barrels per day less than its stream-day capacity. At the start of 1970, the Westland Oil Co. Refinery in Williston, which has a capacity of 5,000 barrels of oil per day was refining 3,000 barrels of oil per day.

The North Dakota Public Service Commission authorized Matador Pipelines Inc. to construct and operate a 21.6-mile pipeline to serve the Zenith oilfield about 2.5 miles south of Belfield.

Federal leaseholds during 1970 decreased by 80,353 acres, to 1,207,359 acres.

The State had no underground or above-ground storage facilities for liquid petroleum gases. No lubricants were produced in the State.

The receipts of petroleum products in the State included 8,775,569 barrels of gasoline, 2.42 percent more than in 1969, and 5,579,580 total barrels of heating and diesel fuel, 4.63 percent more than in 1969.

#### NONMETALS

Clays.—Compared with 1969, the total production of clays was 30 percent less and its total value was 69 percent less. These declines were attributed to a construction slump, and high interest rates. Three companies operated four strip pits in three counties to produce common clay and shale, which were converted into building brick, lightweight aggregate, and other products.

Clay producers were encouraged by the State Highway Department's acceptance of clay-based lightweight aggregates as an alternate seal-aggregate material. Two ½ mile sections of highway with lightweight aggregate as the chip-coat were in use in 1970.

Raw clay was trucked 1 mile to the Dic-Lite plant at Dickinson, Stark County, for drying, crushing, pulverizing, and bagging. The kiln used for drying and curing

<sup>12</sup> Folsom, Clarence B., Jr. North Dakota Crude Oil Inventory as of January 1, 1971. North Dakota Geol. Survey, Misc. Ser. No. 45, 1971, p. 1.

<sup>13</sup> Breakout By State of Crude-Oil and Natural-Gas Reserves in the United States. Oil and Gas Journal, v. 69, No. 15, Apr. 5, 1971, pp. 38-39.



was fueled with slack lignite and automotive crankcase drainings. This plant started manufacturing a mortar-mix plasticizer in addition to making an expanded shale product for use in lightweight block.

The Hebron Brick Co. resumed operation in April with 58 full-time employees after an 8-week shutdown for annual repairs. The brick company, with gross sales of \$700,000 in 1969, was the only survivor among the 25 North Dakota brick companies started since 1913.

**Fly Ash.**—Beginning in mid-April, 75 to 90 tons per day of fly ash collected by Basin Electric Power Cooperative at its Leland Olds electric utility plant in Stanton was marketed under a contract with Industrial Minerals, Inc., of Fargo. After several years of research supported by Basin Electric and the North Dakota Highway Department at the University of North Dakota, the North Dakota Highway Department and the Bureau of Public Roads approved the use of fly ash as a filler in asphalt highway construction in 1969.

Fly ash from Minnkota Power Cooperative's Young plant was hauled in 20-ton-capacity trucks to a lignite mine for use as backfill. Officials of the Young plant stated that fly ash may be used in the future for brick manufacture. This belief was based on research conducted at the University of North Dakota where bricks made of 65 percent fly ash and 35 percent slag were undergoing strength and water-absorption tests.

**Gem Stones.**—Gem stones gathered in the State included agate, chalcedony, jasper, and petrified wood. Their total value was estimated to be the same as in 1969.

**Lime.**—Because less sugar was processed, production of quicklime by the State's single producer, the American Crystal Sugar Co. plant at Drayton, declined 17 percent in quantity and 19 percent in value compared with 1969.

**Salt.**—The State's only evaporated salt producer, Dakota Salt and Chemical Co. produced 9 percent less salt in volume and 14 percent less in value than in 1969. The major market for the salt was livestock-feed dealers and mixers in Minnesota, Montana, North Dakota, South Dakota, and Wyoming. Fewer than 10 percent of the shipments were marketed in Canada.

Vast deposits of nearly pure salt totaling more than 1,700 cubic miles, underlie

much of North Dakota's plains. These deposits were found in the preceding 20 years of oil well drilling.

**Sand and Gravel.**—Sand and gravel averaging 25 cents per ton less in value than in 1969 was produced in 51 counties. Eddy, Grand Forks, Nelson, Richland, Steele, Traill, Walsh, and Ward Counties collectively produced about 40 percent of the total. The total quantity of sand and gravel produced was 15 percent more than in 1969 but its value was 13 percent less. Compared with the average value in 1969, the total sand production was valued at 1.2 cents per ton less, and the total gravel production averaged 28 cents per ton less.

The increased production was attributed to the greater use of sand and gravel for road maintenance and road construction projects contracted for by the State Highway Department in 1969. Sand and gravel produced by the State Highway Department totaled 50,996 tons and was valued at 8 cents per ton; that produced for the State Highway Department under contract totaled 1,402,710 tons, also valued at 8 cents per ton; and that purchased by the State Highway Department from commercial producers totaled 567,566 tons whose unit value is not available.

Commercial sand production was 7 percent more than in 1969 but its total value was only 1.5 percent greater because of a 5.6-cent per ton decline in average value. Commercial gravel production was 84.7 percent more than in 1969 but its total value was only 39 percent greater because of a 27-cent per ton decline in average value.

Sand and gravel production collectively in government-and-contractor operations compared with 1969 was 61 percent less in tonnage and 85 percent less in value.

There were 214 active sand and gravel operations, 56 less than in 1969. These operations included 153 commercial, 16 Federal, 11 State, 31 county, and three municipal.

The total production came from 33 stationary plants, 30 commercial and three government contract; 90 portable plants, 54 commercial and 36 government contract; and two plants of unknown type operated on government contract.

Commercial transportation data indicated that 6,701,000 short tons moved by truck and 249,000 short tons by railroad.

The Oil Field Services Co., Inc., of Tioga, won a \$2.9 million contract for earthwork and structures for the second segment (Reach 3-C) of the McClusky Canal, a major feature of the Garrison Diversion Unit. The 2.26-mile unlined canal will divert water from Lake Audobon to eastern North Dakota for irrigation, municipal water, fish and wildlife, and recreational purposes. The project will need 16,000 cubic yards of gravel. Cuts of from 30 to 100 feet in depth will require moving nearly 7 million cubic yards of earth.

Industrial Blacktop, Inc., at Wahpeton used gravel in the production of asphalt on a ready-mix basis in a new automated 70-ton-per-hour facility. The total investment cost for machinery and equipment was \$150,000.

**Stone.**—Compared with 1969, the production of crushed and broken stone was 43 percent more in tonnage and 27 percent more in value.

Production in eight counties came from operations of seven companies and one county highway department. Because of a

decreased demand for road material, and the lack of new projects, riprap was used only for the repair and maintenance of existing projects. Only 32,000 short tons of crushed rock was used by the State Highway Department, compared with 36,000 tons in 1969. The total production was used in approximately equal amounts as roadbase stone, unspecified aggregate, and riprap. The stone quarries in the State had an apparent consumption of 597,000 pounds of explosives and blasting agents, 99.4 percent of which was ammonium nitrate.

**Sulfur.**—Natural gas processing plants at Lignite and Tioga recovered elemental sulfur as a by product. The output of sulfur increased 22.0 percent from that in 1969, and the value increased about 38 percent. Inventory at yearend was 9 percent more than at the end of 1969. This commodity is not included in the total mineral production of North Dakota (table 1).

**Vermiculite.**—Vermiculite shipped into the State was exfoliated and sold by the Robinson Insulation Co., at Minot. Uses in

**Table 8.—North Dakota: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	473	\$589	485	\$567
Fill.....	162	120	151	138
Paving.....	161	162	221	185
Other uses.....	5	6		
Total <sup>1</sup> .....	801	877	857	890
<b>Gravel:</b>				
Building.....	411	821	804	1,095
Fill.....	109	70	86	87
Paving.....	2,613	2,630	5,047	3,746
Railroad ballast.....	133	58	144	76
Miscellaneous.....	32	32	( <sup>2</sup> )	1
Other uses.....			11	14
Total <sup>1</sup> .....	3,298	3,611	6,093	5,019
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Building.....			27	13
Paving.....	1,183	1,160	13	5
Total <sup>1</sup> .....	1,183	1,160	39	19
<b>Gravel:</b>				
Building.....	3	2	107	47
Fill.....	9	4	12	4
Paving.....	1,746	1,619	981	357
Total <sup>1</sup> .....	1,756	1,626	1,100	408
<b>Total sand and gravel <sup>1</sup>.....</b>	<b>7,039</b>	<b>7,274</b>	<b>8,090</b>	<b>6,336</b>

<sup>1</sup> Data may not add to totals shown because of independent rounding.

<sup>2</sup> Less than  $\frac{1}{2}$  unit.

decreasing order of importance were loose fill and block insulation, concrete and plaster aggregates, poultry litter, and soil conditioning.

**Volcanic Ash (Pumice).**—Dakota Industries initially plans to ship about 500 tons per month of volcanic ash from a strip mine it is developing 4 miles east of Linton. The material will be shipped to its plant at Belfield. At Belfield the ash would

be dried before heating and expanding to increase its absorbent quality. Tests indicated that the product would be satisfactory as the main ingredient in cat litter and floor dryer products. Research continued on the possible use of volcanic ash as a cement additive.<sup>14</sup>

<sup>14</sup> Volcanic Ash Passes Test; Mining, Shipping to Start Soon. North Dakota Industrial News. V. 9, No. 3, August 1970, p. 4.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Clays:</b>			
Baukol-Noonan, Inc.---	Noonan, N. Dak. 58765-----	Open pit mine and plant.---	Divide.
		do-----	Morton.
Hebron Brick Co.-----	Hebron, N. Dak. 58638.-----	Open pit mine-----	Do.
<b>Coal:</b>			
Baukol-Noonan, Inc.---	Noonan, N. Dak. 58765-----	Strip mine; crushing plant, thermal drying.	Burke.
Consolidation Coal Co., Western Division.	Box 200 Stanton, N. Dak. 58571	Strip mine----- Crushing plant-----	Oliver. Mercer.
		Strip mine and crushing plant.	Ward.
Knife River Coal Mining Co.	Bismarck, N. Dak. 58501----	do-----	Bowman.
North American Coal Corp., Lignite Division.	12800 Shaker Blvd. Cleveland, Ohio 44120	do-----	Mercer.
		do-----	Do.
Lime: American Crystal Sugar Co.	600 Boston Bldg. Denver, Colo. 80202	Shaft kiln at beet sugar refinery.	Pembina.
<b>Natural gas and petroleum:</b>			
Amerada Hess Corp.---	Box 2040 Tulsa, Okla. 74102	Crude oil wells: Fryburg field.	Billings.
		Crude oil wells: Lost Bridgefield.	Dunn.
		Crude oil wells: Antelope, Blue Buttes, and Charlson fields.	McKenzie.
		Crude oil wells: Beaver Lodge field.	Williams.
American Oil Co.-----	910 South Michigan Ave. Chicago, Ill. 60680	Refinery-----	Morton.
Chevron Oil Co., Western Division.	1700 Broadway Denver, Colo. 80202	Crude oil wells: Glenburn field.	Renville.
Chandler & Associates, Inc.	1401 Denver Club Bldg. Denver, Colo. 80202	Crude oil wells: Sherwood field.	Bottineau.
Hunt Oil Co. (Hunt Industries).	1401 Elm Dallas, Tex. 75202	Crude oil wells: North Tioga field and gas processing plant.	Burke.
Marathon Oil Co.-----	539 South Main St. Findley, Ohio 45840	Crude oil wells: Glenburn field.	Renville.
Amoco Production Co.--	Box 591 Tulsa, Okla. 74102	Crude oil wells: Black Slough and Rival fields.	Burke.
Petroleum, Inc.-----	300 West Douglas Wichita, Kans. 67202	Crude oil wells: Sherwood field.	Bottineau.
Shell Oil Co.-----	50 West 50th St. New York, N.Y. 10020	Crude oil wells: Cedar Creek field.	Bowman.
The Signal Companies, Inc	1010 Wilshire Blvd. Los Angeles, Calif. 90017	Crude oil wells: Tioga field.	Mountrail.
		Crude oil wells: Beaver Lodge field and gas processing plant.	Williams.
Tenneco Oil Co.-----	Box 2511 Houston, Tex. 77051	Crude oil wells: Glenburn field.	Renville.
Texaco Inc.-----	Box 52332 Houston, Tex. 77052	Crude oil wells: Blue Buttes and Charlson fields.	McKenzie.
		Gas processing plant.-----	Burke.
Union Oil Company of California.	Box 7600 Los Angeles, Calif. 90017	Crude oil wells: Sherwood field.	Renville.
Westland Oil Co.-----	Box 1549 Minot, N. Dak. 58701	Refinery-----	Williams.
Salt: Dakota Salt & Chemical Co.	General Carbon Bldg. West Haven Rd. Lawrenceville, Ill. 62439	Well and plant-----	Do.

Table 9.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Sand and gravel</b>			
<b>(commercial):</b>			
Bradshaw Gravel Supply.	Arvilla, N. Dak. 58214-----	Pit and 2 plants-----	Grand Forks.
Mahrer Construction Co.	Hankinson, N. Dak. 58041---	Pit and plant-----	Walsh.
Minot Sand & Gravel Co.	Box 116	-----do.-----	Richland.
Roy Scheffler, Inc.-----	Minot, N. Dak. 58702	-----do.-----	Ward.
	Box 906	Pit-----	Bottineau.
	Fargo, N. Dak. 58102	Pit-----	Dickey.
		Pit-----	Hettinger.
		Pit-----	Logan.
		Pit-----	Morton.
		Pit and plant-----	Renville.
		Pit-----	Richland.
		Pit-----	Sargent.
		Pit-----	Eddy.
Sheyenne Sand & Gravel, Inc.	Box 178		
	Sheyenne, N. Dak. 58374		
<b>Stone:</b>			
Fisher Sand & Gravel--	Dickinson, N. Dak. 58601---	Quarry and plant-----	Billings.
McKenzie County	Watford City, N. Dak. 58854	-----do.-----	McKenzie.
Highway Dept.			
Midwest Construction Co.	Box 624	-----do.-----	Morton.
	Nebraska City, Nebr. 68410		



# The Mineral Industry of Ohio

By Joseph A. Sutton <sup>1</sup>

For the ninth consecutive year, value of mineral production in Ohio increased, establishing a record high of \$612 million. Value was 5 percent above that of 1969, and this was attributed chiefly to reported higher unit prices for most of the State's mineral production. The quantity of bituminous coal produced increased only 8 percent while value increased approximately 25 percent; this more than offset production declines recorded for other minerals, primarily cement, stone, and

sand and gravel. Decelerated activities in the highway and building programs, the steel, chemical, and other industries were contributing factors for the lower demand for Ohio minerals.

Mineral production was reported in all of the State's 88 counties except Fulton. Belmont and Jefferson Counties with mineral output values of \$69.9 million and 24.1 million, respectively, were the States leading mineral-producing areas.

<sup>1</sup> Physical scientist, Division of Ferrous Metals.

Table 1.—Mineral production in Ohio <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland..... thousand 376-pound barrels ..	15,100	\$50,071	11,752	\$39,997
Masonry..... thousand 280-pound barrels ..	1,123	3,527	867	3,116
Clays..... thousand short tons ..	4,587	11,693	3,920	10,100
Coal (bituminous)..... do ..	51,242	210,082	55,351	262,390
Gem stones.....	NA	3	NA	3
Lime..... thousand short tons ..	4,159	60,975	3,951	61,197
Natural gas..... million cubic feet ..	49,793	12,837	52,113	14,123
Peat..... thousand short tons ..	11	116	6	95
Petroleum (crude)..... thousand 42-gallon barrels ..	10,972	36,098	9,864	32,914
Salt..... thousand short tons ..	5,844	43,519	5,329	47,498
Sand and gravel..... do ..	r 50,029	r 64,552	42,069	57,506
Stone..... do ..	51,792	86,570	47,244	81,506
Value of items that cannot be disclosed: Abrasive stone and gypsum ..	XX	1,815	XX	1,721
Total.....	XX	r 581,858	XX	612,166
Total 1967 constant dollars.....	XX	549,449	XX	p 554,010

p Preliminary. r 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.—Value of mineral production in Ohio, by counties<sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Adams	\$1,629	\$1,571	Stone.
Allen	2,059	W	Stone, sand and gravel.
Ashland	W	W	Sand and gravel, clays.
Ashtabula	W	W	Lime, sand and gravel.
Athens	W	W	Stone, sand and gravel, coal.
Auglaize	W	W	Stone, sand and gravel, clays.
Belmont	60,279	69,900	Coal, stone.
Brown	129	W	Sand and gravel, stone.
Butler	3,620	3,281	Sand and gravel.
Carroll	W	2,960	Coal, clays, sand and gravel, stone.
Champaign	W	W	Sand and gravel, peat.
Clark	W	W	Sand and gravel, lime, stone.
Clermont	W	W	Sand and gravel, stone.
Clinton	W	W	Stone, sand and gravel.
Columbiana	5,097	6,404	Coal, clays, sand and gravel.
Coshocton	W	W	Coal, sand and gravel, stone, clays.
Crawford	W	W	Stone, sand and gravel.
Cuyahoga	W	W	Salt, lime, sand and gravel, clays, peat.
Darke	W	W	Sand and gravel, clays.
Deñance	W	W	Sand and gravel.
Delaware	2,309	W	Stone, lime, clays.
Erie	7,804	W	Stone, lime, sand and gravel.
Fairfield	W	458	Sand and gravel.
Fayette	615	592	Stone.
Franklin	W	W	Sand and gravel, stone, lime, clays, peat.
Gallia	970	W	Coal, stone, sand and gravel.
Geauga	3,444	2,469	Sand and gravel, stone.
Greene	W	W	Cement, stone, sand and gravel, clays.
Guernsey	351	365	Coal, stone.
Hamilton	5,675	4,975	Sand and gravel.
Hancock	1,257	1,184	Stone, lime, clays.
Hardin	W	W	Stone.
Harrison	47,863	W	Coal, stone, clays.
Henry	83	80	Sand and gravel, clays.
Highland	W	W	Stone, sand and gravel.
Hocking	W	W	Coal, clays, sand and gravel.
Holmes	1,623	W	Coal, clays, sand and gravel, stone.
Huron	272	210	Sand and gravel, stone, peat.
Jackson	5,215	5,382	Coal, clays, stone.
Jefferson	W	24,131	Coal, clays.
Knox	W	W	Sand and gravel, stone.
Lake	28,000	W	Salt, lime, sand and gravel.
Lawrence	9,127	7,724	Cement, coal, stone, clays, sand and gravel.
Licking	788	W	Sand and gravel, clays.
Logan	708	W	Stone, sand and gravel, peat.
Lorain	W	W	Stone, sand and gravel, lime, abrasives.
Lucas	8,104	W	Stone, cement, sand and gravel, clays.
Madison	789	705	Stone, sand and gravel.
Mahoning	7,508	W	Stone, coal, clays, sand and gravel, peat.
Marion	1,569	W	Stone, sand and gravel, clays.
Medina	W	W	Sand and gravel, clays.
Meigs	W	W	Sand and gravel, coal, salt.
Mercer	W	W	Stone.
Miami	W	W	Stone, sand and gravel.
Monroe	W	W	Coal, sand and gravel, stone.
Montgomery	W	W	Sand and gravel, stone.
Morgan	W	W	Coal, stone, sand and gravel.
Morrow	65	W	Sand and gravel.
Muskingum	W	W	Cement, stone, coal, sand and gravel, clays.
Noble	10,326	11,824	Coal, stone.
Ottawa	10,208	W	Stone, lime, gypsum.
Paulding	W	W	Cement, stone, clays.
Perry	17,007	W	Coal, sand and gravel, stone, clays.
Pickaway	W	W	Sand and gravel, stone.
Pike	961	1,207	Stone, sand and gravel.
Portage	W	4,416	Sand and gravel.
Preble	W	W	Stone, sand and gravel.
Putnam	769	W	Stone, sand and gravel, clays.
Richland	W	W	Sand and gravel, clays, peat.
Ross	W	W	Sand and gravel, stone.
Sandusky	27,074	W	Lime, stone, sand and gravel.
Scioto	2,292	2,429	Stone, sand and gravel, clays.
Seneca	W	W	Lime, stone, clays.
Shelby	W	W	Sand and gravel, stone.
Stark	W	W	Cement, sand and gravel, coal, stone, clays, peat.
Summit	W	W	Salt, lime, stone, cement, sand and gravel.
Trumbull	W	W	Sand and gravel.
Tuscarawas	14,409	14,239	Coal, clays, sand and gravel, stone.
Union	436	369	Stone, sand and gravel.
Van Wert	1,010	W	Stone, clays.

See footnotes at end of table.

Table 2.—Value of mineral production in Ohio, by counties 1—Continued  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Vinton.....	W	W	Coal, stone, clays.
Warren.....	\$1,727	\$1,657	Sand and gravel.
Washington.....	W	W	Sand and gravel, coal, stone.
Wayne.....	W	W	Salt, sand and gravel, stone, coal, clays.
Williams.....	W	W	Sand and gravel, peat.
Wood.....	1,904	2,169	Stone.
Wyandot.....	W	W	Stone, lime, sand and gravel, peat, clays.
Undistributed 2.....	r 286,783	441,517	
Total 3.....	r 581,858	612,166	

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

1 Fultonton County is not listed because no production was reported. Natural gas and petroleum values are not listed by counties as data are not available; included with "Undistributed."

2 Includes natural gas, petroleum, gem stones, some sand and gravel, and stone, that cannot be assigned to specific counties and values indicated by symbol W.

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

Table 3.—Indicators of Ohio business activity

	1969	1970	Change, percent
Employment and labor force, annual average: 12			
Total labor force.....	4,473.9	4,534.0	+1.3
Unemployment.....	2.8	3.8	+35.7
Employment:			
Manufacturing.....	1,468.3	1,406.4	-4.2
Transportation and public equipment.....	221.2	226.4	+2.4
Wholesale and retail trade.....	759.9	777.1	+2.2
Finance, insurance, and real estate.....	151.4	158.0	+4.4
Services.....	546.1	572.0	+4.7
Government.....	544.8	566.3	+3.9
Contract construction.....	175.7	163.0	-7.2
Mining.....	19.9	20.9	+5.0
Payroll average weekly earnings: 2			
Manufacturing.....	\$152.10	\$154.69	+1.7
Personal income: 3			
Total.....	\$40,145	\$42,530	+5.9
Per capita.....	\$3,801	\$3,983	+4.8
Construction activity: 4			
Cement shipments to and within Ohio.....	thousand 376-pound barrels.. 20,263	17,176	-15.2
Mineral production 4.....	thousands.. r 581,858	\$612,166	+5.2

r Revised.

1 Area Trends in Employment and Unemployment, U.S. Department of Labor.

2 Employment and Earnings, U.S. Department of Labor.

3 Survey of Current Business, U.S. Department of Commerce.

4 U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1969:								
Coal.....	7,706	254	1,954	15,564	13	515	33.92	6,844
Peat.....	18	118	2	15	1	96	21.17	1,843
Nonmetal.....	2,101	270	568	4,581	7	87	20.19	9,646
Sand and gravel.....	2,327	239	555	4,655	4	205	16.15	2,968
Stone.....	5,589	282	1,576	12,941	4	205	16.15	2,968
Total 1.....	17,741	262	4,655	37,757	25	903	24.58	5,251
1970: P								
Coal.....	8,300	257	2,124	16,888	8	560	33.69	3,905
Peat.....	21	109	2	16	1	112	25.59	779
Nonmetal.....	2,090	263	550	4,377	4	64	15.64	1,131
Sand and gravel.....	2,060	234	482	4,093	4	227	19.27	581
Stone.....	5,245	273	1,433	11,781	4	227	19.27	581
Total 1.....	17,695	259	4,591	37,155	8	963	26.16	2,175

P Preliminary.

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



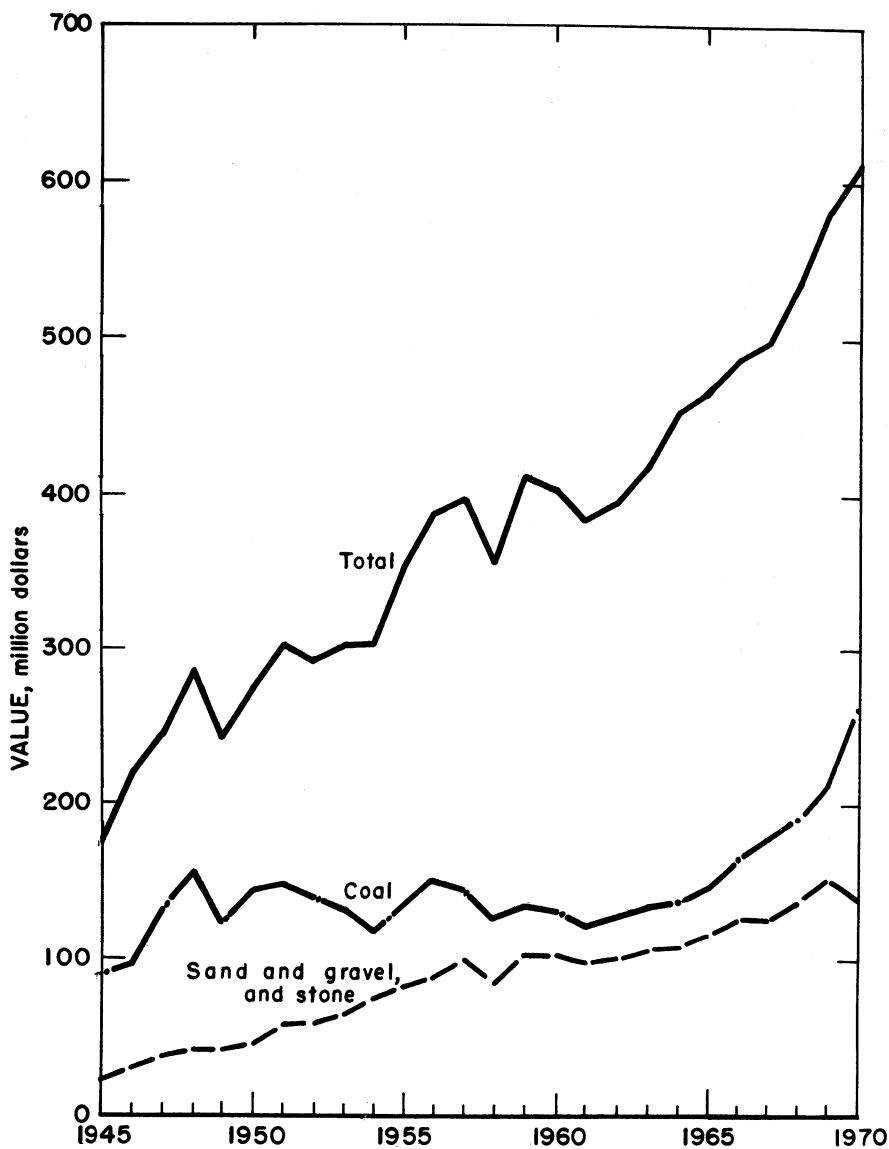


Figure 1.—Value of coal, sand and gravel, and stone, and total value of mineral production in Ohio.

## REVIEW BY MINERAL COMMODITIES

## NONMETALS

**Abrasive Stones.**—Production and value of abrasive stones (grindstones) were below those of 1969. Output was from one operation in Lorain County as a byproduct of sandstone quarrying.

**Cement.**—Shipments of portland and masonry cement decreased 22.2 and 22.8 percent, respectively. Average value per barrel of portland cement decreased from \$3.32 in 1969 to \$3.40; average value of masonry cement increased \$0.45 to \$3.59. Nine plants were active in the State, two each in Lawrence and Greene Counties and one each in Lucas, Paulding, Muskingum, Stark and Summit Counties. Apparent cement consumption in the State totaled 17.2 million barrels of portland cement and 1.3 million barrels of masonry cement. Ohio cement producers supplied 69 percent of the portland cement and 69 percent of the masonry cement consumed. Yearend stocks were 165,000 barrels higher than at the end of 1969.

Portland cement shipments by type of customer were as follows: Building materials, concrete products manufacture, and ready-mix, 10.3 million barrels; highway contractors and Federal, State, and other government agencies, 1.2 million barrels; and miscellaneous (including use by cement companies), 0.9 million barrels. Nearly 8 million barrels was shipped by truck and 1.3 million barrels by train. Most of the cement was delivered in bulk form, with less than 9 percent of the portland cement shipped in containers.

More than 3.6 million tons of limestone and cement rock were used by producing companies as primary raw materials. Other materials used included clay and shale 133,318 tons, sand 62,586 tons, gypsum 101,818 tons, and iron-bearing materials 4,558 tons. Nearly 665,000 tons of bituminous coal was used for clinker production

or power generation. Cement companies used 320 million kilowatt-hours of electrical energy. Of the electricity, 64 percent was purchased from public utilities and 36 percent was generated by the cement companies. A total of 28 kilns were in operation during the year.

The Barberton Mine of PPG Industries, Inc. was awarded the Certificate of Achievement in Safety in the Underground Nonmetal Group of National Safety Competition. The mine operated in 1970 without any lost-time injuries.

**Clays.**—Production of clays (fire clay and miscellaneous clay and shale) was below that of 1969, primarily because of lower demand in the major markets for Ohio clay. Clay used in refractories totaled 457,278 tons compared with 507,234 tons in 1969. Production of clay used in heavy clay products (mainly building brick) declined 8 percent to 2.1 million tons; clay used for manufacturing portland and other cements decreased by 119,000 tons to 601,000 tons. The only end-use category for common clay and shale that did not decrease was floor and wall tile. Fire clay accounted for 48 percent of the total clay production and was used chiefly in heavy clay products and refractories. Other uses of Ohio clay included rotary-drilling mud, floor and wall tile, and pottery and stoneware. Fire clay was produced in 14 counties; Tuscarawas, Columbiana, and Stark Counties led in output and supplied 66 percent of the production. Miscellaneous clay and shale was produced in 33 counties; Tuscarawas, Cuyahoga, Greene, Paulding, Columbiana, and Perry Counties were the leading areas.

**Gem Stones.**—Gem and mineral specimen collectors, mostly members of mineral and lapidary clubs, were active at mines and quarries throughout the State. Value of material collected remained the same as

Table 5.—Ohio: Portland cement salient statistics

(Thousand 376-pound barrels and thousand dollars)

	1969	1970
Number of active plants.....	9	9
Production.....	14,698	11,898
Shipments from mills:		
Quantity.....	15,100	11,752
Value.....	\$50,071	\$39,997
Stocks at mills, Dec. 31.....	1,824	1,989

that of 1969. Specimens collected included calcite, celestite, flint, and jasper. Flint, the State's official gem stone, was recovered chiefly at Flint Ridge in southeastern Licking County and the adjacent area of Muskingum County.

**Graphite (Synthetic).**—The Ohio Carbon Co. at Cleveland produced quantities of synthetic graphite from petroleum coke. Output was shaped for use in electrical motor brushes.

**Gypsum.**—Production and value of crude gypsum declined. Output from one underground mine and one open pit in Ottawa County was calcined at nearby plants for use in manufacturing building products. National Gypsum Co. in Lorain County also calcined gypsum from crude material shipped from outside the State.

**Lime.**—Production of lime decreased and was 5 percent below the record high of 1969. Lower demand occurred in the building and refractory categories. The average unit value for all major uses except refractory dolomite, were higher than those of 1969.

Of the total lime production, 2.4 million tons was captive tonnage or was marketed in Ohio. Other leading marketing areas for Ohio lime were Pennsylvania (316,000 tons); Michigan (237,000 tons); Illinois (237,000 tons); West Virginia (197,000 tons); Indiana (197,000 tons); and other states (316,000 tons). Ohio supplied 20 percent of the national lime output and continued as the leading lime-producing State.

Operators used mostly shaft-type kilns for manufacturing quicklime. Hydrated lime producers used both batch and con-

tinuous hydrators. Fuels used by producers included bituminous coal, coke, natural gas, and fuel oil. Sandusky County continued as the leading area for lime production accounting for nearly 1.2 million tons valued at \$19 million.

**Perlite (Expanded).**—Crude perlite shipped from Western States was processed and expanded at four plants located in Cuyahoga, Hamilton, Lorain, and Ottawa Counties. The quantity of expanded perlite sold or used decreased 3 percent in 1970. Most of the expanded material was used in plaster and concrete aggregate.

**Salt.**—Production of salt decreased for the first time in 12 years and established a new low of 5.3 million tons as output decreased 9 percent below that of 1969. Value increased about \$4 million to \$47.5 million. Salt in the forms of brine, evaporated from brine, and rock, sold or used totaled 34.6 million tons, 9.7 million tons less than in 1969. Rock salt recovered from underground mines in Cuyahoga and Lake Counties was sold mainly for highway ice control and chemical applications. Evaporated salt produced in Cuyahoga, Meigs, Summit, and Wayne Counties was sold for a wide variety of uses; some was marketed as pressed block. Evaporated salt producers used both the vacuum-pan and open-pan processes for recovering the salt. Lake County with two operations continued to rank first in output. Ohio continued as a leading area for salt production, ranking fourth in national output.

**Sand and Gravel.**—Sand and gravel production dropped 16 percent below the record high of 50 million tons achieved in 1969. Value was 11 percent lower and to-

Table 6.—Ohio: Lime sold or used by producers, by uses  
(Short tons)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Steel, BOF.....	932,270	\$12,130,000	1,037,546	\$15,125,901
Refractory dolomite.....	379,710	15,835,790	741,196	13,154,114
Glass.....	379,261	4,930,000	320,546	4,324,089
Other chemicals.....	168,302	2,198,483	185,449	2,492,853
Construction.....	236,002	5,474,085	162,253	4,377,861
Steel, open-hearth.....	94,317	1,227,000	121,068	1,664,926
Water purification.....	99,155	1,290,000	102,790	1,413,718
Agriculture.....	16,250	273,796	13,846	274,946
Other uses.....	1,354,124	17,615,400	1,265,864	18,368,460
Total.....	4,159,391	60,974,554	3,950,558	61,196,868

<sup>1</sup> Includes alkalis, calcium carbide, electric steel furnaces, other metallurgy, paper and pulp, whiting, sugar refining, sewage, other steel furnaces, and silica brick.

taled \$57.5 million. Output was approximately 8 million tons below that of 1969. Commercial sand and gravel used in building and highway construction totaled 41.8 million tons, 279,000 tons less than in 1969. Production and value of industrial sand decreased. Output totaled 1.2 million tons valued at \$5.3 million; average value increased from \$3.93 per ton in 1969 to \$4.55. Most of the industrial sand was marketed for molding, glass manufacture and furnace construction and repair.

Sand and gravel producers were active in 70 counties. Franklin, Hamilton, Portage, Butler, and Montgomery Counties, each with output in excess of 2 million tons, were the leading areas. Seven other counties had production exceeding 1 million tons. Commercial producers processed 91 percent of the total tonnage by washing, screening, sizing, and crushing. Approximately 39 million tons of sand and gravel was shipped to consumers by truck and the remainder by rail or water. The number of commercial operations totaled 399;

151 reported production below 25,000 tons and accounted for approximately 4 percent of the total output. Seven operations produced from 500,000 tons to 1 million tons and three operations had output exceeding 1 million tons.

**Stone.**—Production of stone (limestone and sandstone) decreased for the first time in six years, reflecting the slowing down of activities in the various phases of highway and building construction. Reduced demand for crushed limestone (including dolomite) used as aggregate was the major contributing factor for this decrease and accounted for a 11 percent drop in output. Production and value of dimension limestone (including dolomite) increased but not enough to offset other losses. Output was 11,609 tons valued at \$143,000 compared with 8,085 tons and \$85,000 in 1969. Most of the limestone was used as dressed architectural stone and for pavement purposes. Output was from quarries in Allen, Lucas, Miami, and Seneca Counties. Of the 56 limestone-produc-

Table 7.—Ohio: Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building.....	r 8,140	r \$4,895	6,608	\$8,506
Fill.....	r 1,693	r 1,096	1,284	1,079
Molding.....	525	2,282	464	2,146
Paving.....	r 8,901	r 10,067	8,427	9,999
Other uses <sup>1</sup> .....	1,396	4,422	976	3,442
Total <sup>2</sup> .....	r 20,656	r 27,760	17,759	25,172
Gravel:				
Building.....	r 8,819	r 11,468	7,192	9,905
Fill.....	r 3,711	r 2,842	1,520	1,224
Paving.....	r 15,703	r 20,788	13,970	19,248
Other uses <sup>1</sup> .....	r 1,113	r 1,673	1,402	1,735
Total <sup>2</sup> .....	r 29,347	r 36,770	24,085	32,111
<b>Government and contractor operations:</b>				
Sand:				
Paving.....	3	2	89	93
Total <sup>2</sup> .....	3	2	89	93
Gravel:				
Building.....	-----	-----	3	5
Fill.....	2	1	-----	-----
Paving.....	22	19	134	125
Total <sup>2</sup> .....	24	19	137	130
Total sand and gravel <sup>2</sup> .....	r 50,029	r 64,552	42,069	57,506

<sup>r</sup> Revised.

<sup>1</sup> Includes railroad ballast (1970), blast, engine, filtration, fire or furnace, glass, ground, and other sands.

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

Table 8.—Ohio: Sand and gravel sold or used by producers, by counties  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Ashland.....	6	268	\$243	6	W	W
Ashtabula.....	6	145	158	6	145	\$157
Auglaize.....	9	287	353	8	373	438
Butler.....	19	3,272	3,620	15	2,736	3,281
Clark.....	13	1,325	1,433	10	1,350	1,513
Clinton.....	2	51	45	1	17	20
Columbiana.....	7	150	180	6	56	73
Coshocton.....	8	551	640	7	385	484
Crawford.....	2	W	W	1	35	41
Cuyahoga.....	7	510	640	7	416	529
Erie.....	7	W	W	7	115	282
Fairfield.....	4	312	W	4	319	458
Franklin.....	16	5,427	7,313	16	4,647	6,723
Gallia.....	3	127	W	4	124	254
Geauga.....	10	1,543	W	9	964	1,512
Greene.....	9	1,116	1,122	12	638	674
Hamilton.....	21	5,052	5,675	20	4,157	4,975
Highland.....	1	15	17	1	W	W
Jackson.....	1	1	2	-----	-----	-----
Knox.....	7	1,092	2,633	6	885	2,448
Lake.....	4	130	140	3	W	W
Lawrence.....	3	W	W	3	198	231
Licking.....	11	746	788	12	856	930
Logan.....	6	160	W	4	W	W
Lorain.....	3	296	W	3	353	512
Lucas.....	4	688	314	5	474	263
Mahoning.....	-----	-----	-----	1	56	102
Marion.....	5	297	309	5	245	247
Medina.....	7	641	769	8	641	821
Miami.....	8	1,029	1,278	8	806	1,094
Montgomery.....	20	3,620	4,056	17	2,545	3,249
Morrow.....	1	66	65	1	W	W
Muskingum.....	5	W	W	6	741	654
Pike.....	5	W	W	5	360	516
Portage.....	2	3,405	5,035	24	2,873	4,416
Preble.....	5	188	233	5	222	292
Putnam.....	1	W	W	1	46	63
Richland.....	5	690	722	15	800	868
Ross.....	6	638	747	5	560	680
Scioto.....	5	317	550	5	W	W
Shelby.....	6	426	516	6	368	454
Stark.....	14	1,562	2,418	12	1,551	2,524
Summit.....	15	1,652	1,364	14	984	1,154
Tuscarawas.....	12	1,410	1,805	13	1,377	1,817
Warren.....	10	1,479	1,727	13	1,377	1,657
Washington.....	7	443	536	7	444	497
Wayne.....	4	508	612	4	540	680
Williams.....	9	265	W	7	W	W
Wyandot.....	6	290	333	6	319	381
Undistributed <sup>1</sup> .....	r 59	r 7,837	r 16,160	51	5,970	9,545
Total <sup>2</sup> .....	r 429	r 50,029	r 64,552	415	42,069	57,506

<sup>r</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

<sup>1</sup> Includes Allen, Athens, Brown, Carroll, Champaign, Clermont, Darke, Defiance, Henry, Hocking, Holmes, Huron, Madison, Meigs, Monroe, Morgan, Perry, Pickaway, Sandusky, Trumbull and Union Counties, and some sand and gravel that cannot be assigned to specific counties.

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

ing county, Sandusky County continued as the leading area with output of 4.2 million tons. Erie, Mahoning, Ottawa, and Wyandot Counties also were important limestone-producing areas.

Dimension sandstone production and value declined. Output was 78,000 tons valued at \$3.5 million compared with 94,000 tons valued at \$4.5 million in 1969. Most of the sandstone was fabricated into rough architectural blocks but large quantities

were also sold for dressed architectural applications in the form of cut and sawed stone. Crushed and broken sandstone (including quartzite) production totaled 1,034,503 tons valued at \$2.4 million, a decrease of 6 and 14 percent, respectively. The stone was marketed mainly for glass manufacturing and aggregates. Sandstone was quarried in 14 counties; Scioto, Lorain, and Knox Counties were the leading areas for dimension stone and Lorain,

**Table 9.—Ohio: Crushed and broken limestone and dolomite sold or used by producers, by uses**

(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Bituminous aggregates.....	2,777	\$4,309	2,255	\$3,647
Concrete aggregates.....	6,488	9,198	8,045	11,490
Dense graded road base stone.....	5,452	7,894	5,090	7,705
Macadam aggregates.....	5,336	7,920	4,725	7,196
Surface treatment aggregates.....	1,703	2,680	1,122	1,862
Unspecified aggregate & roadstone.....	9,651	13,961	7,171	11,810
Agricultural limestone.....	1,675	3,328	1,808	3,513
Cement.....	4,718	7,264	3,998	6,886
Flux.....	4,849	7,340	3,911	6,084
Lime.....	3,349	7,085	2,621	5,631
Railroad ballast.....	1,495	1,997	991	1,337
Riprap and jetty stone.....	351	574	339	489
Other uses <sup>1</sup> .....	2,752	5,621	4,044	7,888
Total.....	50,596	79,171	46,120	75,538

<sup>1</sup> Includes stone used for stone sand, chemical stone, mine dusting, asphalt and other filler, dam construction, poultry grit, dead burned dolomite, and other stone in smaller quantities.

Summit, and Monroe Counties for crushed and broken stone.

**Sulfur.**—Production and value of elemental sulfur recovered at the Toledo Refinery of Sun Oil Co. were below those of 1969. Sulfuric acid production at the American Zinc Company's Columbus plant was approximately 9 percent above that of 1969, even though operation of the zinc roasters producing the sulfur gas, was not as uniform as anticipated.

**Vermiculite (Exfoliated).**—The Cleveland Gypsum Co., Division of Cleveland Builders Supply Company, processed crude vermiculite shipped from out-of-State at its Cleveland plant. Production and sales were below those of 1969. The exfoliated vermiculite was sold for plaster and concrete aggregate and horticultural and other applications.

#### MINERAL FUELS

**Coal (Bituminous).**—A new record high production of bituminous coal was reached as output totaled 55.4 million tons valued at \$262 million. Coal tonnage increased for the ninth consecutive year and was 8 percent above the previous high year 1969. Strip mining supplied 64.7 percent of the total tonnage; 32.7 percent came from underground mines and 2.6 percent from auger mines. The average value per ton of coal also increased, \$4.74 per ton compared with \$4.10 in 1969. The total number of active mines producing 1,000 tons or more decreased from 322 in 1969 to 306. Underground mines decreased by 2 to a total of 44; strip mines declined by 13 and auger

mines by 1. Production was reported in 25 counties; Belmont and Harrison Counties with 14.6 and 12.6 million tons, respectively, were the leading areas.

Over 18 million tons of coal was recovered from underground mines, about 500,000 tons less than in 1969. Average value per ton increased by \$0.78 to \$5.43. Production was reported in 14 counties but over half of the underground tonnage came from Belmont and Harrison Counties. The number of continuous mining machines used at underground mines increased from 79 to 83, reflecting a continuing trend for greater mechanization. Almost 10.6 million tons of coal was mined and loaded by continuous mining machines compared with 10.3 million tons in the previous year. Eighty-four percent of the tonnage mined by continuous mining machines was loaded into shuttle cars and the remainder went on to conveyers. Production of coal recovered from auger mines decreased 12.5 percent from that of 1969 and totaled 1.4 million tons valued at \$6 million. Average unit price was \$0.55 higher, increasing from \$3.63 per ton to \$4.18. Columbiana County was the leading area for auger-mined coal with an output of 218,000 tons. Other leading areas having tonnages in excess of 155,000 tons were Harrison, Tuscarawas, and Jefferson Counties.

Strip-mined tonnage was 4.8 million tons above that of 1969 and totaled 35.8 million tons valued at \$15.8 million. Average value per ton increased from \$3.79 in 1969 to \$4.41. Belmont County was the leading area for strip-mined tonnage accounting for

8.4 million tons followed by Harrison, Morgan, and Jefferson Counties with 6 million, 4.4 million, and 4.1 million tons, respectively. Noble and Coshocton Counties, each with production exceeding 2 million tons, also, were leading producing areas.

Eighteen coal-cleaning and preparation plants were active, one less than in 1969. Producers cleaned 14.5 million tons of coal of which only 143,000 tons was cleaned by pneumatic methods and the remainder was cleaned by washing. Of the total tonnage cleaned, 79.8 percent was from underground mines, 18.6 percent from strip mines, and the remainder was from auger mines. Over 3.5 million tons of coal was dried after cleaning at six preparation plants. At mines having crushing and treatment facilities, 32.8 million tons of coal was crushed. Production at captive mines totaled 6.6 million tons compared with 6.4 million tons in 1969. Of the State's total coal output, 34.1 million tons were shipped by rail or water, 15.3 million tons by truck, and the rest was consumed locally.

Preliminary employment data indicates that an average of 8,300 men worked 16.9 million man-hours compared with nearly

15.6 million man-hours in 1969. Only eight fatalities were recorded compared with 13 the previous year. Of the eight fatalities, four were in underground mines—one each was caused by a fall of roof, a haulage accident, a machinery accident, and a electrical accident. Of the other four fatalities, three occurred at strip mines—one from a haulage accident and two from machinery accidents. One fatal accident from a miscellaneous cause occurred at an auger mine. The number of nonfatal injuries totaled 560. The State's fatal injury rates of 0.47 per million man-hours and 0.15 per million short tons were well below the national rates of 1.02 per million man-hours and 0.43 per million tons.

In National Safety Competition, the West Farm No. 22 mine of Hanna Coal Co., Division of Consolidation Coal Company, was the winner of the surface group competition and was awarded a trophy for having the best safety record of the year. The mine worked 213,637 man-hours without any disabling injuries. Also in the same competition, the Bradford No. 16 Mine, Hanna Coal Co., Division of Consolidation Coal Company, was awarded a Cer-

**Table 10.—Ohio: Bituminous coal production, by type of mine and county**  
(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines				Production (thousand short tons)				Value (thousands)
	Under-ground	Strip	Auger	Total	Under-ground	Strip	Auger	Total <sup>1</sup>	
Athens.....	2	3	-----	5	13	44	-----	56	\$222
Belmont.....	8	20	8	36	6,047	8,371	153	14,572	69,591
Carront.....	-----	3	1	4	-----	W	-----	503	2,391
Columbiana.....	3	27	8	38	61	960	218	1,239	5,470
Coshocton.....	1	8	2	11	W	2,172	W	2,865	14,196
Gallia.....	2	5	-----	7	18	200	-----	218	935
Guernsey.....	-----	2	-----	2	-----	48	-----	48	219
Harrison.....	5	15	3	23	6,351	6,041	183	12,575	62,352
Hocking.....	-----	7	-----	7	-----	165	-----	165	718
Holmes.....	-----	3	-----	3	-----	372	-----	372	1,498
Jackson.....	7	10	2	19	101	837	31	963	3,883
Jefferson.....	2	27	6	35	818	4,148	156	5,122	23,729
Lawrence.....	1	4	-----	5	-----	W	-----	W	W
Mahoning.....	-----	8	1	9	-----	W	W	448	2,116
Meigs.....	1	1	1	3	6	6	1	13	74
Monroe.....	1	-----	-----	1	1,241	-----	-----	1,241	7,197
Morgan.....	-----	2	-----	2	-----	4,437	-----	4,437	21,026
Muskingum.....	3	7	2	12	50	599	94	743	2,202
Noble.....	-----	4	2	6	-----	2,380	153	2,533	11,399
Perry.....	5	15	3	23	2,556	1,102	74	3,731	17,307
Stark.....	-----	9	-----	9	-----	339	-----	339	1,379
Tuscarawas.....	3	27	6	36	323	1,675	170	2,167	9,302
Vinton.....	-----	8	-----	8	-----	605	-----	605	2,440
Washington.....	-----	1	-----	1	-----	W	-----	W	W
Wayne.....	-----	1	-----	1	-----	40	-----	40	174
Undistributed <sup>2</sup> .....	-----	-----	-----	-----	527	1,279	189	350	1,571
Total <sup>1</sup> .....	44	217	45	306	18,111	35,818	1,422	55,351	262,390

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

<sup>1</sup> Data may not add to totals shown because of independent rounding.

<sup>2</sup> Includes mines and value indicated by symbol W.

tificate of Achievement in Safety for working without any disabling injuries. In National Safety Competition for underground coal mines, the Simco-Peabody No. 2 mine of Simco-Peabody Company was awarded a Certificate of Achievement in Safety for their safety record.

**Peat.**—Shipments and value of peat were below those of 1969 but higher unit prices were reported. The average value per ton increased from \$10.55 in 1969 to \$15.83. Production was reported in 10 counties; Cuyahoga County ranked first in tonnage with one operation. At active operations, production of humus peat predominated but quantities of moss and reed-sedge peat also were recovered. Peat was processed prior to marketing mostly by shredding and only a limited quantity was unprepared or kiln-dried. Approximately 50 percent of the peat was sold in bulk for general soil improvement. The rest was sold for a variety of uses, the most important being as an ingredient for potting soils.

**Petroleum and Natural Gas.**—Production and value of petroleum declined, but natural gas output and value increased above that of 1969. According to the American Association of Petroleum Geologists, total well completions and footage drilled increased from 1,238 to 1,350 and 4,752,000 to 5,510,000, respectively. A total of 1,314 development and 36 wildcat completions were reported. Development wells were drilled in 40 counties; Guernsey, Muskingum, Tuscarawas, Stark, and Noble were the leading areas. Wildcat completions were reported in 22 counties. The leading area for wildcat activity was Meigs County. Drilling operations were mainly by the cable tool method.

According to the American Gas Association and American Petroleum Institute, reserves on December 31, 1970, were 993,458 million cubic feet of natural gas (14.73 pounds per square inch absolute, at 60° F), and 127.9 million barrels of crude petroleum. Reserves of natural gas increased by 184 million cubic feet and crude petroleum by 545,000 barrels. Of the natural gas reserves 436,003 million cubic feet was held in underground storage.

Refineries were active throughout the State processing crude petroleum into gasoline and other petroleum products including asphalt, coke, lubricants, and paraffin. Companies used catalytic and thermal cracking and reforming, hydrocracking,

coking, and alkylation processing for recovering gasoline and other products.

## METALS

**Aluminum.**—Production of primary aluminum was below that of 1969. The Ormet Corporation, the primary aluminum complex owned jointly by Revere and Olin Corporation, operated at capacity until about the middle of September when a shortage of carbon anodes, caused by a labor slowdown, necessitated the shutdown of one of the six potlines in the reduction plant. The closing of this 38,400-ton-per-day potline caused aluminum production to be cut by 16 percent.

**Beryllium.**—Beryllium metal, alloys, and compounds were produced from beryllium hydroxide by the Brush Beryllium Corp. at Elmore. Bertrandite ore mined at the corporation's Roadside mine near Delta, Utah, was processed into beryllium hydroxide and shipped to the Elmore plant. Production was mostly beryllium and beryll-copper master alloy.

**Ferroalloys.**—Production of ferroalloys decreased 9 percent, but value increased 7 percent compared with that of 1969. Of the 2.5 million tons of ferroalloys produced in the United States, furnaces located in Ohio were responsible for 325,784 tons. Production of nine plants, consisted mainly of ferroalloys of boron, columbium, chromium, manganese, silicon, silvery pig iron, silicomanganese, titanium, and vanadium. Plants were located at Ashtabula, Beverly, Brilliant, Cambridge, Jackson, Marietta, Philo, Powhatan Point, and Vancoram. Among the 16 ferroalloy-producing States, Ohio continued to be the leading producer.

**Iron and Steel.**—Steel production at Ohio plants was 21.7 million short tons, 10 percent less than that of 1969, according to the American Iron and Steel Institute. Production of pig iron was 16.3 million tons, 600,000 tons below that of 1969. Shipments decreased 4 percent and totaled 16.3 million tons valued at \$1.12 billion. Nearly 15.5 million tons of basic pig iron was produced, 180,000 tons below that of 1969. Of the 44 blast furnaces in the State, 27 were active and 17 were idle. Ohio steel plants received 4.8 million tons of domestic iron ore and 3 million tons of imported iron ore. Iron ore receipts were 600,000 tons less than those of 1969. Receipts of ag-



Table 11.—Ohio: Oil and gas well drilling in 1970, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Allen			1				1	1,341
Ashland	13		11			2	26	26,904
Ashtabula	2	76					78	279,964
Athens	1	3	1			1	6	13,701
Belmont						1	1	486
Carroll	57	1	2			1	62	334,577
Columbiana	18	18	1			1	20	121,182
Coshocton	14	4	5				23	76,820
Crawford						1	1	2,902
Delaware			2			1	3	9,790
Fairfield	5		2				7	18,888
Fulton						2	2	6,072
Gallia			3		1		4	14,365
Guernsey	45	188	10		1		244	1,219,675
Harrison			1				1	3,274
Henry		1					1	1,598
Henry	26	3	4				33	99,699
Hocking	4	3	1			1	9	33,608
Holmes	1	1	1			1	3	6,410
Jackson	18	5	4				27	76,622
Knox			1	1	1		2	4,415
Lawrence			6		1	1	78	200,045
Licking	70		1				6	12,448
Lorain		5					2	13,712
Mahoning		2					2	13,712
Medina	1	11	7				19	61,846
Meigs	1	14	10		5	1	31	116,147
Mercer						1	1	1,893
Monroe	4	14	4				22	43,739
Morgan		10	3		1		14	62,696
Morrow	7	2	21				30	100,311
Muskingum	69	114	12				195	825,720
Noble		77	2			3	82	442,208
Noble						1	1	1,959
Paulding							80	241,420
Perry	70	2	8				2	5,979
Pickaway						2	1	285
Pike		1					1	4,825
Portage	1						1	396
Richland			1				1	1,277
Sandusky	1						4	1,615
Scioto		4					86	431,914
Stark	74	11	1				1	4,290
Trumbull						1	93	457,362
Tuscarawas	7	84	2				5	7,182
Vinton	2	2	1				20	58,853
Washington	4	5	8			3	18	57,225
Wayne	5	5	8				2	2,755
Wyandot	1		1					
Total	502	666	146	1	17	18	1,350	5,510,395

Source: American Association of Petroleum Geologists (AAPG).

glomerates decreased by 991,000 tons and totaled 15.3 million tons. Of the agglomerated material, 14.3 million tons was domestic regular iron ore pellets.

Blast furnaces consumed 3.7 million tons of domestic and 832,000 tons of foreign iron ore as well as 19.1 million tons of agglomerates. In addition 2.1 million tons of limestone and 1.2 million tons of dolomite were consumed as fluxing material. Ton-nages of other materials consumed included coke and coke breeze, 10.1 million; home and purchased scrap, 771,000; slag scrap, 181,000; mill cinder and roll scale 3.2 million, open-hearth, basic oxygen, and Bessemer slag, 750,000 tons; and flue dust, 21,000 tons. Approximately 4.4 million tons of slag and 178,000 tons of scrap iron were

produced at blast furnaces, and 614,000 tons of flue dust was recovered. Steel producers also consumed substantial quantities of supplemental fuels in blast furnaces including natural gas, bunker oil, and fuel tar.

**Titanium.**—Reactive Metals, Inc., jointly owned by the United States Steel Corp. and National Distillers & Chemical Corp., produced titanium sponge metal by sodium reduction of titanium tetrachloride at its Ashtabula plant. The sponge was shipped to the company's Niles plant for melting and processing. Primary titanium metal shipped from Henderson, Nev., was rolled and fabricated at Toronto by Titanium Metals Corporation of America (TMCA). Sherwin-Williams Co. went into operation in 1969 and completed its first

full year of titanium dioxide production. Cabot Titanium Corp. at Ashtabula produced titanium pigments (titanium dioxide) used in manufacturing paint.

**Zirconium.**—Zirconium sponge was produced at the Ashtabula plant of Reactive Metals, Inc. The company shipped the sponge to Niles for production of ingots. The Chas. Taylor Sons Company in Cincinnati produced zircon and zirconia-base

refractories. Zirconium Corporation of America (ZIRCOA), now affiliated with Corning Glass, produced at Solon zirconium oxide as well as zircon refractories. Foote Mineral Co. processed zircon to produce zirconium alloys at Cambridge and Continental Mineral Processing Corp. processed zircon at Sharonville for use by the iron and steel foundries.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Abrasives:</b>			
<b>Metalllic:</b>			
Cleveland Metal Abrasive Co., Div. of Fanner Mfg. Co.	Brookside Park Cleveland, Ohio 44109	Plant.....	Cuyahoga.
Do.....		do.....	Lucas.
Globe Steel Abrasives Co.....	P.O. Box 1247, P.O. Annex Mansfield, Ohio 44903	do.....	Richland.
Metal Blast, Inc.....	871 East 67th St. Cleveland, Ohio 44103	do.....	Cuyahoga.
The National Metal Abrasive Co.	3560 Norton Rd. Cleveland, Ohio 44111	do.....	Do.
Steel Abrasives, Inc.....	Hamilton, Ohio 45010.....	do.....	Butler.
<b>Cement:</b>			
Alpha Portland Cement Co. <sup>1</sup> .....	15 South Third St. Easton, Pa. 18043	do.....	Lawrence.
Columbia Cement Co. <sup>2</sup> .....	P.O. Box 1513 Zanesville, Ohio 43701	do.....	Muskingum.
The Diamond Portland Cement Co., <sup>3</sup> Div. of The Flintkote Co.	Middle Branch, Ohio 44652	do.....	Stark.
Peninsular Portland Cement Div., General Portland Cement Co. <sup>4</sup>	709 Clay St. Ft. Wayne, Ind. 46802	do.....	Paulding.
Marquette Cement Mfg. Co. <sup>5</sup> .....	20 North Wacker Dr. Chicago, Ill. 60606	do.....	Lawrence.
Medusa Portland Cement Co. <sup>6</sup> .....	P.O. Box 5668 Cleveland, Ohio 44101	do.....	Lucas.
PPG Industries, Inc. <sup>7</sup> .....	P.O. Box 31 Barberton, Ohio 44203	do.....	Summit.
Southwestern Portland Cement Co. <sup>4</sup>	P.O. Box 191 Fairborn, Ohio 45324	do.....	Greene.
Universal Atlas Cement Div., <sup>4</sup> U.S. Steel Corp.	Chatham Center, Box 2969 Pittsburgh, Pa. 15230	do.....	Do.
<b>Clays:</b>			
<b>Fire clay:</b>			
AFC Corporation.....	P.O. Box 157 Canfield, Ohio 44406	Pit.....	Mahoning.
The Belden Brick Co.....	P.O. Box 910 Canton, Ohio 44701	Pit.....	Holmes.
Do <sup>8</sup> .....		5 pits.....	Stark, Tuscarawas.
The Belden Brick Co.....		Underground.....	Tuscarawas.
Cedar Heights Clay Co.....	P.O. Box 368 Oak Hill, Ohio 45656	4 pits.....	Jackson.
Glen-Gery Corporation <sup>8</sup> .....	P.O. Box 1656 East Canton, Ohio 44730	2 pits.....	Carroll.
Glen-Gery Corporation.....		2 pits.....	Hocking, Stark.
Kimble Coal Co. <sup>8</sup> .....	R. D. 1, Dover, Ohio 44622.....	Pit.....	Tuscarawas.
Metropolitan Industries, Inc.....	306 Market Ave. North Canton, Ohio 44702	Pit.....	Columbiana.
H. K. Porter Co., Inc.....	Porter Bldg. Pittsburgh, Pa. 15219	2 underground....	Columbiana, Jefferson.
Ralph A. Veon, Inc.....	Darlington, Pa. 16115.....	Pit.....	Columbiana.
Zoar Mining Co. <sup>8</sup> .....	Box 327 Beach City, Ohio 44608	2 pits.....	Tuscarawas.
<b>Common clay and shale:</b>			
Amvit Corp., AMVIT Div.....	24480 Lakeland Blvd. Euclid, Ohio 44123	2 pits.....	Columbiana, Tuscarawas.
The Claycraft Co.....	P.O. Box 866 Columbus, Ohio 43216	3 pits.....	Franklin, Tuscarawas, and Wyandot.
Cleveland Builders Supply Co..	2100 West Third St. Cleveland, Ohio 44113	2 pits.....	Cuyahoga.
General Wadsworth Brick Corp.	Box 340 Wadsworth, Ohio 44281	Pit.....	Medina.

See footnotes at end of table.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Clays—Continued			
Common clay and shale—Continued			
Hydraulic Press Brick Co.-----	705 Olive St. St. Louis, Mo. 63101	Pit-----	Cuyahoga.
Marion Brick Corp.-----	Box 548, Marion, Ohio 43301	Pit-----	Marion.
The Richland Brick Co.-----	Box 328 Mansfield, Ohio 44901	2 pits-----	Richland.
Coal (bituminous):			
B & N Coal Company-----	Box 100 Dexter City, Ohio 45727	2 strip mines-----	Noble.
Boich Mining Company-----	R.D. 1 Bloomingdale, Ohio 43910	---do-----	Jefferson, Muskingum.
Central Ohio Coal Company-----	Box 93 Cumberland, Ohio 43732	Strip-----	Morgan.
Cravat Coal Company-----	Box 157 Holloway, Ohio 43985	3 strip mines-----	Belmont, Harrison.
Do-----	-----	Underground-----	Belmont.
Cross Creek Coal Co.-----	Box 167 New Philadelphia, Ohio 44663	Strip-----	Tuscarawas.
Hanna Coal Company, Division of Consolidation Coal Company.	Cadiz, Ohio 43907-----	5 strip mines-----	Belmont, Jefferson, and Harrison.
Do-----	-----	Auger-----	Do.
Do-----	-----	Underground-----	Harrison.
Hardy Coal Company-----	Berlin, Ohio 44610-----	4 strip mines-----	Coshocton, Holmes, and Tuscarawas.
Island Creek Coal Company-----	P.O. Box 196 Freeport, Ohio 43973	Underground-----	Harrison.
The North American Coal Corpora- tion.	12800 Shaker Boulevard Cleveland, Ohio 44120	3 underground mines.	Belmont, Jefferson.
Do <sup>9</sup> -----	-----	---do-----	Monroe, Belmont.
Oglebay Norton Company-----	P.O. Box 6508 Cleveland, Ohio 44101	2 underground mines.	Belmont.
Ohio River Collieries Company-----	Route 1 Bloomingdale, Ohio 43910	Strip-----	Do.
Do-----	-----	Auger-----	Do.
Peabody Coal Company-----	301 No. Memorial Drive St. Louis, Mo. 63102	2 strip mines-----	Coshocton, Perry.
Do-----	-----	Underground-----	Perry.
R. & F. Coal Company-----	Box 218, Cadiz, Ohio 43907	5 strip mines-----	Belmont, Harrison, and Noble.
Simco-Peabody Coal Company-----	301 No. Memorial Drive St. Louis, Mo. 63102	---do-----	Coshocton.
Do-----	-----	Underground-----	Do.
The Youghiogheny & Ohio Coal Company.	4614 Prospect Ave. Cleveland, Ohio 44103	3 underground mines.	Belmont, Harrison.
Ferroalloys:			
Foote Mineral Co.-----	Dept. 602 Route 100 Exton, Pa. 19341	2 plants-----	Guernsey, Jefferson.
Interlake Steel Corp.-----	210 S. Michigan Ave. Chicago, Ill. 60604	---do-----	Washington.
Ohio Ferro-Alloys Corp.-----	837 30th N.W. Canton, Ohio 44709	---do-----	Jefferson, Muskingum.
Union Carbide Corp.-----	270 Park Ave. New York, N.Y. 10017	---do-----	Ashtabula, Washington.
Graphite (synthetic):			
The Ohio Carbon Co.-----	12508 Berea Rd. Cleveland, Ohio 44111	---do-----	Cuyahoga.
Gypsum:			
Crude:			
The Celotex Corporation <sup>10</sup> -----	1500 North Dale Mabry Tampa, Fla. 33607	Pit-----	Ottawa.
United States Gypsum Co. <sup>10</sup> -----	101 South Wacker Dr. Chicago, Ill. 60606	Underground-----	Do.
Calcined: National Gypsum Company.	325 Delaware Ave. Buffalo, N.Y. 14202	Plant-----	Lorain.
Lime:			
Basic Incorporated-----	845 Hanna Bldg. Cleveland, Ohio 44115	---do-----	Seneca.
Cuyahoga Lime Company-----	Menlo Park, N.J. 08817	---do-----	Cuyahoga.
Diamond Shamrock Chemical Co., Unit of Diamond Shamrock Corp.	300 Union Commerce Bldg. Cleveland, Ohio 44115	---do-----	Lake.
The National Lime & Stone Co.	First National Bank Bldg. Findlay, Ohio 45840	---do-----	Wyandot.
Huron Lime Co.-----	P.O. Box 428 Huron, Ohio 45840	---do-----	Erie.
Ohio Lime Co.-----	Woodville, Ohio 43469	---do-----	Sandusky.
Chas. Pfizer & Co., Inc.	836 National Bank Bldg. Toledo, Ohio 43604	---do-----	Do.

See footnotes at end of table.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Lime—Continued</b>			
PPG Industries, Inc.-----	Barberton, Ohio 44203-----	Plant-----	Summit.
Republic Steel Corp.-----	1630 Republic Bldg. Cleveland, Ohio 44101-----	do-----	Lake.
Standard Lime & Refractories Co., Div. Martin-Marietta Corp.-----	2000 First National Bank Bldg. Baltimore, Md. 21203-----	do-----	Sandusky.
Union Carbide Corp., Chemicals & Plastics.-----	P.O. Box 299 Marietta, Ohio 45750-----	do-----	Ashtabula.
United States Gypsum Co.-----	101 South Wacker Dr. Chicago, Ill. 60606-----	do-----	Ottawa.
U.S. Steel Corp.-----	600 Grant St. Pittsburgh, Pa. 15230-----	do-----	Lorain.
<b>Peat:</b>			
Beaver Peat Products Co.-----	Box 136 Damascus, Ohio 44619-----	Bog-----	Mahoning.
Corell Peat Moss-----	Box 340, Rt. 1 Beach City, Ohio 44608-----	Bog-----	Stark.
The Humus Co.-----	2628 South Michigan St. South Bend, Ind. 46614-----	Bog-----	Wyandot.
Lantz Peat Moss, Inc.-----	4594 Fulton Dr., N.W. Canton, Ohio 44718-----	Bog-----	Stark.
Lingvai Peat Co.-----	Rte. 2, Box 82 Edgerton, Ohio 43517-----	Bog-----	Williams.
Dan E. Poljack-----	19675 Sheldon Rd. Cleveland, Ohio 44130-----	Bog-----	Cuyahoga.
Reynolds Farms, Inc.-----	Route 1 Shelby, Ohio 44875-----	Bog-----	Richland.
Sphagnum Peat Moss Products-----	Rt. 1 West Liberty, Ohio 43357-----	Bog-----	Champaign.
Paul Thompson Peat Co.-----	R.D. 1 West Liberty, Ohio 43357-----	Bog-----	Logan.
W. C. Utzinger & Sons-----	6268 Jackson Pike Grove City, Ohio 43123-----	Bog-----	Franklin.
<b>Perlite (expanded):</b>			
The Cleveland Gypsum Co., Div. The Cleveland Builders Supply Co. <sup>11</sup> -----	2100 West Third St. Cleveland, Ohio 44113-----	Plant-----	Cuyahoga.
National Gypsum Co.-----	325 Delaware Ave. Buffalo, N.Y. 14202-----	do-----	Lorain.
Philip Carey Corporation-----	320 South Wayne Ave. Cincinnati, Ohio 45215-----	do-----	Hamilton.
<b>Petroleum refineries:</b>			
Ashland Oil and Refining Co.-----	1409 Winchester Ave. Ashland, Ky. 41101-----	3 plants-----	Hancock, Licking, and Stark.
Chevron Asphalt Company-----	555 Market St. San Francisco, Calif. 94105-----	Plant-----	Hamilton.
Gulf Oil Corp.-----	Pittsburgh, Pa. 15219-----	2 plants-----	Hamilton, Lucas.
Standard Oil Company of Ohio-----	Midland Bldg. Cleveland, Ohio 44115-----	do-----	Allen, Lucas.
Sun Oil Company <sup>12</sup> -----	1608 Walnut St. Philadelphia, Pa. 19103-----	do-----	Lucas.
<b>Salt:</b>			
<b>Brine:</b>			
Diamond Shamrock Chemical Co., a Unit of Diamond Sham- rock Corp.-----	300 Union Commerce Bldg. Cleveland, Ohio 44115-----	Well-----	Lake.
PPG Industries, Inc. <sup>13</sup> -----	P.O. Box 31 Barberton, Ohio 44203-----	do-----	Summit.
<b>Evaporated:</b>			
Diamond Crystal Salt Co. <sup>14</sup> -----	916 South Riverside St. Clair, Mich. 48079-----	do-----	Do.
Excelsior Salt Works, Inc.-----	P.O. Box 267 Pomeroy, Ohio 45769-----	do-----	Meigs.
Morton Salt Co., Div. of Mor- ton International, Inc.-----	110 North Wacker Dr. Chicago, Ill. 60606-----	do-----	Wayne.
<b>Rock:</b>			
International Salt Co. <sup>15</sup> -----	Clarks Summit, Pa. 18411-----	Underground-----	Cuyahoga.
Morton Salt Co., Div. of Morton International, Inc.-----	110 North Wacker Dr. Chicago, Ill. 60606-----	do-----	Lake.
<b>Sand and gravel:</b>			
American Aggregates Corp.-----	Garst Avenue at Avenue B Greenville, Ohio 45331-----	9 pits-----	Champaign, Clark, Darke, Franklin, Licking, and Montgomery.
Do-----		Dredge-----	Clark.
American Materials Corp.-----	P.O. Box 154 Hamilton, Ohio 45010-----	2 pits-----	Butler.
Do-----		Pit-----	Hamilton.

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>			
The F. H. Brewer Co.....	P.O. Box 128 Lancaster, Ohio 43130	2 pits.....	Athens, Fairfield.
Canton Aggregate Co.....	1243 Raff Rd. S.W. P.O. Box 1337 Station C Canton, Ohio 44708	3 pits.....	Stark.
The Central Silica Co.....	806 Market St. Zanesville, Ohio 43701	2 pits.....	Knox, Perry.
Hilltop Concrete Corp.....	Lane Avenue Cincinnati, Ohio 45214	2 pits.....	Greene, Montgomery.
Wm. Miller Sand & Gravel Co.....	1237 Jackson Pike Columbus, Ohio 43223	Pit.....	Franklin.
The Middletown Sand and Gravel Co.	2100 South Main St. Middletown, Ohio 45042	3 pits.....	Butler.
Moraine Materials Co.....	2500 East River Road Dayton, Ohio 45409	2 pits.....	Montgomery.
Morrow Gravel Company.....	3535 Round Bottom Road Cincinnati, Ohio 45244	Pit.....	Warren.
Ohio Gravel Co., Div. of Dravo Corp.	5253 Wooster Road Cincinnati, Ohio 45226	7 pits.....	Butler, Hamilton, and Warren.
Pennsylvania Glass Sand Corp.....	General Operations Dept. Berkeley Springs, W. Va. 25411	3 pits.....	Portage, Tuscarawas.
R. W. Sidley, Inc.....	R.F.D. 1 Thompson, Ohio 44086	2 pits.....	Geauga.
Edgar Spring, Inc.....	Box 507 New Philadelphia, Ohio 44663	6 pits.....	Columbiana, Holmes, and Tuscarawas.
The Standard Slag Co.....	1200 Stambaugh Bldg. Youngstown, Ohio 44501	3 pits.....	Pike, Scioto.
Stocker Sand and Gravel Co.....	Gnadenhütten, Ohio 44629	2 pits.....	Tuscarawas.
Tri-State Materials Corp.....	Box 1933 Parkersburg, W. Va. 26100	Pit.....	Meigs.
<b>Smelters:</b>			
Aluminum: Ormet Corp.....		Plant.....	Monroe.
Titanium sponge: Reactive Metals, Inc.		do.....	Ashtabula.
Zinc: American Zinc Company.....		do.....	Franklin.
<b>Stone:</b>			
<b>Dolomite (crushed and broken):</b>			
Basic Incorporated.....	845 Hanna Bldg. Cleveland, Ohio 44115	Quarry.....	Seneca.
Davon, Inc.....	Box 5765 Columbus, Ohio 43221	2 quarries.....	Adams.
Kellstone, Inc.....	Kellys Island Ohio 43438	Quarry.....	Erie.
The Melvin Stone Co.....	R.R. 4 Wilmington, Ohio 45177	do.....	Clinton.
Ohio Lime Co.....	Woodville, Ohio 43469	do.....	Sandusky.
Standard Lime & Refractories Co., Div. Martin-Marietta Corp.	2000 First National Bank Bldg. Baltimore, Md. 21203	do.....	Do.
White Rock Quarry.....	Clay Center Ohio 43408	do.....	Ottawa.
Dolomite (dimension): E. R. Lintner Co.	Route 3, Flat Rock Rd. Bellevue, Ohio 44811	do.....	Seneca.
<b>Limestone (crushed and broken):</b>			
American Aggregates Corp.....	Garst Avenue at Avenue B Greenville, Ohio 45331	4 quarries.....	Montgomery.
Armco Steel Corp.....	P.O. Box 911 Piqua, Ohio 45356	Quarry.....	Miami.
Bessemer Cement Co., Subsidiary of Louisville Cement Co. <sup>3</sup>	510 Hanna Bldg. Cleveland, Ohio 44115	do.....	Mahoning.
Carbon Limestone Co.....	Lowellville, Ohio 44436	do.....	Do.
Cedarville Limestone Co.....	Box 4 Cedarville, Ohio 45314	do.....	Greene.
The France Stone Co.....	1800 Toledo Trust Bldg. Toledo, Ohio 43604	4 quarries.....	Lucas, Sandusky, Seneca, and Wood.
Industrial Stone, Inc.....	R.D. 3 McConnelsville, Ohio 43756	Quarry.....	Morgan.
Marble Cliff Quarries Co.....	2100 Tremont Center Columbus, Ohio 43221	3 quarries.....	Delaware, Franklin, and Preble.
Maumee Stone Co.....	P.O. Box 369 Maumee, Ohio 43537	4 quarries.....	Lucas, Paulding, and Wood.

See footnotes at end of table.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
National Lime & Stone Co. ....	First National Bank Bldg. Findlay, Ohio 45840	8 quarries .....	Allen, Auglaize, Crawford, Delaware, Hancock, Marion, Putnam, and Wyandot.
Sandusky Crushed Stone Co., Inc.	P.O. Box 527 Sandusky, Ohio 44870	Quarry .....	Erie.
Standard Slag Co. ....	1200 Stambaugh Bldg. Youngstown, Ohio 44501	2 quarries .....	Mahoning, Ottawa.
Toledo Stone & Glass Sand Co.	1800 Toledo Trust Bldg. Toledo, Ohio 43604	Quarry .....	Lucas.
Wagner Quarries Co. ....	East Market St. Sandusky, Ohio 44870	...do.....	Erie.
Woodville Lime & Chemical Co.	Box 218 Woodville, Ohio 43469	...do.....	Sandusky.
Wyandot Dolomite, Inc. ....	Carey, Ohio 43316 .....	...do.....	Wyandot.
Limestone (dimension):			
Armco Steel Corp. ....	P.O. Box 911 Piqua, Ohio 45365	...do.....	Miami.
Bluffton Stone Co. ....	Bluffton, Ohio 45817 .....	...do.....	Allen.
Gregory Stone Co., Inc.	1860 No. Gettysburg St. Ludlow Falls, Ohio 45339	...do.....	Miami.
Quartzite (crushed):			
Cambria Clay Products Co.	Black Fork, Ohio 45615 .....	...do.....	Pike.
A. P. Green Refractories Co., Durex Division.	P.O. Box 255 Oak Hill, Ohio 45656	3 quarries .....	Do.
Sharon Silica Co. ....	Rte. 2 Jackson, Ohio 45640	Quarry .....	Do.
R. W. Sidley, Inc. ....	R.F.D. 1 Thompson, Ohio 44086	...do.....	Geauga.
Sandstone (crushed and broken):			
Cannon Sand & Rock Co., Inc.	Box 65 Twinsburg, Ohio	...do.....	Summit.
Walter C. Best, Inc. ....	Box 37 Chardon, Ohio 44024	...do.....	Geauga.
PPG Industries, Inc. ....	P.O. Box 31 Barberton, Ohio 44203	...do.....	Summit.
Sperry Road Sand & Gravel Co., Inc.	R.D. 4, Hobart Rd. Willoughby, Ohio 44094	...do.....	Lake.
Sandstone (dimension):			
Briar Hill Stone Co. ....	Glenmont, Ohio 44628 .....	10 quarries .....	Coshocton, Holmes, and Knox.
Cleveland Quarries Co. <sup>15</sup> .....	Amherst, Ohio 44001 .....	7 quarries .....	Erie, Lorain, Tuscarawas.
Stutzman Stone Co. ....	R.D. #1 Dover, Ohio 44622	Quarry .....	
The Taylor Stone Co. ....	McDermott, Ohio 45652 .....	...do.....	Scioto.
The Waller Brothers Stone Co.	.....	3 quarries .....	Do.

<sup>1</sup> Also cement rock.    <sup>2</sup> Also shale and limestone.    <sup>3</sup> Also clay, shale, and limestone.    <sup>4</sup> Also clay and limestone.    <sup>5</sup> Also clay and cement rock.    <sup>6</sup> Also sand, shale, and limestone.    <sup>7</sup> Also limestone.    <sup>8</sup> Also shale.    <sup>9</sup> One operation in two counties.    <sup>10</sup> Also calcined.    <sup>11</sup> Also exfoliated vermiculite.    <sup>12</sup> Also byproduct sulfur.    <sup>13</sup> Also evaporated salt.    <sup>14</sup> Also brine.    <sup>15</sup> Also grindstones and crushed and broken sandstone.



# The Mineral Industry of Oklahoma

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

By L. G. Southard,<sup>1</sup> K. S. Johnson,<sup>2</sup> and J. F. Roberts<sup>2</sup>

The value of minerals produced in 1970 was \$1,137 million, a net gain of 4.3 percent over 1969. Gains in value were made in all of the mineral fuels (excluding helium), which collectively supplied 94.0 percent of the total value of minerals produced. High-purity helium and nonmetallic minerals had lower values than in 1969. An aggregate gain of 5.0 percent in value was reported in the output of mineral fuels with increases in all commodities. Value of coal production in-

creased 42.7 percent. The total value of helium was 19.1 percent less than in 1969. A general decline in production and value of nonmetals reduced their total value to 5.0 percent of the State's gross mineral value. The value of metals recorded a net gain of 24.1 percent above the value in 1969.

<sup>1</sup> Mineral specialist, Bureau of Mines.

<sup>2</sup> Geologist, Oklahoma Geological Survey, Norman, Oklahoma.

Table 1.—Mineral production in Oklahoma<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays <sup>2</sup> ..... thousand short tons..	802	\$1,182	769	\$1,120
Coal (bituminous)..... do.....	1,838	10,662	2,427	15,211
Gypsum..... do.....	980	3,912	874	2,616
Helium:				
High-purity..... million cubic feet..	221	7,717	149	5,214
Crude..... do.....	133	1,123	245	1,935
Lead (recoverable content of ores, etc.)..... short tons..	605	180	797	249
Natural gas..... million cubic feet..	1,523,715	233,128	1,594,943	248,811
Natural gas liquids and cycle products				
LP gases..... thousand 42-gallon barrels..	14,621	38,931	14,813	39,933
Petroleum (crude)..... do.....	27,304	34,403	23,029	52,975
Salt..... do.....	224,729	701,155	223,574	712,419
Sand and gravel..... thousand short tons..	9	51	13	78
Stone..... do.....	5,262	7,156	5,675	7,258
Zinc (recoverable content of ores, etc.)..... short tons..	13,799	23,650	18,177	23,701
Value of items that cannot be disclosed: Bentonite, cement, copper, lime, silver, tripoli, and volcanic ash..... do.....	2,744	801	2,650	812
	XX	26,758	XX	24,935
Total.....	XX	1,090,809	XX	1,137,267
Total 1967 constant dollars.....	XX	1,030,051	XX	1,029,227

<sup>1</sup> Preliminary. <sup>2</sup> Revised. 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; included with "Value of items that cannot be disclosed."



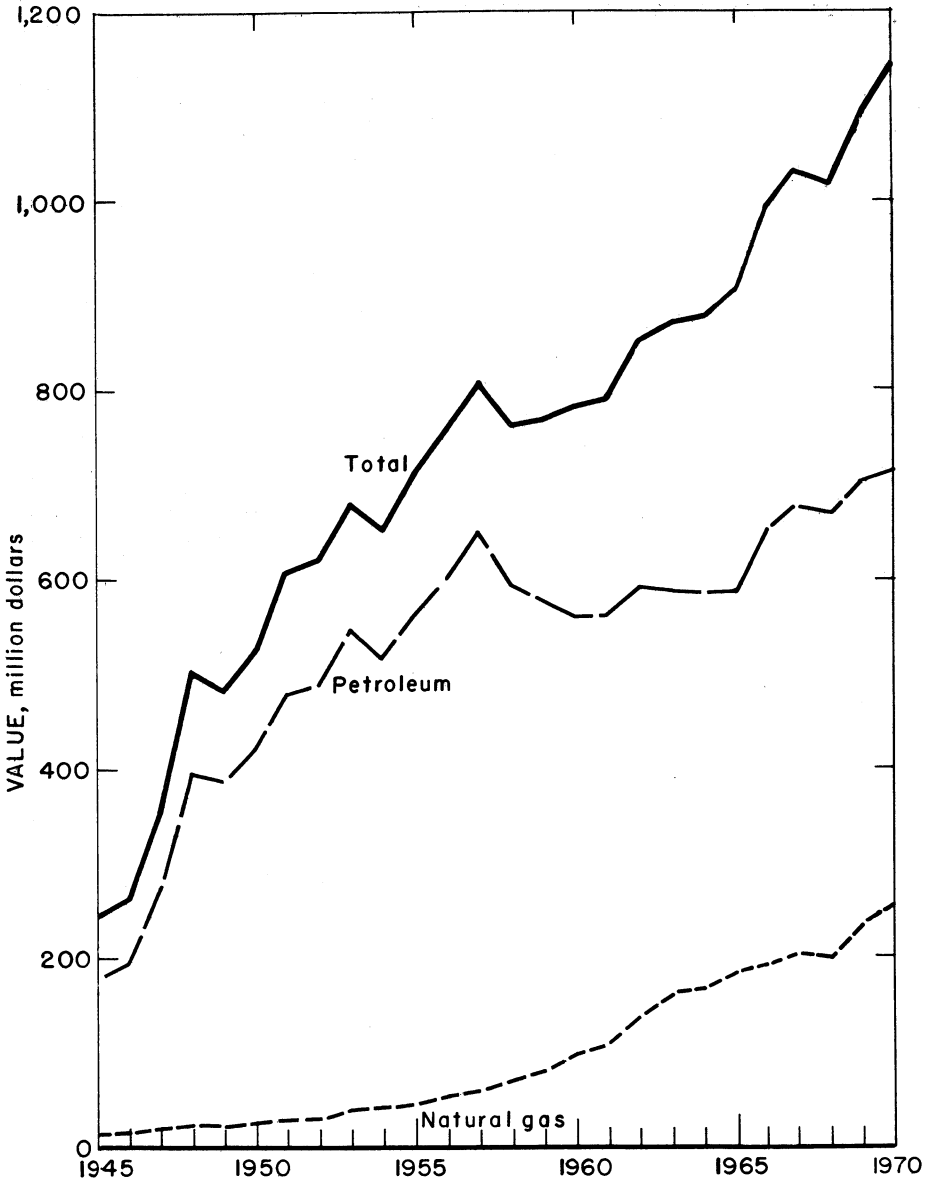


Figure 1.—Value of natural gas, petroleum, and total value of mineral production in Oklahoma.

Table 2.—Value of mineral production in Oklahoma, by counties <sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Alfalfa	\$7,391	\$6,908	Petroleum, natural gas, natural gas liquids, sand and gravel.
Atoka	W	W	Stone, petroleum, natural gas.
Beaver	57,697	57,440	Natural gas, petroleum, natural gas liquids, volcanic ash.
Beckham	7,677	8,425	Natural gas, natural gas liquids, petroleum.
Blaine	15,260	20,745	Natural gas, petroleum, gypsum, natural gas liquids.
Bryan	2,522	2,370	Petroleum, natural gas, stone, sand and gravel.
Caddo	22,356	22,116	Petroleum, natural gas, stone, gypsum, natural gas liquids.
Canadian	5,389	5,435	Natural gas, petroleum, sand and gravel, clays, gypsum.
Carter	66,645	74,577	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Cherokee	W	W	Stone.
Choctaw	546	W	Do.
Cimarron	16,473	17,034	Helium, natural gas, petroleum, natural gas liquids, stone.
Cleveland	17,515	16,378	Petroleum, natural gas liquids, natural gas, stone.
Coal	2,426	2,790	Natural gas, petroleum, stone, sand and gravel.
Comanche	3,271	W	Stone, petroleum, gypsum, natural gas, sand and gravel.
Cotton	3,580	W	Petroleum, sand and gravel.
Craig	W	W	Coal, petroleum, natural gas.
Creek	37,582	35,550	Petroleum, natural gas liquids, stone, natural gas, clays, sand and gravel.
Custer	8,065	5,744	Natural gas, petroleum, clays.
Dewey	26,845	24,429	Petroleum, natural gas, natural gas liquids, clays.
Ellis	11,202	9,390	Natural gas, petroleum.
Garfield	40,372	32,935	Petroleum, natural gas, natural gas liquids, sand and gravel.
Garvin	72,049	71,187	Petroleum, natural gas liquids, natural gas, sand and gravel.
Grady	21,125	22,512	Petroleum, natural gas, natural gas liquids, sand and gravel, stone.
Grant	6,786	5,723	Petroleum, natural gas, natural gas liquids.
Greer	499	436	Stone, petroleum, clays, natural gas.
Harmon	20	W	Salt.
Harper	22,292	23,608	Natural gas, natural gas liquids, petroleum, sand and gravel.
Haskell	10,637	W	Natural gas, coal.
Hughes	5,660	6,395	Petroleum, natural gas, sand and gravel, stone.
Jackson	3,099	3,566	Copper, petroleum, gypsum, silver, sand and gravel, zinc.
Jefferson	2,712	2,426	Petroleum, natural gas, sand and gravel, stone.
Johnston	W	W	Sand and gravel, stone.
Kay	16,399	15,921	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kingfisher	59,386	62,205	Petroleum, natural gas liquids, natural gas, sand and gravel.
Kiowa	2,000	1,910	Stone, petroleum, sand and gravel, natural gas.
Latimer	17,013	24,660	Natural gas, petroleum.
Le Flore	6,309	10,591	Natural gas, coal, stone, clays.
Lincoln	11,420	10,110	Petroleum, natural gas, natural gas liquids.
Logan	8,680	7,401	Petroleum, natural gas, natural gas liquids, sand and gravel.
Love	7,758	8,027	Petroleum, natural gas, natural gas liquids.
McCain	25,711	23,761	Petroleum, natural gas, natural gas liquids, sand and gravel.
McCurtain	104	W	Stone, sand and gravel.
McIntosh	236	W	Natural gas, stone.
Major	27,215	28,432	Petroleum, natural gas, natural gas liquids, sand and gravel.
Marshall	6,599	6,808	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Mayes	W	W	Cement, stone, clays, petroleum.
Murray	5,176	6,982	Petroleum, stone, sand and gravel, natural gas.
Muskogee	2,323	1,828	Petroleum, sand and gravel, stone, coal, natural gas.
Noble	6,463	6,083	Petroleum, natural gas, natural gas liquids.
Nowata	2,345	2,238	Petroleum, stone, natural gas.

See footnotes at end of table.

Table 2.—Value of mineral production in Oklahoma, by counties 1—Continued  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Okfuskee.....	\$5,310	\$4,558	Petroleum, natural gas, natural gas liquids.
Oklahoma.....	19,930	20,462	Petroleum, natural gas, natural gas liquids, sand and gravel, clays, stone.
Okmulgee.....	3,958	3,831	Petroleum, stone, natural gas.
Osage.....	50,027	45,766	Do.
Ottawa.....	2,334	2,321	Stone, zinc, tripoli, lead.
Pawnee.....	5,360	5,149	Petroleum, sand and gravel, natural gas, stone.
Payne.....	7,548	7,781	Petroleum, natural gas, sand and gravel, stone.
Pittsburg.....	4,464	8,664	Natural gas, stone, clays, sand and gravel.
Pontotoc.....	22,334	21,198	Petroleum, cement, stone, sand and gravel, clays, natural gas, natural gas liquids.
Pottawatomie.....	10,114	9,905	Petroleum, natural gas, sand and gravel, stone.
Pushmataha.....	38	--	
Roger Mills.....	3,519	3,089	Natural gas, petroleum.
Rogers.....	15,529	16,521	Cement, coal, petroleum, stone, clays, natural gas.
Seminole.....	28,366	31,214	Petroleum, natural gas liquids, stone, sand and gravel, natural gas, clays.
Sequoyah.....	W	W	Lime, stone, natural gas, sand and gravel.
Stephens.....	82,349	98,530	Petroleum, natural gas liquids, natural gas.
Texas.....	70,520	89,064	Natural gas, petroleum, natural gas liquids, sand and gravel.
Tillman.....	923	918	Petroleum.
Tulsa.....	9,417	8,620	Petroleum, stone, sand and gravel, clays, natural gas.
Wagoner.....	465	347	Petroleum.
Washington.....	4,560	4,149	Petroleum, stone, natural gas.
Washita.....	662	630	Natural gas, petroleum.
Woods.....	12,409	12,301	Natural gas, petroleum, salt, sand and gravel.
Woodward.....	10,813	10,837	Natural gas, petroleum, natural gas liquids, sand and gravel.
Undistributed <sup>2</sup> .....	17,031	36,294	
Total <sup>3</sup> .....	1,090,809	1,137,267	

<sup>1</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

<sup>2</sup> Adair and Delaware Counties are not listed because no production was reported.

<sup>3</sup> Includes some stone and sand and gravel that cannot be assigned to specific counties and values indicated by symbol W.

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

Table 3.—Indicators of Oklahoma business activity

	1969	1970	Change, percent
Employment and labor force, annual average:			
Total labor force.....	thousands... 1,024.1	1,049.2	+2.5
Unemployment.....	do... 34.1	45.3	+32.8
Employment:			
Construction.....	do... 36.7	37.5	+2.2
Manufacturing.....	do... 129.9	134.8	+3.8
Mining.....	do... 40.7	39.0	-4.2
Other <sup>1</sup> .....	do... 547.9	559.4	+2.1
Personal income:			
Total.....	millions... \$7,825	\$8,385	+7.2
Per capita.....	do... \$3,087	\$3,269	+5.9
Construction activity:			
Building permits, total private nonresidential.....	millions... \$139.6	\$171.1	+22.6
State highway commission contracts awarded.....	do... \$79.7	\$64.3	-19.3
Cement shipments to and within Oklahoma.....	thousand 376-pound barrels... 7,282.1	6,573.0	-9.7
Farm marketing receipts.....	millions... \$939.3	\$947.7	+0.9
Mineral production.....	do... \$1,090.8	\$1,137.3	+4.3

<sup>1</sup> Includes services; wholesale and retail trade; finance, insurance, and real estate; transportation and public utilities; and government.

Sources: Employment and Earnings and Monthly Report on the Labor Force, Survey of Current Business, Area Trends in Employment and Unemployment, Farm Income Situation, Construction Review, Roads and Streets Magazine, and U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non-fatal	Frequency	Severity
<b>1969:</b>								
Coal.....	349	264	92	715	3	26	40.53	27,045
Metal.....	222	277	61	492	—	15	30.47	886
Nonmetal.....	520	244	127	1,007	1	46	46.69	6,750
Sand and gravel.....	296	258	76	657	—	19	28.93	621
Stone.....	1,354	270	366	3,054	—	74	24.23	790
Total <sup>1</sup> .....	2,741	264	723	5,926	4	180	31.05	4,962
<b>1970:<sup>2</sup></b>								
Coal.....	425	260	110	857	2	39	47.84	16,368
Metal.....	195	278	54	429	—	21	48.95	1,867
Nonmetal.....	540	253	137	1,076	1	34	32.52	7,311
Sand and gravel.....	310	259	80	679	—	17	25.05	1,048
Stone.....	1,375	264	364	3,009	—	88	29.25	735
Total <sup>1</sup> .....	2,845	262	745	6,050	3	199	33.39	4,235

<sup>2</sup> Preliminary.<sup>1</sup> Data may not add to totals shown because of independent rounding.

**Employment and Wages.**—The Oklahoma Employment Security Commission reported 39,000 persons employed in the mineral industry compared with 40,700 (revised) in 1969; the loss in employment was in the petroleum industry, which accounted for 94 percent of the State's mineral industry employment. Employment in mining other than petroleum and natural gas increased from the previous year.

**Legislation and Government Programs.**—Construction of the navigational facilities for the McClellan-Kerr Arkansas-Verdigris Navigation System was completed by the end of the year. Only installation of some electric generating equipment, bank stabilization, removal of abandoned railroad bridges, and preparation of recreation areas were incomplete. Installation of a concrete pier, a storage warehouse, a railroad spur, service roads, and sewer and water lines at Muskogee at a cost of \$4 million qualified the city for designation as Oklahoma's first port city.<sup>3</sup>

All oil wells within the limits of the Oologah Reservoir that had a potential to pollute the water in the reservoir were plugged. The Corps of Engineers continued constructing Hugo Dam on the Kiamichi River in Choctaw County and Kaw Dam and Reservoir in Kay County.

The State Legislature passed a law in 1970 that required the posting of a \$2,500 bond per well, or a blanket bond of \$10,000, by all operators to assure plugging of abandoned oil and gas wells.

House Bill 1626 was passed by the State Legislature and signed by the Governor in March, making Oklahoma a member of the Interstate Mining Compact. Oklahoma's entry provided the fourth State necessary to make the compact effective.

A new function of the Federal Bureau of Mines, that of Liaison Officer, was established, with an office opened in Oklahoma City early in 1971.

**Pollution and Environment.**—Construction of an air pollution control system by Armco Steel Corp. at their Sand Springs plant was begun in February. Delays in installing equipment to cool and filter gases from two 75-ton electric furnaces postponed completion until early 1971.

A system for controlling dust from the Delta Mining Corp. plant for crushing dolomitic limestone at Troy in Johnston County was about 90 percent completed by yearend. The company anticipated selling bagged dust as a soil conditioner.

The Oklahoma Clean Air Act of 1967 was strengthened when regulations proposed by the Oklahoma Air Pollution Council were approved by the State Board of Health. Included were the following Regulations: No. 3 Defining Terms Used in Oklahoma Air Pollution Regulations; No. 4 Pertaining to the Registration of Air Contaminant Sources; No. 5 Pertaining to the Type, Operation and Maintenance of Incinerators and Defining Acceptable Emissions Emitting Therefrom; and No. 6 Per-

<sup>3</sup> Oklahoma Today, Winter 70-71.

taining to the Control of the Emission of Particulate Matter From Fuel-Burning Equipment.

The State Legislature provided for systematic statewide regulation of solid waste disposal by passing the Oklahoma Solid Waste Management Act of 1970. Basically the act created an advisory committee, delegated authority to municipal and county governments to singly or in concert establish systems and enforce regulations for waste disposal, defined the administrative, coordinating, and investigative role of the State Department of Health, and established the power of injunction for restraint of violations and penalties for violations.

The State Deputy Commissioner for Environmental Services reported that all radiation levels in air filters and water samples taken during 1970 were below the maximum permissible level.

The Bureau of Mines Bartlesville Energy Research Center continued fuels combustion research to identify the constituents of combustion products and to develop tests, procedures, and methods of measurements to meet unique requirements of fuels, engines, and other power systems. Research studies on the types of sulfur compounds in petroleum and petroleum fuels were performed to provide information needed to develop processes for sulfur removal. Engineering investigations were conducted to assess oil and gas recovery by increasing permeability in very tight oil and gas reservoirs and oil shale and to evaluate fracture systems. Basic production research continued to determine the composition and physical properties of oilfield brines and their solubility relationships for purposes of detecting, tracing, preventing, and abating water pollution.

## REVIEW BY MINERAL COMMODITIES

### MINERAL FUELS

The amount of crude oil produced decreased, but the output of both natural gas and coal increased from that in 1969. Reduction in drilling activity and in reserves followed the general trend of the national industry. Four firms were active in planning or constructing significant pipeline facilities, and four petroleum refineries underwent noteworthy modernization and enlargement. A petrochemical plant was being constructed in Oklahoma City. Production of oil, natural gas, or both was recorded in all counties except Adair, Cherokee, Choctaw, Delaware, Harmon, Johnston, McCurtain, Ottawa, and Pushmataha.

Wells drilled in search of oil and gas in Oklahoma in 1970 were 13.7 percent fewer than in 1969, according to American Petroleum Institute (API) statistics. In completing 2,685 wells, drills penetrated a total of 13,996,891 feet, which was 13.3 percent less than in 1969. Average drilled footage per well was 5,213 feet in 1970 compared with an average of 5,187 in 1969. Completions included 1,343 oil wells, 321 gas wells, and 1,021 dry holes. A success ratio of 22.3 percent was achieved in drilling 458 exploratory wells, of which 59 were oil discoveries, 43 were gas discoveries, and 356 were dry holes.

Kingfisher County accounted for the most wells drilled, 241; Osage County, 209; Beaver, 137; Major, 135; and Seminole, 114. The major area of development and exploration was on the north flank of the Anadarko Basin in western Oklahoma, extending the development of, and exploring for deeper reservoirs in, lower Pennsylvanian sands and the dolomites in the Silurian-Devonian Hunton. At yearend Beckham County had three ultradeep wells drilling: one was projected for 28,000 feet, which would make it the deepest well drilled in the world to date; the others were projected for 26,000 feet and 24,500 feet. A major exploration and development program was in progress at yearend in western Grady County, extending into Caddo County, with 17 active drilling operations.

**Carbon Black.**—The quantity and value of furnace carbon black produced from liquid hydrocarbons by Continental Oil Co. at its Ponca City plant in Kay County decreased during 1970. Carbon black is used by the rubber industry in the manufacture of tires, shoe soles and heels, gaskets, conveyor belts, and other products.

**Coal.**—Bituminous coal was produced in Oklahoma by 10 companies. Nearly 90 percent of the coal was taken from surface mines, and the remainder was from underground mines.

Coal output in 1970 increased about 32 percent in quantity and about 43 percent in value above the 1969 figures. The 1970 production of 2,427,000 tons was the highest in 20 years and represented the third straight year of sharp increases from an alltime low of 823,000 tons mined in 1967.

About three-fourths of the coal was used in electric power generation and the remainder was metallurgical coking coal for export.

Development work continued in 1970 on the underground mines of Kerr-McGee Corp. in Haskell County and Howe Coal Co. in Le Flore County. Production reported by both companies increased from 1969 output. Kerr-McGee achieved production increases despite a labor dispute and 5-month strike.

Training of miners is carried out in Kerr-McGee's new teaching facility. Underground mining situations are reproduced so that trainees can become familiar with actual conditions and potential hazards. Mine rescue teams and two mine rescue trucks went into service in 1970. Rescue teams are trained and prepared for work in case of underground accidents, but also will give assistance in other types of disaster. Howe Coal Co. completed a building for training and practice of rescue techniques.

**Helium.**—The Bureau of Mines extracted helium from natural gas at its Keyes, Okla., plant. Total output was 394 million cubic feet in 1970 compared with 354 million cubic feet in 1969. A decrease in the production of high-purity helium from 221 million cubic feet in 1969 to 149 million cubic feet in 1970 caused a correlative decrease in total value from \$8.8 million in 1969 to \$7.1 million in 1970. Crude helium output increased to 245 million cubic feet in 1970 compared with 133 million cubic feet in 1969. Value of crude helium increased from \$1.1 million in 1969 to \$1.9 million in 1970.

**Natural Gas.**—Production of 1,594,943 million cubic feet of natural gas ranked Oklahoma third among the gas-producing States. Gas was obtained from 8,557 wells in 63 counties. Texas County of the Oklahoma Panhandle supplied a total 247,659 million cubic feet, followed by Beaver County with 150,524 million cubic feet. Latimer County with production of 143,208

million cubic feet of gas and Harper County with 98,220 million cubic feet ranked third and fourth in the State.

Natural gas reserves were estimated to be 16,954 billion cubic feet by the American Gas Association (AGA) on December 31, 1970, a decrease of 639 billion cubic feet from the previous year. There were slight increases in discoveries and extensions but these were offset by a larger increase in production. Based on 1970 production estimates by the AGA, Oklahoma has a 9.7-year supply of natural gas.

**Natural Gas Liquids.**—Oklahoma's production of natural gas liquids was 42,842,000 barrels in 1970, an increase of 917,000 barrels from the previous year. The value of the natural gas liquids increased 26.7 percent from the value in 1969. The State ranks third in the production of natural gas liquids.

Reserves of natural gas liquids were estimated by the AGA to be 358.6 million barrels, a decrease of 107.1 million barrels from the previous year.

**Petrochemicals.**—Conoco Plastics, Inc. (Continental Oil Co.) was constructing a \$6 million plant in Oklahoma City to use vinyl chloride monomer as feedstock for preparation of polyvinyl chloride at the rate of 50 million pounds per year. Completion was expected by mid-1971.

**Petroleum.**—Oklahoma production of crude oil was 223.6 million barrels in 1970, which was about 0.5 percent less than in 1969. Stephens County led the State's 63 oil producing counties with a year's total of 26.4 million barrels. Successively Carter and Garvin Counties had productions of 20.8 million and 18.9 million barrels in 1970.

Oklahoma ranked fourth among the States in production of crude oil. Production of oil was obtained from 78,212 wells compared with 80,947 wells in 1969. Daily average production from all producing wells was 7.8 barrels compared with 7.6 barrels in 1969.

During 1970 Oklahoma's crude oil production failed to meet the market demand. Increases of the production allowable, which is based on a depth-acreage factor, to 125 percent in May and 150 percent in December failed to stimulate the necessary production.

Oklahoma's crude oil reserves were estimated by the American Petroleum Institute (API) to be 1,351,353,000 barrels at yearend, a decrease of 38,630,000 barrels from 1969. In terms of API estimated 1970 production this is a 6.4-year supply.

According to the National Stripper Well Association as of January 1, 1970, Oklahoma had 57,429 stripper wells which average 4.15 barrels per day and could produce 86,991,000 barrels for the year. Stripper wells in Oklahoma account for about 39 percent of the State's total crude oil production.

Bell Oil and Gas Co. was spending \$3 million on modernization and improvements at its Ardmore, Okla., refinery. The crude unit will be expanded to increase plant capacity to 30,000 barrels per day of crude. A platformer is being added to improve motor fuel octane quality to meet proposed Federal and State regulations on no-lead and low-lead gasoline. The platformer as licensed by Universal Oil Products Co. has a designated capacity of 6,500 barrels per day. Pollution abatement equipment was added to the refinery in 1970.

Continental Oil Co. in Ponca City was expanding the refinery from 78,000 barrels daily to 88,000 barrels daily at a cost of \$1.5 million.

The Okmulgee Refining Co. of Okmulgee, Okla., was adding a 2,000-barrel-per-day alkylation unit, and Champlin Petro-

leum Co. contracted to add a 2,000-barrel-per-day alkylation unit to its Enid refinery.

*Pipeline.*—The Cities Service Gas Co., Oklahoma City, received the approval of the Federal Power Commission (FPC) to build a 184-mile 26-inch, gas pipeline from Hemphill County, Tex., to Kay County, Okla.

Oklahoma Natural Gas Co. put its western Oklahoma line into service. The line extends 45 miles from south of the Niles community in Canadian County to a point a few miles west of Norman and links the Oklahoma Natural Gas system with potential gas reserves in the Anadarko Basin.

Transok Pipe Line Co., Inc., planned 1970 completion of its 144-mile line, constructed between Ames in Major County and Oologah, north of Tulsa, to provide the northeastern Oklahoma market with gas produced in Major County. Initial deliveries over the line are expected to be about 35 million cubic feet per day.

Arkansas Louisiana Gas Company applied to the FPC for permission to construct 298 miles of gas line from Wilburton, Okla. (Latimer County) to Hemphill County, Tex. The line would transmit gas from the Anadarko Basin to company lines in eastern Oklahoma and Arkansas. Estimated construction cost of the line, including 156 miles of 30-inch and 142 miles of 24-inch pipe, was \$66.6 million. Pipeline companies established in the area opposed the proposal.

Table 5.—Oklahoma: Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

	Proved reserves Dec. 31, 1969	Changes in proved reserves due to revisions, extensions, new discoveries, and production in 1970	Proved reserves Dec. 31, 1970 (production deducted)	Change from 1969 (percent)
Crude oil..... thousand 42-gallon barrels..	1,389,983	-38,630	1,351,353	-2.8
Natural gas liquids <sup>1</sup> ..... do.....	465,694	-107,091	358,603	-23.0
Natural gas..... million cubic feet..	17,593,197	-638,930	16,954,267	-3.6

<sup>1</sup> Includes condensate, natural gasoline, and LP gases.

Source: American Gas Association and American Petroleum Institute.

**Table 6.—Oklahoma: Crude petroleum production, indicated demand, and stocks, in 1970 by months**

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Oklahoma
January .....	18,443	19,571	17,176
February .....	17,309	17,156	17,329
March .....	18,940	19,383	16,886
April .....	18,654	17,363	18,177
May .....	19,447	19,611	18,013
June .....	18,641	17,724	18,930
July .....	19,204	19,445	18,689
August .....	18,618	19,748	17,559
September .....	18,293	19,594	16,258
October .....	18,908	18,361	16,805
November .....	18,080	17,455	17,430
December .....	19,037	18,878	17,589
<b>Total:</b>			
1970 .....	223,574	224,289	XX
1969 .....	224,729	224,997	XX

XX Not applicable.



Table 7.—Oklahoma: Oil and gas well drilling completions, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
Alfalfa.....	19	4	3	1	--	6	33	215,212
Atoka.....	3	--	--	--	--	1	4	9,795
Beaver.....	73	28	29	1	--	6	137	897,296
Beckham.....	--	1	3	--	1	4	9	71,241
Blaine.....	5	17	13	1	1	1	38	360,151
Bryan.....	1	--	--	--	--	1	2	15,832
Caddo.....	14	3	2	5	--	18	42	184,193
Canadian.....	5	11	7	--	2	1	26	269,478
Carter.....	61	2	17	3	--	5	88	307,790
Cimarron.....	31	5	7	2	--	5	50	195,608
Cleveland.....	4	3	6	1	1	9	24	180,508
Coal.....	--	--	--	--	1	6	7	44,835
Comanche.....	14	--	--	--	--	1	24	47,572
Cotton.....	2	--	5	--	--	3	10	21,362
Craig.....	--	--	--	--	--	3	8	1,516
Creek.....	44	--	16	2	--	5	67	170,985
Custer.....	--	1	1	--	--	3	5	83,141
Delaware.....	1	--	--	--	--	--	1	1,878
Dewey.....	15	5	13	4	3	--	46	494,096
Ellis.....	3	16	13	--	1	6	39	355,309
Garfield.....	18	19	12	--	1	7	57	336,239
Garvin.....	21	4	17	5	1	15	63	278,842
Grady.....	19	1	9	3	1	8	41	427,088
Grant.....	10	1	2	--	1	2	16	89,721
Greer.....	1	1	2	--	--	5	9	11,295
Harper.....	2	15	13	--	2	4	36	237,832
Haskell.....	--	2	7	--	1	3	13	86,789
Hughes.....	33	9	16	1	--	2	61	163,251
Jackson.....	--	--	--	--	--	4	4	23,234
Jefferson.....	2	--	1	--	--	21	24	49,077
Kay.....	17	1	22	1	--	10	51	184,727
Kingfisher.....	207	1	13	10	4	6	241	1,948,279
Kiowa.....	20	--	21	--	--	4	45	33,212
Latimer.....	--	8	3	--	--	--	11	76,153
Le Flore.....	--	8	9	--	--	--	17	118,008
Lincoln.....	15	--	9	--	--	12	36	139,902
Logan.....	11	1	14	--	--	10	36	194,365
Love.....	16	--	13	1	--	7	37	277,798
McCain.....	6	1	12	2	--	8	29	266,519
McClain.....	--	--	--	--	--	1	1	2,845
McIntosh.....	--	4	--	--	1	--	5	16,229
Major.....	72	22	29	3	5	4	135	1,080,759
Marshall.....	--	1	4	--	--	4	9	51,600
Murray.....	10	--	4	--	--	7	21	58,240
Muskogee.....	3	--	3	--	--	--	6	12,798
Noble.....	7	--	6	2	--	16	31	120,159
Nowata.....	7	1	4	--	--	2	14	10,979
Okfuskee.....	10	1	9	1	1	4	26	94,852
Oklahoma.....	6	--	2	--	2	3	13	74,582
Okmulgee.....	30	1	22	1	--	--	54	91,347
Osage.....	137	5	58	1	--	8	209	428,236
Pawnee.....	13	--	7	--	--	4	24	72,386
Payne.....	16	1	13	--	--	6	36	107,133
Pittsburg.....	--	17	5	--	--	7	29	225,830
Pontotoc.....	20	--	9	2	--	3	34	73,405
Pottawatomie.....	23	--	14	1	--	5	43	188,369
Roger Mills.....	9	3	2	--	--	2	16	145,159
Rogers.....	5	--	1	--	--	2	8	3,604
Seminole.....	65	2	39	1	--	7	114	430,700
Sequoyah.....	--	2	3	--	--	1	6	35,867
Stephens.....	48	4	16	--	1	9	78	295,214
Texas.....	32	13	25	2	--	11	85	491,557
Tillman.....	30	--	1	--	--	--	31	91,802
Tulsa.....	18	1	5	1	--	1	26	44,671
Wagoner.....	11	--	11	--	--	1	23	24,114
Washington.....	12	--	2	--	--	--	14	16,843
Washita.....	--	--	--	--	1	1	2	23,067
Woods.....	6	12	18	1	3	13	53	323,814
Woodward.....	1	20	14	--	6	16	57	490,601
Total.....	1,284	278	665	59	43	356	2,685	13,996,891

Source: American Petroleum Institute.

**Table 8.—Oklahoma: Crude petroleum production, by fields**  
(Thousand 42-gallon barrels)

Field <sup>1</sup>	1969	1970	Cumulative to Dec. 31, 1970
Allen	3,260	3,013	115,878
Bowlegs	1,116	1,976	151,614
Burbank	6,550	6,067	486,765
Cement	2,536	2,500	131,518
Cushing	5,095	4,757	449,619
Edmond, West	922	812	152,363
Eola-Robberson	5,019	4,881	90,475
Fitts	1,334	1,240	142,987
Glenn Pool	3,106	2,714	300,934
Golden Trend	11,661	12,770	359,955
Headton	3,861	4,070	269,301
Hewitt	3,332	4,256	195,698
Oklahoma City	1,892	1,799	725,409
Seminole Greater	1,296	1,391	194,339
Sho-Vel-Tum	33,483	23,425	864,586
Sooner Trend	17,244	17,624	135,539
St. Louis	1,674	1,567	211,234
Other fields	121,348	128,712	NA
Total	224,729	223,574	NA

NA Not available.

<sup>1</sup> Based on Oil & Gas Journal data adjusted to Bureau of Mines total.

**Table 9.—Oklahoma: Petrochemical plants operating in 1970**

Company	Location		Plant feed	Products and quantity <sup>1</sup>
	County	Nearest town		
ARCO Chemical Co. (Div. of Atlantic Richfield Co.)	Tulsa	Sand Springs	Petroleum fraction	Demulsifying agents, corrosion inhibitors, acid-layer-type petroleum sulfonate (sodium salt), and oil-layer-type petroleum sulfonate (sodium salt).
Cherokee Nitrogen Co. (Owned by Okla. Ordinance Works Authority)	Mayes	Pryor	Natural gas, urea	Ammonia (160 t/d), nitric acid (180 t/d), ammonium nitrate (150 t/d), and urea-ammonium nitrate solutions (240 t/d).
Continental Carbon Co.	Kay	Ponca City	Benzine, naphtha fraction, and propylene.	Benzine (350 b/d), propylene tetramer, and toluenexylenes mix (1,200 b/d).
Nipak, Inc.	Mayes	Pryor	Natural gas	Ammonia and urea (feed and fertilizer grade).
Do	Tulsa	West Tulsa	do	Ammonia and diammonium phosphates.
Sun Oil Co. (DX Div.)	Stephens	Duncan	Refinery gases	Propylene tetramer (775 b/d). Construction: Isobutane cracker and merox desulfurizing unit.
Do	Tulsa	Tulsa	Light reformates	Benzene, toluene, and mixed xylenes (2,200 b/d).
Petrolite Corp. (Bareco Div.)	Osage	Barnsdall	Petroleum hydrocarbons and chemicals.	Demulsifiers, corrosion inhibitors, fuel additives, industrial bactericides, antifoaming agents, anti-foamants, emulsifiers, foamers, microcrystalline waxes, synthetic waxes, polymers.

<sup>1</sup> Quantity: b/d = barrels per day; t/d = tons per day.

### NONMETALS

**Cement.**—Output of portland and masonry cement in Oklahoma decreased during 1970 as a result of the decline in construction.

**Clays.**—Clays and shales, used in making brick and tile products, were mined by 12

companies in 13 counties. Fire clay was mined in Creek County and bentonite was mined in Dewey County. Total output of clays, including bentonite, showed a slight decrease in both quantity and value in response to the decline in construction.

**Gypsum.**—Gypsum production decreased slightly in both quantity and value during

1970. Production was reported by seven companies operating in Blaine, Caddo, Canadian, Comanche, and Jackson Counties in western Oklahoma. Gypsum was strip mined and processed for use in wallboard, plaster, portland cement, and soil conditioner products.

**Lime.**—Chemical-grade lime was produced by St. Clair Lime Co. at their plant in Sequoyah County. Production during 1970 was up from the previous year. Contracts were let in 1970 by St. Clair to install an additional rotary kiln that would increase daily capacity by 400 tons. The company planned to put the new kiln on stream in mid-1971.

**Salt.**—Salt output rose sharply during 1970. Production was by solar evaporation. Two companies operating in northern Harmon County and one in Woods County evaporated natural brines emitted in springs and salt plains of western Oklahoma in solar pans. Blackmon Salt Co. started construction of additional evaporating pans in Woods County to increase

their production acreage from 10 acres to 60 acres.

**Sand and Gravel.**—In 1970, production of sand and gravel increased by 413,000 short tons and by \$102,000 which reflected a small increase in construction during the year. Construction programs of the Oklahoma Department of Highways had a paid value of \$80.8 million during the year, but contracts awarded were valued at only \$64 million in contrast with \$79.6 million in 1969. Contract construction placement of the Corps of Engineers in 1970 required payment of more than \$38.7 million.

**Stone.**—Stone production decreased in quantity but increased slightly in value in 1970. Stone output included limestone, dolomite, granite, sandstone, and chat (crushed chert, limestone, and dolomite rejected from the lead-zinc milling process).

**Sulfur.**—Sulfur was recovered from sour gas at a plant in Marshall County, and by-product sulfuric acid was produced from zinc smelter gases in Washington County.

Table 10.—Oklahoma: Sand and gravel sold or used by producers, by classes of operations and uses  
(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	1,862	\$1,943	1,737	\$1,899
Fill.....	280	192	254	141
Paving.....	939	1,012	717	826
Other uses <sup>1</sup> .....	892	2,593	1,086	2,902
Total <sup>2</sup> .....	3,973	5,741	3,794	5,768
<b>Gravel:</b>				
Building.....	19	31	42	54
Paving.....	51	70	37	50
Miscellaneous.....	--	--	5	20
Other uses <sup>3</sup> .....	17	33	--	--
Total <sup>2</sup> .....	86	134	84	123
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Building.....	288	359	323	304
Fill.....	5	4	--	--
Paving.....	781	749	1,020	386
Other uses.....	--	--	9	7
Total <sup>2</sup> .....	1,074	1,112	1,353	697
<b>Gravel:</b>				
Building.....	33	72	25	37
Paving.....	96	99	420	634
Total <sup>2</sup> .....	129	170	446	671
<b>Total sand and gravel <sup>2</sup>.....</b>	<b>5,262</b>	<b>7,156</b>	<b>5,675</b>	<b>7,258</b>

<sup>1</sup> Includes ground and unground, railroad ballast, and other sands.

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

<sup>3</sup> Includes fill, miscellaneous, and other gravel.

**Table 11.—Oklahoma: Stone sold or used by producers, by kinds**  
(Thousand short tons and thousand dollars)

Kind of stone	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Limestone.....	2	\$23	2	\$23
Granite.....	12	1,274	9	1,014
<b>Total</b> .....	<b>14</b>	<b>1,297</b>	<b>10</b>	<b>1,037</b>
<b>Crushed and broken:</b>				
Limestone <sup>1</sup> .....	16,870	20,622	16,393	20,907
Other stone <sup>2</sup> .....	1,916	1,731	1,773	1,757
<b>Total</b> .....	<b>18,786</b>	<b>22,353</b>	<b>18,166</b>	<b>22,664</b>
<b>Grand total<sup>3</sup></b> .....	<b>18,799</b>	<b>23,650</b>	<b>18,177</b>	<b>23,701</b>

<sup>1</sup> Data include dolomite.

<sup>2</sup> Data include sandstone.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

**Tripoli.**—Tripoli, recovered from two mines in Ottawa County, was used in buffing compounds and in foundry processes. Production during 1970 decreased from that of 1969.

**Volcanic Ash.**—Tilco, Inc., of Wichita, Kans., acquired Franolite Minerals, Inc., and reorganized it into Custer City Mining Corp. for reopening its volcanic ash pit in Custer County. Mining was suspended during 1970, but the operators planned its resumption in 1971. Axtell Mining Corp. in Beaver County was the sole producer of volcanic ash in 1970.

## METALS

**Copper.**—Copper production in 1970 was essentially the same as in 1969. Ore was produced in Jackson County by Eagle-Picher Industries, Inc., from a "red bed" copper shale 6 to 10 inches thick. Overburden 10 to 15 feet thick was removed by stripping. Concentrates from ore treated at the company mill were shipped to a

smelter in El Paso, Tex. At the end of the year Eagle-Picher put into operation a new 26-cubic-yard dragline to supplement stripping capacity of two 13-cubic-yard draglines already in use.

Lobaris Copper Co. continued development of a copper shale strip mine and construction of a mill in Jackson County.

**Germanium.**—Germanium was recovered by Eagle-Picher Industries, Inc., at their Quapaw plant (Ottawa County) from residues accumulated at two of the State's zinc smelters. Production in 1970 rose sharply above that in 1969.

**Lead and Zinc.**—Lead and zinc production in Oklahoma ceased late in 1970 after a marked decline from the previous year. Mines and mills of the Picher field, one of the great mining districts of the world, closed in October after having produced 1.3 million tons of lead and 5.2 million tons of zinc since mining started in 1891. Oklahoma had been the leading producer of zinc in the United States almost every year from 1918 through 1945.

**Table 12.—Oklahoma: Mine production (recoverable) of lead and zinc**

	1968	1969	1970
Mines producing: Lode.....	23	12	5
Material sold or treated:			
Zinc ore..... thousand short tons..	275,475	97,995	64,367
Zinc tailing..... do.....	( <sup>1</sup> )	( <sup>1</sup> )	8,297
Production (recoverable):			
Quantity:			
Lead..... short tons..	2,387	605	797
Zinc..... do.....	6,921	2,744	2,650
Value:			
Lead..... thousands..	\$631	\$180	\$249
Zinc..... do.....	1,869	801	812
<b>Total</b> ..... do.....	<b>2,500</b>	<b>981</b>	<b>1,061</b>

<sup>1</sup> Figure not available; included in zinc ore.

Many factors led to the demise of this once great field in Ottawa County and adjacent parts of Kansas and Missouri. Higher grade ores have been depleted through the years leaving only low-grade ore; the market price had declined; most of the interconnected mine systems were flooding, causing an excessive pumping load on remaining companies. Concurrently, increased operational and pollution-control expenses made it uneconomical to continue mining in the field.

**Silver.**—The value of silver recovered from smelting copper concentrates produced by Eagle-Picher Industries, Inc., in Jackson County in 1970 increased 15 percent above the 1969 value.

**Uranium.**—Kerr-McGee Corp. made the first shipment of natural uranium hexafluoride produced at its newly opened \$25 million Sequoyah facility in eastern Oklahoma. The 38,000-pound shipment was sent to the Atomic Energy Commission's

gaseous diffusion plant at Oak Ridge, Tenn. Only one other facility in the Nation was designed to convert uranium oxide ( $U_3O_8$ ), or yellow cake, into uranium hexafluoride ( $UF_6$ ).

**Custom Mills and Smelters.**—Horizontal retort zinc smelters were operated by American Metal Climax, Inc., at Blackwell and National Zinc Co., Inc., at Bartlesville. Both companies treated zinc concentrates.

Five Star Industries, Inc. (formerly J & S Iron Foundry), at Dewey, Washington County, completed a \$1.3 million expansion program in October 1970. Addition of the automated greensand match plate foundry unit increased plant capacity about 500 percent.

Armco Steel Corp. increased the capacity of its Sand Springs steel plant by 80 percent with completion of a \$5 million expansion program. Production of reinforcing bars and fence posts in the new electric furnace began in December 1970.

Table 13.—Principal producers

Commodity and company	Address	Type of activity	County
Carbon Black: Continental Carbon Co.	P.O. Box 22085 Houston, Tex. 77027	Furnace.....	Kay.
Cement:			
Dewey Rocky Mountain Cement Co. <sup>1</sup>	1210 Fourth Nat'l. Bank Tulsa, Okla. 74119	Quarry and plant..	Rogers.
Ideal Cement Co., Div. Ideal Basic Industries, Inc. <sup>1</sup>	420 Ideal Cement Bldg. Denver, Colo. 80202	....do.....	Pontotoc.
Oklahoma Cement Co. Div. OKC Corp. <sup>1</sup>	P.O. Box 68 Pryor, Okla. 74361	....do.....	Mayes.
Clays:			
Acme Brick Co.....	P.O. Box 425 Fort Worth, Tex. 76101	Mine and plant....	Custer, Oklahoma, Tulsa.
Chandler Materials Co.....	Box 627 Tulsa, Okla. 74101	....do.....	Rogers, Oklahoma.
Filtrol Corp.....	3250 E. Washington Los Angeles, Calif. 90023	....do.....	Dewey.
Mangum Brick Co.....	Box 296 Mangum, Okla. 73554	....do.....	Greer.
Oklahoma Brick Corp.....	Box 87 Union City, Okla. 73090	....do.....	Canadian.
Sapulpa Brick & Tile Corp.	Box 460 Sapulpa, Okla. 74066	....do.....	Creek.
Superior Clay Products, Inc.	Box 1501 Ada, Okla. 74820	....do.....	Pontotoc.
United Clay Pipe Co.....	Box 552 Seminole, Okla. 74868	....do.....	Seminole.
Wewoka Brick and Tile Co.	415 W. 10th Street Wewoka, Okla. 74884	....do.....	Do.
Coal:			
Bills Coal Co., Inc.....	Route 1 Welch, Okla. 74369	Strip mine.....	Craig.
Evans Coal Co.....	Box 126 McCurtain, Okla. 74944	Strip and auger mine.....	Haskell.
Garland Coal & Mining Co.	Box 186 Fort Smith, Ark. 72901	Strip mine.....	Do.
Howe Coal Co.....	Box 99 Heavener, Okla. 74937	Underground mine.....	Le Flore.
Kerr-McGee Corp.....	Kerr-McGee Bldg. Oklahoma City, Okla. 73102	....do.....	Haskell.
McNabb Coal Co.....	Box C Catoosa, Okla. 74105	Strip mine.....	Rogers.
Peabody Coal Co.....	301 N. Memorial Drive St. Louis, Mo. 63102	....do.....	Do.
Copper and silver: Eagle-Picher Industries, Inc.	P.O. Box 910 Miami, Okla. 74354	....do.....	Jackson.

See footnote at end of table.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Gypsum:</b>			
Republic Gypsum Co. ....	1100 Mercantile Bank Bldg. Dallas, Tex. 75201	Quarry and plant..	Jackson.
United States Gypsum Co. ....	101 S. Wacker Drive Chicago, Ill. 60606	---do-----	Blaine.
Universal Atlas Cement, Div. of United States Steel Corp. ....	600 Grant St. Box 2969 Pittsburgh, Pa. 15230	Quarry-----	Do.
<b>Lead and zinc:</b>			
C & H Mining Co. ....	Box 281 Ficher, Okla. 74360	Underground mine.	Ottawa.
Henry Eby .....	Box 464 Baxter Springs, Kans. 66713	---do-----	Do.
Geo. T., Inc. ....	Box 128 Ficher, Okla. 74360	---do-----	Do.
Lime: St. Clair Lime Co. ....	Box 894 Oklahoma City, Okla. 73101	Plant and quarry..	Sequoyah.
<b>Salt:</b>			
Blackmon Salt Co. ....	Freedom, Okla. 73842	Solar evaporation..	Woods.
Western Salt Co. ....	Route 2 Erick, Okla. 73645	---do-----	Harmon.
<b>Sand and gravel:</b>			
Bagby-Harris Sand Co. ....	P.O. Box 926 Jenks, Okla. 74037	Dredge-----	Tulsa.
Joe Brown Sand & Gravel Co. ....	Box 102 Sulphur, Okla. 73086	Stationary-----	Murray.
The Dolese Co. ....	13 NW 13th St. Oklahoma City, Okla. 73103	---do-----	Canadian, McClain, Kingfisher, Logan, Garfield.
McMichael Concrete Co. ...	Box 9486 Tulsa, Okla. 74107	Dredge-----	Tulsa.
Midcontinent Glass Sand Co. ....	Roff, Okla. 74865	Stationary-----	Pontotoc.
Mohawk Rock & Sand Co. ...	1340 E. 16th St. Tulsa, Okla. 74120	Dredge-----	Tulsa.
Pennsylvania Glass Sand Corp. of Okla. ....	Berkeley Springs, W. Va. 25411	Stationary-----	Johnston.
Sand Products, Inc. ....	3405 E. Reno Oklahoma City, Okla. 73117	Stationary and dredge.	Oklahoma.
Tulsa Sand Co. ....	Box 1954 Tulsa, Okla. 74101	Stationary-----	Pawnee, Tulsa.
Yahola Sand & Gravel Co. ...	323 Merchants Bank Bldg. Ft. Smith, Ark. 72901	---do-----	Muskogee.
<b>Stone:</b>			
Anchor Stone Co. ....	Box 1630 Tulsa, Okla. 74106	Quarry-----	Tulsa.
Arkholo Sand & Gravel Co. ....	323 Merchants Bank Bldg. Ft. Smith, Ark. 72901	---do-----	Cherokee.
Dolese Brothers Co. ....	13 NW 13th St. Oklahoma City, Okla. 73103	---do-----	Caddo, Carter, Coal, Comanche, Kiowa, Murray, Pittsburg, Seminole.
Eagle-Picher Industries, Inc. ....	P.O. Box 910 Miami, Okla. 74354	---do-----	Ottawa.
The Quapaw Company ....	Box 72 Drumright, Okla. 74030	---do-----	Creek, Okmulgee.
Sooner Rock and Sand Co. ....	2835 NE 23d Oklahoma City, Okla. 73111	---do-----	Murray.
Standard Industries, Inc. ...	P.O. Box 15670 Admiral Station Tulsa, Okla. 74115	---do-----	Osage, Tulsa.
Trinity Concrete Products Co. ....	Box 1290 Dallas, Tex. 75221	---do-----	Atoka.
Tulsa Rock Co. ....	Box 15691 Admiral Station Tulsa, Okla. 74115	---do-----	Tulsa.
Tripoli: The Carborundum Co., American Tripoli Div. ....	Seneca, Mo. 64865	Open pit-----	Ottawa.
Volcanic ash: Axtell Mining Corp. ....	Laverne, Okla. 73848	---do-----	Beaver.
Helium: U.S. Bureau of Mines.	P.O. Box 46 Keyes, Okla. 73947	Helium processing.	Cimarron.
<b>Smelters:</b>			
American Metal Climax, Inc., Blackwell Zinc Co. ...	Blackwell, Okla. 74631	Zinc-----	Kay.
Kaiser Chemicals, Inc. ....	Tulsa, Okla. 74100	Magnesium-----	Tulsa.
National Zinc Co. ....	Bartlesville, Okla. 74003	Zinc-----	Washington.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Petroleum refineries:</b>			
Allied Materials Corp.....	Stroud, Okla. 74079.....	Refinery.....	Lincoln.
Apeco Oil Corp.....	Cyril, Okla. 73029.....	do.....	Caddo.
Bell Oil and Gas Co.....	Ardmore, Okla. 73401.....	do.....	Carter.
Champlin Petroleum Co.....	Enid, Okla. 73701.....	do.....	Garfield.
Continental Oil Co.....	Ponca City, Okla. 74601.....	do.....	Kay.
Kerr-McGee Corp.....	Cushing, Okla. 74023.....	do.....	Payne.
Do.....	Wynnewood, Okla. 73098.....	do.....	Garvin.
Midland Cooperatives, Inc.....	Cushing, Okla. 74023.....	do.....	Payne.
Okmulgee Refining Co.....	Okmulgee, Okla. 74447.....	do.....	Okmulgee.
Sequoyah Refining Corp.....	Ponca City, Okla. 74601.....	do.....	Kay.
Sun Oil Co., DX Div.....	Duncan, Okla. 73533.....	do.....	Stephens.
Do.....	Tulsa, Okla. 74100.....	do.....	Tulsa.
Texaco Inc.....	do.....	do.....	Do.
Tonkawa Refining Co.....	Arnett, Okla. 73832.....	do.....	Ellis.
<b>Natural gas liquids:</b>			
Champlin Petroleum Co.....	Fort Worth, Tex. 76100.....	Natural gas liquids processing.....	Garfield, Oklahoma.
Cities Service Oil Co.....	Bartlesville, Okla. 74003.....	do.....	Garfield, Kay, Oklahoma, Texas.
Humble Oil & Refining Co.....	Tulsa, Okla. 74100.....	do.....	Dewey, Kingfisher.
Mobil Oil Corp.....	Taloga, Okla. 73667.....	do.....	Dewey, Grady, Stephens, Texas, Woodward.
Phillips Petroleum Co.....	Bartlesville, Okla. 74003.....	do.....	Garvin, Oklahoma.
Shell Oil Co.....	Oklahoma City, Okla. 73100.....	do.....	Beckham, Carter, Dewey.
Signal Oil & Gas Co.....	Ardmore, Okla. 73401.....	do.....	Carter.
Skelly Oil Co.....	Tulsa, Okla. 74100.....	do.....	Stephens.
Sun Oil Co.....	do.....	do.....	Cleveland, Grant, Harper, Kay, Lincoln, McClain.
Texaco, Inc.....	do.....	do.....	Beaver, Caddo, Lincoln, Love.
Union Texas Petroleum, Div. of Allied Chemical Corp.....	do.....	do.....	Major.
Warren Petroleum Corp....	do.....	do.....	Beaver, Garvin, Grady, Stephens.

<sup>1</sup> Also crushed and broken limestone, and clays.

# The Mineral Industry of Oregon

By John D. Corrick<sup>1</sup>

The value of Oregon's mineral production in 1970, \$68.1 million, was a 13.2 percent increase over the 1969 value of \$60.2 million. Sand, gravel, and stone accounted for 69 percent of the total production value, an increase from 65 percent in 1969.

Three metals showed significant changes in value of production compared with that of 1969. Mercury output increased nearly sixfold, and the value of production increased fivefold in spite of a 20-percent drop in the annual average price of the metal. Gold and silver declined significantly in value of production.

Construction of a natural gas liquification complex was completed in 1968, by Northwest Natural Gas Co. An additional vaporizing capacity of 200,000 therms per day was scheduled for the first of the year, bringing the total vaporizing capacity to

800,000 therms per day. This was the first plant of its kind in the Northwest.

Zirconium Technology Corp. (Zirtech) began redrawing titanium and zirconium tubing at the company's new \$1.7 million manufacturing plant in Albany. The longest cold-wall, vertical-vacuum annealing furnace ever built was an integral part of the plant.

Kaiser Aluminum & Chemical Corp. opened an aluminum fabricating plant and warehouse in Salem. The plant was equipped with new high-speed equipment for roll forming and for cutting coated-aluminum coil stock.

A potential power shortage in the Northwest was described in two published articles. The articles also described the po-

<sup>1</sup> Physical scientist, Division of Ferrous Metals.

Table 1.—Mineral production in Oregon<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays <sup>2</sup> ..... thousand short tons	215	\$321	134	\$180
Diatomite..... short tons	85	W	500	5
Gem stones.....	NA	750	NA	750
Gold (recoverable content of ores)..... troy ounces	875	36	256	9
Lead (recoverable content of ores)..... short tons	( <sup>3</sup> )	( <sup>3</sup> )	( <sup>3</sup> )	( <sup>3</sup> )
Lime..... thousand short tons	115	2,337	96	1,777
Mercury..... 76-pound flasks	43	22	274	112
Nickel (content of ore and concentrate)..... short tons	17,056	W	15,933	W
Pumice and volcanic cinder..... thousand short tons	875	1,139	1,061	1,252
Sand and gravel..... do	15,740	20,491	17,532	25,978
Silver (recoverable content of ores)..... thousand troy ounces	5	9	4	6
Stone..... thousand short tons	11,662	18,897	13,439	20,948
Zinc..... short tons	( <sup>3</sup> )	( <sup>3</sup> )	-----	-----
Value of items that cannot be disclosed: Cement, clay (fire), copper, talc, and values indicated by symbol W.....	XX	16,162	XX	17,084
Total.....	XX	60,164	XX	68,101
Total 1967 constant dollars.....	XX	56,813	XX	<sup>p</sup> 61,631

<sup>p</sup> Preliminary. NA Not available. XX Not applicable.

W Withheld to avoid disclosing individual company confidential data, included with "Value of items that cannot be disclosed."

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

<sup>2</sup> Excludes fire clay; included with "Value of items that cannot be disclosed."

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



Table 2.—Value of mineral production in Oregon, by counties  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Baker	\$4,566	\$6,153	Cement, sand and gravel, stone, lime, clays, gold, silver, pumice, copper, lead, zinc.
Benton	566	1,030	Sand and gravel, stone, clays.
Clackamas	9,432	11,433	Cement, sand and gravel, stone, clays.
Clatsop	761	505	Stone, sand and gravel.
Columbia	W	W	Do.
Coos	1,083	814	Do.
Crook	265	196	Stone, sand and gravel, clays, mercury.
Curry	393	582	Stone, sand and gravel.
Deschutes	886	760	Pumice, sand and gravel, stone.
Douglas	W	W	Nickel, sand and gravel, stone, mercury, pumice.
Gilliam	1	W	Sand and gravel, stone.
Grant	997	538	Stone, sand and gravel.
Harney	W	W	Sand and gravel, stone.
Hood River	W	W	Stone, sand and gravel.
Jackson	1,049	975	Sand and gravel, stone, pumice, mercury.
Jefferson	83	W	Stone, sand and gravel, pumice.
Josephine	1,247	799	Sand and gravel, stone, gold, talc.
Klamath	2,139	2,945	Stone, sand and gravel, pumice, clays.
Lake	503	239	Pumice, sand and gravel, stone, diatomite, mercury.
Lane	3,953	3,046	Sand and gravel, stone.
Lincoln	880	701	Stone, sand and gravel.
Linn	1,149	1,238	Sand and gravel, stone.
Malheur	W	W	Lime, sand and gravel, stone, mercury.
Marion	652	550	Sand and gravel, stone, clays.
Morrow	152	W	Stone.
Multnomah	7,937	7,402	Sand and gravel, lime, stone, clays.
Polk	460	709	Sand and gravel, stone.
Sherman	572	612	Stone, sand and gravel.
Tillamook	327	409	Stone, sand and gravel, clays.
Umatilla	568	598	Stone, sand and gravel.
Union	504	632	Do.
Wallowa	168	513	Do.
Wasco	W	869	Sand and gravel, stone.
Washington	2,678	2,276	Stone, sand and gravel, clays.
Wheeler	106	W	Stone, sand and gravel.
Yamhill	515	580	Sand and gravel, stone, clays.
Undistributed <sup>1</sup>	15,572	21,001	
Total	60,164	* 68,101	

W Withheld to avoid disclosing individual company confidential data.

<sup>1</sup> Includes value of mineral production that cannot be assigned to specific counties and values indicated by symbol W.

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

tential effect that four nuclear power systems would have on the ecology in Oregon.<sup>2</sup>

The use of automobile hulks by the Oregon scrap steel industry was described in a published article.<sup>3</sup> The two major problems confronting the scrap industry were (1) an inadequate market for scrap automobiles and (2) transportation of automobile hulks to scrap processors.

**Employment, Trade, and Markets.**—According to figures published by the Oregon Department of Employment, the State's 1970 civilian labor force increased by 2.0 percent over the 1969 force, which was 3.0 percent more than the 1968 force. Total employment during December 1970 was 858,800, an increase of 2.1 percent over the January 1970 figure of 841,000. The seasonally adjusted unemployment rate reached 6.6 percent in June 1970 and has been trending downward since, reaching 6.2 percent in December 1970. This is still a con-

siderable increase over the 4.5 percent registered 1 year ago. Oregon's December 1970 seasonally adjusted unemployment rate equalled the Nation's rate for the same month. The mining industry, which showed an appreciable decline in employment in 1969 (-7.2 percent), declined 13.3 percent in 1970. Oregon's wage and salary employment index<sup>4</sup> averaged 147.1 in December 1970, compared with 147.7 in December 1969. This approximated the national pattern, which reached 136.5 in December 1970, compared with 136.7 1 year earlier.

<sup>2</sup> Hughes, Harold. A Matter of Power Need vs. Ecologic Demand. Sunday Oregonian Forum, Portland, Ore., July 12, 1970, pp. 1-11.

<sup>3</sup> Thompson, Wayne. Is There Really a Power Shortage Coming? Sunday Oregonian Forum, Portland, Ore., July 12, 1970, pp. 1-11.

<sup>4</sup> Shaffer, Leslie D., and Roy B. Collins. Automobiles and the Scrap Steel Industry of Oregon. *Org. Bus. Rev.*, August 1970, pp. 1-6.

<sup>5</sup> This index and all others used in the text assume a base of 1957-1959=100.

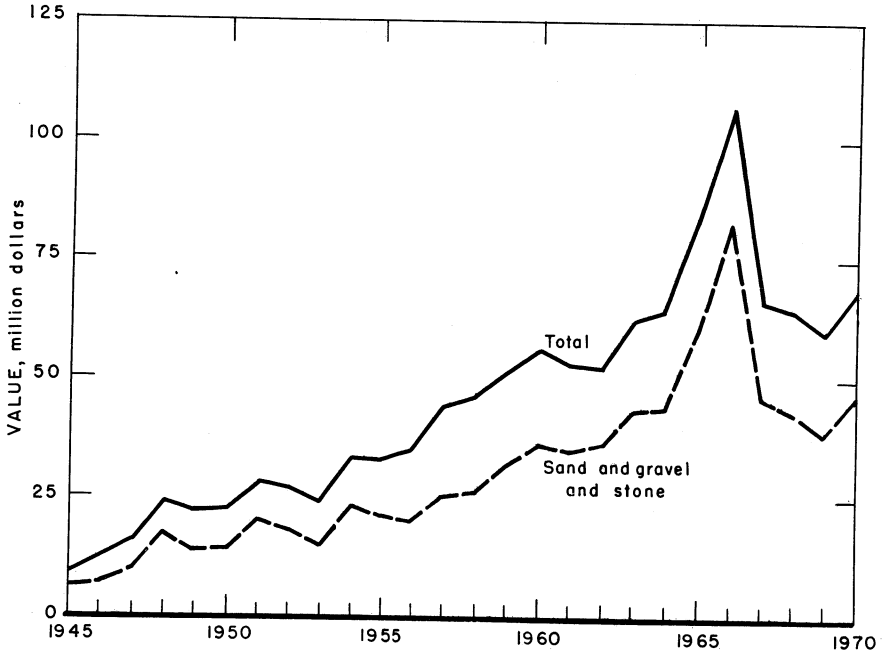


Figure 1.—Value of sand and gravel and stone, and total value of mineral production in Oregon.

Oregon's economy began a downward trend in the second quarter of 1969, principally in the lumber industry, owing to a restricted money supply for housing starts. Employment in the durable goods manufacturing industry, other than wood products, continued to expand (after seasonal adjustments) through the third quarter of 1969. This sector included the metals industries, transportation, etc. Diversification in Oregon's manufacturing industries in the late 1960's broadened the economic base and increased employment stability. The current downward trend in these industries reflected the trend in the Nation. The net result was a rising wage and salary index through January 1970; it peaked at 148.4. Hourly earnings in manufacturing rose 5.7 percent in 1970; and as in the

previous year, the effect of wage increases was partially offset by a decline in the average production workweek from 39.4 hours in December 1969, to 38.6 hours in December 1970. However, a decline was noted in hours worked between November and December, when a slight upturn is normal. This decline, in factory man-hours worked, marked a resumption of the unfavorable trend experienced over the past year. The shorter workweeks in December occurred principally in the production of lumber and wood products, primary metals, and other food products. Separations in the primary metals industries as shown by "quits" and "layoffs" were running at a higher rate in December 1970 (2.3 per 100 employees) than in December 1969 (1.5 per 100 employees).

Table 3.—Indicators of Oregon business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total labor force..... thousands	909.6	927.9	+2.0
Unemployment..... do	40.0	55.3	+38.3
<b>Employment:</b>			
Construction..... do	32.4	28.2	-13.0
Lumber and wood products..... do	70.9	66.9	-5.6
Food products..... do	24.3	23.9	-1.6
Mining..... do	1.5	1.3	-13.3
All manufacturing..... do	179.4	171.6	-4.3
<b>Personal income:</b>			
Total..... millions	\$7,261	\$7,775	+7.1
Per capita..... do	\$3,521	\$3,700	+5.1
<b>Construction activity:</b>			
Number of authorized private and public residential units.....	16,130	15,797	-2.1
Value of non-residential construction..... millions	\$130.6	\$100.7	-22.9
Value of highway contracts awarded..... do	\$127.8	\$99.3	-22.3
Cement shipments to and within Oregon thousand 376-pound barrels.....	3,642.9	3,423.0	-6.0
Cash receipts from farm marketings..... millions	\$545.1	\$560.1	+2.6
Mineral production..... do	\$60.2	\$68.1	+13.1

Sources: Survey of Current Business, Construction Review, Farm Income Situation, Employment and Earnings, Roads and Streets, Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Coal and peat.....	5	59	( <sup>1</sup> )	2	-----	-----	-----	-----
Metal.....	112	182	20	164	-----	3	18.34	134
Nonmetal.....	153	195	31	246	-----	5	20.31	357
Sand and gravel.....	1,210	190	230	1,847	1	32	17.87	3,854
Stone.....	1,066	234	250	2,020	-----	66	32.67	732
Total <sup>2</sup> .....	2,551	208	532	4,280	1	106	25.00	2,034
<b>1970:<sup>p</sup></b>								
Coal.....	5	36	( <sup>1</sup> )	1	-----	-----	-----	-----
Metal.....	110	192	21	170	1	6	41.07	41,121
Nonmetal.....	180	135	33	268	-----	4	14.92	504
Sand and gravel.....	1,010	226	228	1,811	2	59	33.67	7,677
Stone.....	900	222	200	1,607	1	54	34.23	7,252
Total <sup>2</sup> .....	2,205	219	483	3,858	4	123	32.92	8,478

<sup>p</sup> Preliminary.

<sup>1</sup> Less than 500.

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

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Cement.**—Output of portland cement in 1970 increased 8 percent over 1969 production, marking the first increase in 4 years. Oregon's only cement producer, Oregon Portland Cement Co., operated plants at Lime, Baker County, and Oswego, Clackamas County.

Combined shipments from three plants located in Oregon and Nevada totaled 4.1 million barrels (376 pounds each) of finished portland cement in 1970. The same plants shipped 3.7 million barrels in 1969. The average value of portland cement

shipped in 1970 from these plants showed an increase in price-per-barrel over that shipped in 1969.

**Clays.**—Output of clay or shale sold or used by producers in 1970 declined 38 percent from that of 1969. The major reason for the decline was lower production of bloating shale used for making lightweight concrete aggregate and concrete admixtures (pozzolan).

Expandable shale was produced at a quarry in Washington County. Clay and shale used at cement plants came from Baker County. Miscellaneous clay, for making heavy clay products, was produced at

operations in Benton, Clackamas, Klamath, Marion, Multnomah, Tillamook, Washington, and Yamhill Counties. Crude bentonitic clay was mined at a deposit in Crook County.

**Diatomite.**—Diatomaceous earth was mined from an operation near Silver Lake (Lake County) by A.M. Matlock, and near Keating (Baker County), by Keating Diatomaceous Earth Co. The Silver Lake material was trucked to Eugene, Lane County, for processing into pet litter and plywood glue extender. Keating material was not shipped during the year.

**Gems and Gem Materials.**—The value of gems and gem materials produced in 1970 equaled that of 1969. Production was concentrated in the Lebanon (Linn County), Nyssa (Malheur County), and Prineville (Crook, Jefferson, and Wheeler Counties) areas. Output of gems and gem materials was principally by amateur mineral collectors, including local enthusiasts and tourists. Fee-site deposits in the Prineville area were described and locations given in two publications.<sup>5</sup>

**Lime.**—Lime production in 1970 amounted to 96,031 short tons valued at \$1,776,585, a decrease of about 17 percent compared with 1969 production. The principal reason for the decline was the April closure of Chemical Lime Co.'s Baker plant. The major portion of lime produced in Oregon was consumed in the State. Washington accounted for the remainder. Ash Grove Cement Co. (Portland), and Chemical Lime Co. (Baker) produced quicklime and hydrated lime for the electroprocess, metallurgical, and paper industries. Quicklime for manufacturing calcium carbide was produced by Pacific Carbide and Alloys Co. (Portland). Amalgamated Sugar Co. (Nyssa) produced and used quicklime for sugar refining.

**Perlite.**—Supreme Perlite Co. (Portland) expanded crude perlite from Nevada. The expanded product was used chiefly as a building plaster aggregate. Small quantities were sold for soil conditioning and for concrete aggregate.

**Pumice and Volcanic Cinders.**—An increased demand for unprocessed cinder for road construction and maintenance in 1970 resulted in an approximate 21 percent higher output than in 1969. The major portion of the 1,061,000 short tons pro-

duced in 1970 was for roads. Small amounts of cinder and pumice were processed and used in lightweight concrete aggregate, concrete admixture (pozzolan), and abrasives.

Oregon Portland Cement Co. announced it will supply 63,000 tons of pozzolan from its pumice deposit near Lime for use in constructing the Lower Granite Dam on the Snake River near Wawawai, Wash.

**Sand and Gravel.**—Output of sand and gravel increased to 17.5 million tons in 1970, an increase of 11 percent over 1969. Production for the intermediate years was 35.3 million tons in 1966, 19.6 million tons in 1967, 18.3 million tons in 1968, and 15.7 million tons in 1969. Reduced demand for sand and gravel in recent years resulted from a series of highway and dam projects being completed.

During 1970, growing concern was expressed for future supplies of sand and gravel, particularly in western Oregon. The Department of Geology and Mineral Industries made several sand and gravel resource studies at the request of local government bodies. The requested information was on the location and reserves of sand and gravel in communities; this information was to aid these governments in making long-range plans.

**Stone.**—Production of stone increased 15 percent in tonnage and 11 percent in value in 1970. Major uses of stone were in surface treatment aggregate, dense graded roadbase stone, unspecified aggregate and roadstone, and bituminous aggregate. Those uses showing the greatest increase in tonnage sold or used in 1970 over 1969 were bituminous aggregate (158 percent) and dense graded roadbase stone (45 percent). Uses showing a significant decrease in tonnage sold or used in 1970 were riprap and jetty stone (47 percent) and other (53 percent).

**Talc and Soapstone.**—A small quantity of soapstone used principally for sculpturing purposes by educational institutions, was produced from a deposit in Josephine County.

<sup>5</sup> Rodgers, Jim. *A Visit to the Antelope and Ashwood Areas in Oregon*. *Lapidary J.*, v. 24, No. 2, April 1970, pp. 151-154.

———. *The Kennedy Ranch—Reopened After 25 Years*. *Lapidary J.*, v. 24, No. 3, June 1970, pp. 420-426.

**Table 5.—Oregon: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building.....	1,415	\$1,875	1,213	\$1,780
Fill.....	417	396	368	311
Paving.....	270	380	819	997
Other uses <sup>1</sup> .....	167	189	247	296
Total <sup>2</sup> .....	2,269	2,840	2,648	3,384
Gravel:				
Building.....	2,942	3,705	2,951	3,918
Fill.....	567	451	875	594
Paving.....	5,192	6,647	4,775	6,360
Miscellaneous.....	-----	-----	90	106
Other uses <sup>3</sup> .....	976	1,123	819	944
Total.....	9,677	11,926	9,510	11,922
<b>Government-and-contractor operations:</b>				
Sand:				
Building.....	21	43	-----	-----
Fill.....	6	3	6	3
Paving.....	103	90	217	347
Other uses.....	12	12	6	4
Total <sup>2</sup> .....	142	148	228	354
Gravel:				
Building.....	280	360	155	89
Fill.....	120	71	37	19
Paving.....	3,220	5,049	4,954	10,208
Other uses.....	32	97	-----	-----
Total <sup>2</sup> .....	3,652	5,577	5,147	10,317
Total sand and gravel <sup>2</sup> .....	15,740	20,491	17,532	25,978

<sup>1</sup> Includes railroad ballast, blast, engine, and other sands.

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

<sup>3</sup> Includes railroad ballast.

**Table 6.—Oregon: Stone sold or used by producers, by use**

(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Bituminous aggregate.....	500	\$787	1,290	\$1,957
Concrete aggregate.....	W	W	688	1,488
Dense graded roadbase stone.....	2,625	3,678	3,794	5,241
Macadam aggregate.....	366	585	381	562
Surface treatment aggregate.....	3,597	5,528	3,820	5,653
Unspecified aggregate & roadstone.....	2,569	4,394	2,472	4,278
Abrasives.....	26	129	23	118
Ferrosilicon.....	25	173	10	92
Riprap and jetty stone.....	574	969	307	471
Other <sup>1</sup> .....	1,380	2,653	655	1,088
Total <sup>2</sup> .....	11,662	18,897	13,439	20,948

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

<sup>1</sup> Includes building stone (dimension); stone used at cement, paper and chemical plants, sugar refineries, stone for agricultural purposes, rock fill, railroad ballast, flux stone, glass, and for miscellaneous unspecified purposes; also building products and drain fields (1970).

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

## METALS

**Aluminum.**—Aluminum production in 1970 was at about the same level as that of 1969.

Reynolds Mining Co., a subsidiary of Reynolds Metals Co., engaged in small-scale mining at deposits in Columbia, Washington, and Marion Counties to obtain laterite ferruginous bauxite for research purposes. The company shipped 50,000 tons to Arkansas for conversion to alumina.

American Metal Climax, Inc. (AMAX) purchased a 300-acre plant site near Warrenton, in Clatsop County, on which Northwest Aluminum Co. had planned to build a \$3 million primary aluminum-reduction facility. AMAX Pacific Corp., an AMAX subsidiary that took over the site, also assumed the low-cost Bonneville power contract for 2.1-mill power to be available originally in the fall of 1973. AMAX Pacific Corp. did not expect to start construction of the aluminum-reduction plant until the spring of 1972. The reason given for the delay was to give authorities an opportunity to investigate and satisfy any environmental concerns. Public groups were concerned that fluorides emitted from the plant might be detrimental to the Columbia River salmon industry. AMAX planned to install a fluoride-recovery unit capable of reclaiming 93 to 96 percent of the fluoride effluents emitted from the plant. The halting of construction of the plant will result in the Bonneville Power Administration delaying by about 1 year the construction of transmission lines and other electrical facilities needed by the two potline buildings. The plant was designed to process alumina obtained from the Kimberly region of Western Australia; it will initially employ 700 to 800 persons.

**Antimony.**—The Jay Bird mine dump, Upper Applegate district, Jackson County, yielded a small quantity of antimony metal. A combination of flotation, chemical leaching, and electrolytic recovery was used to reclaim the metal. Some exploration for antimony was done at the Grey Eagle mine, Virtue Flats district, Baker County.

**Copper.**—A small quantity of copper was recovered from gold-silver ores produced at the Brass Ledge mine, west of Galice, in Josephine County, and the Bald Mountain mine in Baker County. The Brass Ledge copper mine shut down during the latter

part of 1970, but did ship one load of handpicked ore to the Tacoma smelter.

Nuclear Development Co. took samples from the Standard and Copperopolis mines in the Quartzburg district of Grant County. Reconnaissance examinations were carried out by St. Joe Minerals Corp. in the eastern Oregon copper belt. During 1970 a western regional office was opened in Eugene by St. Joe, and a drilling program was initiated at the Rowley mine in the Tiller-Drew district of Douglas County. Oregon Copper Co.'s copper prospects in the Lower Powder River and Sparta mining districts of Baker County were examined by the geological consulting firm of E.P. Sheppard and Associates Ltd. of Vancouver, B.C. for Baker Mountain Copper, Ltd., of Vancouver, B.C. This examination may be followed-up by an airborne magnetometer survey. The area studied covered more than 100 mining claims and included most of the prospects held under option to the Cyprus Mining Corp. in 1967-68.

A Japanese firm, Nissho-Iwai Canada, Ltd., expressed interest in copper-zinc deposits in Douglas County, and at yearend was discussing plans for a mill.

Two reports on copper deposits of the Homestead area and the mineral resources of Klamath and western Lake Counties were published by the State of Oregon Department of Geology and Mineral Industries.<sup>6</sup>

**Gold and Silver.**—Reported output of gold and silver in 1970 was less than in 1969. Most of the metals recovered came from the Bald Mountain mine, Baker County, where a new oreshoot was discovered and opened up with a minable width of 100 feet along the strike. Two carloads of \$55-per-ton gold ore were shipped during 1970. The average annual price was \$35.88 per ounce for gold and \$1.8143 per ounce for silver.

Nuclear Development Co. was active at the Bald Mountain and Ibex mines. In addition to production from the Bald Mountain mine, considerable exploratory work was done on the area between the two

<sup>6</sup> Vailler, Tracy L., and Howard C. Brooks. The Geology and Copper Deposits of the Homestead Area, Oregon and Idaho. The Ore Bin, v. 32, No. 3, March 1970.

Peterson, N.V., and J.R. McIntyre. Mineral Resources of Eastern Klamath County and Western Lake County. State of Oregon Department of Geology and Mineral Industries, Bull. 66, 1970, 80 pp.

mines. One objective was to determine the distance between the working faces of the mines and thereby determine the feasibility of joining the two.

Mill testing, on an intermittent basis, was reported by Northwest Mine and Milling, Inc., at the Star mine group of claims in the Bohemia district, Lane County. This area, 30 miles southeast of Cottage Grove, had significant production between 1892-1913, when \$11 million in gold was removed.

**Iron and Steel.**—A revolutionary method for handling iron ore slurries imported from Peru was proven at the Portland harbor during the year. The concentrated iron ore slurry was converted to metallic pellets at the Midland-Ross Co.'s Portland facility before being processed at the Oregon Steel Mills' plant. Cost for handling the slurry was claimed to be substantially lower than cost for hauling and unloading iron ore concentrate by conventional methods. Oregon Steel Mills' Midrex facility in Portland planned to expand present capacity from 200,000 net tons per year to 300,000 tons per year. Cascade Steel Rolling Mills, Inc., of McMinnville, continued to process scrap metal obtained from Portland area dealers.

**Mercury.**—About a sixfold increase in the output of mercury (274, 76-pound flasks) was indicated for 1970 over that of 1969. The average annual price was \$409 per flask.

Major production was by Alcona Mining, Inc., from its Elkhead mine in Douglas County. The Maury Mountain mine in Crook County, also contributed to the State total. Small production, but no shipments, was reported from the Canyon Creek mercury mine in Grant County. The Meteoric Mercury Mining & Milling Co. of Phoenix, Ariz., set up a mill at its Mother Lobe mercury mine at Johnson Creek, near Prineville. An unknown quantity (probably small) of mercury was produced at this property. The Jackson Mountain Mining Co. operating at the northwest end of Glass Buttes mercury district went out of business and auctioned off its equipment during the latter part of 1970.

David Griffith was exploring the eastern end of Glass Buttes mercury district near Burns. Old workings were opened, three mercury-bearing structures were exposed and a small test mill was constructed. Exploration was conducted at the Doodle Bug mine on Palmer Creek, Jackson

County. El Paso Natural Gas Co. prepared for drilling at the Conner Creek cinnabar property. High-grade ore from this property was to be shipped to the company plant at Weiser, Idaho. No work was done on the property west of the Horse Heaven mine, Jefferson County, under the Office of Minerals Exploration loan granted in 1969, although 17 flasks of mercury were reportedly shipped from the site.

**Nickel.**—Hanna Mining Co. processed 1,138,072 tons of nickel laterite ore containing 1.40 percent nickel from the Nickel Mountain mine in Douglas County. The ore contained 15,933 tons of nickel, 12,649 tons of which was recovered in 25,198 tons of ferronickel. This represented a 7-percent decrease in nickel production from 1969. Lower production in 1970 was due to operating difficulties which have been corrected. Ferrosilicon, totaling 19,825 tons and averaging 49 percent silicon, was produced by Hanna Nickel Smelting Co. for use in the reduction process. Hanna followed a recent round of nickel price increases by raising the price of ferronickel 2½ cents per pound to \$1.305 per pound of nickel contained. The new price became effective with November shipments. Hanna announced proven ore reserves for 20 years of operation, and extended its power contract with Bonneville Power Administration through July 30, 1976.

Consolidated Mining & Smelting Co. of Canada, Ltd. (COMINCO), AMAX, and AMEX (Placer Development) investigated low-grade nickel deposits in southwestern Oregon. COMINCO staked claims on Rough and Ready Creek Ridge. AMEX has also been prospecting for nickel in the John Day area.

**Titanium.**—Planned construction and expansion of the Oregon Metallurgical Corp.'s Albany facility were completed. The new plant provided an integrated operation for processing Australian titanium ore (rutile) to metal ingot. Magnesium metal was recovered from the magnesium chloride and recycled in the plant.

Rem Metals Corp., also of Albany, entered the titanium powder metal business by purchasing the technology and assets of Fansteel, Inc., powder metal operation at Harbor City, Calif. The equipment was to be moved to Albany to supplement casting and machining facilities. The company received a U.S. Air

Force contract to study forming of close-tolerance titanium aircraft parts.

**Uranium.**—Gulf Oil Corp., Nuclear Fuels Division, completed work in Malheur and Harney Counties. No activity was reported from either the Lucky Lass or White King properties, both former producers, in Lake County.

**Zirconium.**—Zirconium Technology Corp. (Zirtech) completed and dedicated its \$1.7 million manufacturing facility at Albany. The plant was designed primarily to make small-diameter precision bar and tubing. Metals other than zirconium were scheduled to be fabricated. The light-weight, high-strength alloy tubing has desirable properties for use in the new jumbo jets.

Wah Chang Albany Corp. announced plans to install a third electron-beam vacuum melting furnace. A new building was planned to house the furnace which will be used to purify metals during the melting process.

#### MINERAL FUELS

**Geothermal Energy.**—The successful use of geothermal energy for heating a green-

house was reported.<sup>7</sup> The legal aspects of using geothermal energy were discussed in another article.<sup>8</sup>

**Petroleum and Natural Gas.**—Texaco, Inc. leased about 150,000 acres of federal land, about 50,000 acres of privately owned land, and about 4,000 acres of State land in Crook County, for oil and gas exploration. Geological surveys of these lands were completed and test drillings were to begin in 1971. Two test holes were drilled in the Buena Vista, Marion County area.

Northwest Natural Gas Co. scheduled completion of an additional 200,000 therms per day natural gas vaporizing capacity for early in 1971. This will bring the company's vaporizing capacity to 800,000 therms per day. The vaporized gas was reported to be completely interchangeable with natural gas.

<sup>7</sup> Oregon Department of Geology and Mineral Industries. Geothermal Energy for Greenhouse Heating. The Ore Bin, v. 32, No. 9, September 1970, pp. 182-183.

<sup>8</sup> Bowen, Richard G. How Long? How Long? The Ore Bin, v. 32, No. 10, October 1970, pp. 202-204.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
NONMETALS			
Cement:			
Oregon Portland Cement Co. ....	111 S.E. Madison St. Portland, Ore. 97214	Plant.....	Baker and Clackamas.
Clays:			
Central Oregon Bentonite Co. ....	Bear Creek Route Prineville, Ore. 97754	Pit and plant...	Crook.
Ceramco, Inc. ....	P.O. Box 5 McMinnville, Ore. 97128	...do.....	Yamhill.
Columbia Brick Works.....	1320 S.E. Water St. Portland, Ore. 97214	...do.....	Multnomah.
Corvallis Brick & Tile Works, Inc.	P.O. Box 327 Corvallis, Ore. 97330	...do.....	Benton.
Empire Lite-Rock, Inc. ....	9255 N.E. Halsey St. Portland, Ore. 97220	...do.....	Washington.
Klamath Falls Brick & Tile Co. ....	P.O. Box 573 Klamath Falls, Ore. 97601	...do.....	Klamath.
Mandrone Mining Co., Inc. ....	Rt. 1, Box 337 Molalla, Ore. 97038	Pit.....	Clackamas.
McMinnville Brick Co. ....	451 College Ave. McMinnville, Ore. 97128	Pit and plant...	Yamhill.
Monmouth Brick & Tile Co. ....	Rt. 1, Box 22 Monmouth, Ore. 97361	...do.....	Polk.
Monroe Clay Products Co. ....	P.O. Box A Monroe, Ore. 97456	...do.....	Benton.
Needy Brick & Tile Co. ....	Rt. 1, Box 102 Hubbard, Ore. 97032	...do.....	Clackamas and Marion.
Oregon Portland Cement Co. ....	111 S.E. Madison St. Portland, Ore. 97214	Pit.....	Baker.
Scholls Tile Co. ....	Rt. 2, Box 208 Hillsboro, Ore. 97123	Pit and plant...	Washington.
Tillamook Clay Works.....	6690 Brickyard Rd. Tillamook, Ore. 97141	...do.....	Tillamook.
Willamina Clay Products Co., Inc.	9780 S.W. Hunziker St. Tigard, Ore. 97223	...do.....	Yamhill.
Diatomite:			
A. M. Matlock.....	P.O. Box 3307 Eugene, Ore. 97402	Mine and plant...	Lake.

See footnote at end of table.



Table 7.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
NONMETALS—Continued			
Lime:			
Amalgamated Sugar Co.....	Nyssa, Oreg. 97913.....	Plant.....	Malheur.
Ash Grove Cement Co.....	101 W. 11th St. Kansas City, Mo. 64105	...do.....	Multnomah.
Pacific Carbide & Alloys Co.....	P.O. Box 17008 Portland, Oreg. 97200	...do.....	Do.
Perlite (expanded):			
Supreme Perlite Co.....	P.O. Box 66 North Portland, Oreg. 97043	...do.....	Do.
Pumice:			
Central Oregon Pumice Co.....	5 Greenwood Ave. Bend, Oreg. 97701	Mine and plant...	Deschutes.
Graystone Corp.....	Box 1087 Bend, Oreg. 97701	...do.....	Do.
Chester Hiatt.....	147 N. 12th St. Redmond, Oreg. 97756	...do.....	Do.
Oregon Portland Cement Co.....	111 S.E. Madison St. Portland, Oreg. 97214	Mine.....	Baker.
Jed Wilson & Son.....	Box 125 La Pine, Oreg. 97739	Mine and plant...	Lake.
Roofing Granules:			
Flintkote Co.....	P.O. Box 2744 Portland, Oreg. 97208	Plant.....	Multnomah.
Sand and gravel:			
Albany Rock Products Co.....	Rt. 1, Box 232K Albany, Oreg. 97321	Pit and plant....	Linn.
Baker Rock Crushing.....	2030 E. Main St. Hillsboro, Oreg. 97123	...do.....	Washington.
Bethel-Danebo Sand & Gravel...	150 Bertelsen Road S. Eugene, Oreg. 97402	...do.....	Lane.
Copeland Sand & Gravel.....	695 S.E. J St. Grants Pass, Oreg. 97526	...do.....	Josephine.
Delta Sand & Gravel.....	999 Division Ave. Eugene, Oreg. 97402	...do.....	Lane.
Eugene Sand & Gravel.....	Box 1067 Eugene, Oreg. 97401	...do.....	Do.
Glacier Sand & Gravel.....	5975 E. Marginal Way Seattle, Wash. 98134	...do.....	Multnomah.
McKenzie Sand & Gravel.....	Box 347 Eugene, Oreg. 97400	...do.....	Lane.
M. P. Materials.....	645 Seventh St. Salem, Oreg. 97300	...do.....	Marion.
Milwaukie Sand & Gravel.....	1635 S.E. McLoughlin Blvd. Milwaukie, Oreg. 97222	Dredge and plant.	Clackamas.
Morse Brothers.....	Lebanon, Oreg. 97355.....	Pit and plant....	Benton and Linn.
Chas. T. Parker Construction....	6457 N.E. Columbia Blvd. Portland, Oreg. 97203	...do.....	Multnomah and Columbia.
Portland Sand & Gravel.....	10717 S.E. Division Ave. Portland, Oreg. 97266	...do.....	Multnomah.
Rich Valley Top Soil Co.....	Box 30 Oregon City, Oreg. 97045	...do.....	Clackamas.
Rock Creek Sand & Gravel.....	Clackamas, Oreg. 97015.....	...do.....	Multnomah.
Roseburg Sand & Gravel.....	Box 1207 Roseburg, Oreg. 97470	...do.....	Douglas.
Ross Island Sand & Gravel.....	4129 S.E. McLoughlin Blvd. Portland, Oreg. 97200	Dredge and plant.	Multnomah.
Umpqua River Navigation Co....	Box 25 Reedsport, Oreg. 97467	...do.....	Douglas.
Willamette Hi-Grade Concrete Co.	Foot N. Portsmouth Ave. Portland, Oreg. 97203	...do.....	Multnomah.
Stone:			
L. V. Anderson.....	Box 757 Oakridge, Oreg. 97463	Quarry and plant.	Lane.
Beaver State Sand & Gravel, Inc.	Winchester, Oreg. 97495.....	Quarry.....	Douglas.
Boise Cascade Corp.....	La Grande, Oreg. 97850.....	Quarry and plant.	Union, Umatilla, Wallowa.
L. H. Cobb.....	8275 S.W. 145th Ave. Beaverton, Oreg. 97005	...do.....	Washington.
Eckman Creek Quarries.....	Box 15 Waldport, Oreg. 97394	...do.....	Lincoln.
Goodat Crushed Rock.....	P.O. Box 488 Longview, Wash. 98632	Quarry.....	Columbia.
L. W. Govro.....	Rt. 4, Box 253-W Albany, Oreg. 97321	Quarry and plant.	Linn.
Grant Construction Co.....	Hayden Lake, Idaho.....	Quarry.....	Various.
Roy L. Houck Sons.....	1158 Chemeketa N.E. Salem, Oreg. 97301	Quarry and plant.	Coos, Various.
Peter Kiewit Sons Co.....	Box 1777 Vancouver, Wash. 98663	...do.....	Various.

See footnote at end of table.

Table 7.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
NONMETALS—Continued			
Stone—Continued			
Materne Bros.....	Box O—Rosewood Station Spokane, Wash. 99208	Quarry and plant.	Various.
Oregon Portland Cement Co.....	111 S.E. Madison St. Portland, Oreg. 97214	---do-----	Baker.
Pacific Crushing Co.....	610 Irving Drive Eugene, Oreg. 97402	---do-----	Klamath, Lane.
Pioneer Construction Co.....	7881 N.W. St. Helens Rd. Portland, Oreg. 97229	---do-----	Multnomah.
Quality Rock Co.....	Rt. 2, Box 608 Beaverton, Oreg. 97005	---do-----	Washington.
Rogue River Paving Co., Inc.....	1133 S. Riverside Medford, Oreg. 97501	---do-----	Coos, Douglas, Jackson, Josephine.
Roseburg Sand & Gravel Co.....	Box 1207 Roseburg, Oreg. 97470	---do-----	Coos, Douglas, Lane.
Sunset Crushed Rock.....	Clatsop Airport Astoria, Oreg. 97103	---do-----	Clatsop.
Talc and Soapstone:			
John H. Pugh.....	2891 Elk Lane Grants Pass, Oreg. 97526	Mine.....	Josephine.
Vermiculite (exfoliated):			
Supreme Perlite Co.....	P.O. Box 66 North Portland, Oreg. 97043	Plant.....	Do.
Vermiculite-Northwest, Inc.....	P.O. Box A Auburn, Wash. 98002	---do-----	Do.
METALS			
Aluminum:			
Reynolds Metals Co.....	Troutdale, Oreg. 97060	---do-----	Multnomah.
Ferroalloys:			
Hanna Nickel Smelting Co.....	Riddle, Oreg. 97469	---do-----	Douglas.
Union Carbide Corp., Mining and Metals Division. <sup>1</sup>	Portland, Oreg. 97200	---do-----	Multnomah.
National Metallurgical Co.....	Springfield, Oreg. 97477	---do-----	Lane.
Gold and Silver:			
Baker Assets Co.....	Baker, Oreg. 97814	Mine and mill	Baker.
Cornucopia Placer Co.....	Halfway, Oreg. 97834	Placer	Do.
Mercury:			
Alcona Mining, Inc.....	366 S. 79th St. Springfield, Oreg. 97477	Mine.....	Douglas.
C. F. Taylor.....	1128 Phelps Ave. San Jose, Calif. 95117 (Prineville, Oreg.)	---do-----	Crook.
Nickel:			
Hanna Mining Co.....	Riddle, Oreg. 97469	---do-----	Douglas.
Steel:			
Cascade Steel Rolling Mills, Inc..	McMinnville, Oreg. 97128	Plant.....	Yamhill.
Oregon Steel Mills.....	Portland, Oreg. 97200	---do-----	Multnomah.
Titanium:			
Oregon Metallurgical Corp.....	Albany, Oreg. 97321	---do-----	Linn.
Rem Metals Corp.....	P.O. Box 829 Albany, Oreg. 97321	---do-----	Do.
Zirconium:			
Wah Chang Albany Corp.....	Albany, Oreg. 97321	---do-----	Do.

<sup>1</sup> Produces ferromanganese and silicomanganese.



# The Mineral Industry of Pennsylvania

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Pennsylvania Bureau of Topographic and Geologic Survey under a cooperative agreement for collecting information on all minerals except fuels. The contribution of unpublished information by many individuals is gratefully appreciated.

By Franklin D. Cooper <sup>1</sup>

Pennsylvania mineral production in 1970 had a record output value of \$1,096 million, a \$119 million increase over that of 1969. Those minerals showing an increase in total value compared with that of 1969, in million dollars, were anthracite, 4.6; bituminous coal, 123.5; lime, 0.3; sand and gravel, 2.5; and stone, 2.5. Those minerals having decreased in total value, in million dollars, were cement (portland and masonry), 6.0; clays, 3.8; copper, 0.3; petroleum (crude), 1.6; natural gas, 0.4; zinc, 0.6; and all other minerals whose individual values cannot be disclosed, 1.4.

Compared with 1969, the average f.o.b.

mine value of anthracite increased \$1.21 per ton and bituminous coal advanced \$1.40 per ton. Collectively, solid fuels production accounted for 67 percent of the total mineral production value in 1970 and was 23 percent greater than in 1969.

Leading producing counties, with primary commodities in parentheses, were Washington, Greene, Allegheny, Armstrong and Indiana (bituminous coal), Northampton (cement), and Schuylkill (anthracite). Counties reporting no mineral production were Cameron, Juniata, and Pike.

<sup>1</sup> Physical scientist, Division of Fossil Fuels.

Table 1.—Mineral production in Pennsylvania <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>Cement:</b>				
Portland.....thousand 376-pound barrels..	44,893	\$126,941	40,909	\$121,100
Masonry.....thousand 280-pound barrels..	3,085	8,504	2,804	8,324
Clays <sup>2</sup> .....thousand short tons..	2,727	19,637	2,665	15,845
<b>Coal:</b>				
Anthracite.....do.....	10,473	100,770	9,729	105,341
Bituminous.....do.....	78,631	461,579	80,491	585,057
Copper.....short tons..	3,382	3,215	2,539	2,930
Gem stones.....do.....	NA	4	NA	4
Lime.....thousand short tons..	2,008	28,952	1,887	29,279
Mica, scrap.....short tons..	W	W	1,000	60
Natural gas.....million cubic feet..	79,134	21,841	76,841	21,439
<b>Natural gas liquids:</b>				
LP gases.....thousand 42-gallon barrels..	35	78	34	87
Natural gasoline and cycle products.....do....	22	61	19	50
Peat.....thousand short tons..	35	407	44	517
Petroleum (crude).....thousand 42-gallon barrels..	4,448	20,086	4,093	18,500
Sand and gravel.....thousand short tons..	18,105	31,451	18,504	33,915
Stone.....do.....	66,992	117,726	66,241	120,187
Zinc <sup>3</sup> (recoverable content of ores, etc.).....short tons..	33,035	9,646	29,554	9,055
Value of items that cannot be disclosed:				
Clays (kaolin), cobalt, gold, iron ore, pyrites, sericite-schist, silver, and tripoli.....	XX	25,470	XX	24,053
Total.....	XX	976,368	XX	1,095,743
Total 1967 constant dollars.....	XX	921,984	XX	991,647

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

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

<sup>2</sup> Excludes kaolin; included with "Value of items that cannot be disclosed."

<sup>3</sup> Recoverable zinc valued at the yearly price of prime western zinc, East St. Louis market. Represents value established after transportation, smelting, and manufacturing charges have been added to the value of the ore at the mine.

Table 2.—Value of mineral production in Pennsylvania, by counties<sup>1 2</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Adams	W	W	Stone, lime, clays, sericite-schist.
Allegheny <sup>3</sup>	\$34,646	\$35,582	Coal, cement, clays, sand and gravel, stone.
Armstrong	42,098	W	W Coal, clays, sand and gravel, stone.
Beaver	3,420	W	W Sand and gravel, coal, clays.
Bedford	W	W	W Stone, coal, lime, sand and gravel.
Berks	W	W	W Iron ore, cement, stone, clays, coal, sand and gravel, pyrites, cobalt.
Blair	2,138	2,110	W Stone.
Bradford	W	W	W Sand and gravel.
Bucks	12,376	W	W Stone, sand and gravel, clays.
Butler	412,694	W	W Coal, stone, cement, lime, sand and gravel.
Cambria	W	W	W Coal, clays, stone.
Carbon	5,450	5,318	W Coal, sand and gravel, stone.
Centre	21,808	23,581	W Lime, coal, stone, clays.
Chester	W	W	W Stone, lime, clays.
Clarion	17,143	22,723	W Coal, stone, sand and gravel, clays.
Clearfield	27,564	34,372	W Coal, clays.
Clinton	W	W	W Coal, stone, clays.
Columbia	3,982	W	W Coal, stone, sand and gravel, peat.
Crawford	537	740	W Sand and gravel.
Cumberland	3,021	W	W Stone, sand and gravel, clays.
Dauphin	3,253	W	W Stone, coal, sand and gravel, clays.
Delaware	W	W	W Stone.
Elk	W	W	W Coal, stone.
Erie	W	W	W Sand and gravel, peat.
Fayette	7,578	17,482	W Coal, stone, clays.
Forest	461	W	W Sand and gravel.
Franklin	1,581	W	W Stone, sand and gravel.
Fulton	W	W	W Do.
Greene	89,913	102,285	W Coal.
Huntingdon	W	W	W Sand and gravel, stone, clays.
Indiana	W	60,525	W Coal.
Jefferson	W	W	W Coal, clays, stone.
Lackawanna	W	W	W Coal, peat, sand and gravel.
Lancaster	10,794	10,499	W Stone, coal, clays, sand and gravel.
Lawrence	W	W	W Cement, coal, stone, sand and gravel, clays, peat.
Lebanon	23,850	W	W Iron ore, lime, copper, stone, cobalt, pyrites, gold, silver.
Lehigh	34,654	32,842	W Cement, zinc, stone.
Luzerne	37,769	35,212	W Coal, sand and gravel, stone, peat, clays.
Lycoming	W	W	W Stone, sand and gravel, coal, tripoli.
McKean	217	W	W Clays, stone.
Mercer	2,166	W	W Coal, sand and gravel, stone.
Mifflin	W	W	W Sand and gravel, stone, lime.
Monroe	869	W	W Stone, sand and gravel, clays, peat.
Montgomery	W	W	W Stone, cement, lime, clays.
Montour	W	W	W Stone, lime.
Northampton	60,824	63,992	W Cement, stone, sand and gravel.
Northumberland	W	W	W Coal, clays, stone.
Perry	W	W	W Stone.
Philadelphia	-----	W	W Sand and gravel.
Potter	107	93	W Stone.
Schuylkill	41,241	W	W Coal, stone, sand and gravel, clays.
Snyder	398	W	W Sand and gravel, stone, coal.
Somerset	23,911	27,348	W Coal, stone, clays.
Sullivan	160	964	W Coal.
Susquehanna	W	606	W Stone.
Tioga	W	W	W Coal, sand and gravel.
Union	W	W	W Stone, clays.
Venango	W	W	W Coal, sand and gravel, stone.
Warren	696	933	W Sand and gravel.
Washington	W	W	W Coal, stone, clays.
Wayne	632	W	W Stone, sand and gravel, peat.
Westmoreland	W	24,375	W Coal, sand and gravel, stone.
Wyoming	1,322	W	W Sand and gravel.
York	410,226	W	W Cement, stone, lime, clays, sand and gravel, mica.
Undistributed	436,868	594,213	
Total <sup>5</sup>	976,368	1,095,743	

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

<sup>1</sup> Cameron, Juniata, and Pike Counties are not listed because no production was reported.

<sup>2</sup> Values of natural gas, natural gasoline, LP gases, petroleum, gem stones, sand and gravel, and stone unspecified by counties; included with "Undistributed."

<sup>3</sup> Excludes cement, included with "Undistributed."

<sup>4</sup> Excludes cement and lime; included with "Undistributed."

<sup>5</sup> Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Pennsylvania business activity

	1969	1970	Change, percent
Employment and labor force, annual average:			
Total labor force..... thousands.....	5,013.2	5,043.5	+0.6
Unemployment..... percent of work force.....	2.9	4.0	+37.9
Employment:			
Manufacturing..... thousands.....	1,580.9	1,525.6	-3.5
Durable goods..... do.....	940.2	902.4	-4.0
Lumber and wood products..... do.....	14.5	14.0	-3.4
Furniture and fixtures..... do.....	29.3	27.8	-6.7
Stone, clay, and glass products..... do.....	66.7	64.1	-3.9
Primary metals..... do.....	253.0	244.2	-3.5
Fabricated metal products..... do.....	116.3	112.8	-3.0
Nonelectrical machinery..... do.....	141.7	138.0	-2.6
Electrical equipment..... do.....	160.9	152.4	-5.3
Transportation equipment..... do.....	77.9	72.7	-6.7
Instruments..... do.....	38.7	37.9	-2.1
Nondurable goods..... do.....	640.6	623.3	-2.7
Food products..... do.....	114.6	114.0	-.5
Apparel and related products..... do.....	132.4	171.5	+6.0
Paper products..... do.....	48.7	48.7	-----
Printing..... do.....	69.5	70.1	+1.9
Chemical products..... do.....	63.0	62.1	-1.4
Nonmanufacturing..... do.....	2,738.8	2,823.5	+1.2
Mining..... do.....	38.9	39.6	+1.8
Contract construction..... do.....	203.1	195.6	-3.7
Personal income:			
Total..... millions.....	\$43,132	\$45,962	+6.4
Per capita..... do.....	\$3,678	\$3,893	+5.8
Construction activity:			
Value of authorized nonresidential construction..... millions.....	\$514.0	\$255.4	-44.5
Number of new residential units authorized.....	44,039	41,622	-5.5
Cement shipments to and within Pennsylvania thousand 376-pound barrels.....	19,901	17,259	-13.3
Mineral production..... millions.....	\$976.4	\$1,095.7	+12.2

Sources: Pennsylvania Department of Labor and Industry, Bureau of Employment Security and Statistics; Survey of Current Business; Construction Review; U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man- days worked (thou- sands)	Man- hours worked (thou- sands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non- fatal	Fre- quency	Severity
<b>1969:</b>								
Bituminous coal.....	21,139	245	5,169	41,424	26	1,073	26.53	5,690
Anthracite.....	5,927	232	1,377	10,073	13	492	50.14	9,090
Metal.....	1,383	303	419	3,348	1	29	8.96	2,044
Nonmetal.....	1,344	254	342	2,772	1	73	26.69	4,935
Sand and gravel.....	1,127	250	282	2,426	-----	55	22.67	739
Stone.....	8,470	278	2,354	18,709	2	296	15.93	1,705
Peat.....	56	232	13	106	-----	1	9.43	160
Total <sup>1</sup> .....	39,446	252	9,955	78,858	43	2,019	26.15	4,837
<b>1970: <sup>p</sup></b>								
Bituminous coal.....	22,000	250	5,507	44,143	31	1,170	27.16	5,854
Anthracite.....	6,000	240	1,447	10,533	5	485	46.71	4,123
Metal.....	1,350	303	409	3,273	1	20	6.42	2,172
Nonmetal.....	1,100	252	278	2,240	-----	82	36.61	1,997
Sand and gravel.....	1,125	240	270	2,360	2	34	36.45	8,443
Stone.....	7,900	276	2,177	18,079	5	267	15.04	2,714
Peat.....	55	231	13	90	-----	4	44.34	3,303
Total <sup>1</sup> .....	39,580	255	10,100	80,717	44	2,112	26.71	4,741

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

**Environment.**—The abatement of environmental problems, many of which involved the mineral industry directly, was prominent in 1970 Pennsylvania news. The State's implementation of many noteworthy

projects was facilitated by funding from a portion of the \$500 million bond issue for conservation made available by popular vote in the May 1966 primary election.

**Air Pollution.**—The National Air Pollu-

tion Control Administration (NAPCA) awarded the Consolidation Coal Co. a \$280,916 contract to obtain, in the company's laboratories at Library, basic information needed to demonstrate a new process for producing electricity from high-sulfur steam coal without polluting the atmosphere. This experimental program, being of particular interest to new power stations using both gas and steam turbines, will use the carbon dioxide-acceptor concept previously developed by the company in a

coal-gasification project sponsored by the Office of Coal Research.

The construction of a small experimental plant in Pittsburgh to produce solid sulfur from coal was provided for by a \$892,561 contract between NAPCA and Black, Sivals, & Bryson, Inc. Pulverized coal burned in a combustor containing molten iron will produce solid sulfur as a byproduct rather than sulfur dioxide.

The Allegheny Power System was one of six U.S. and Canadian utilities that agreed to underwrite a \$1.6 million test of the

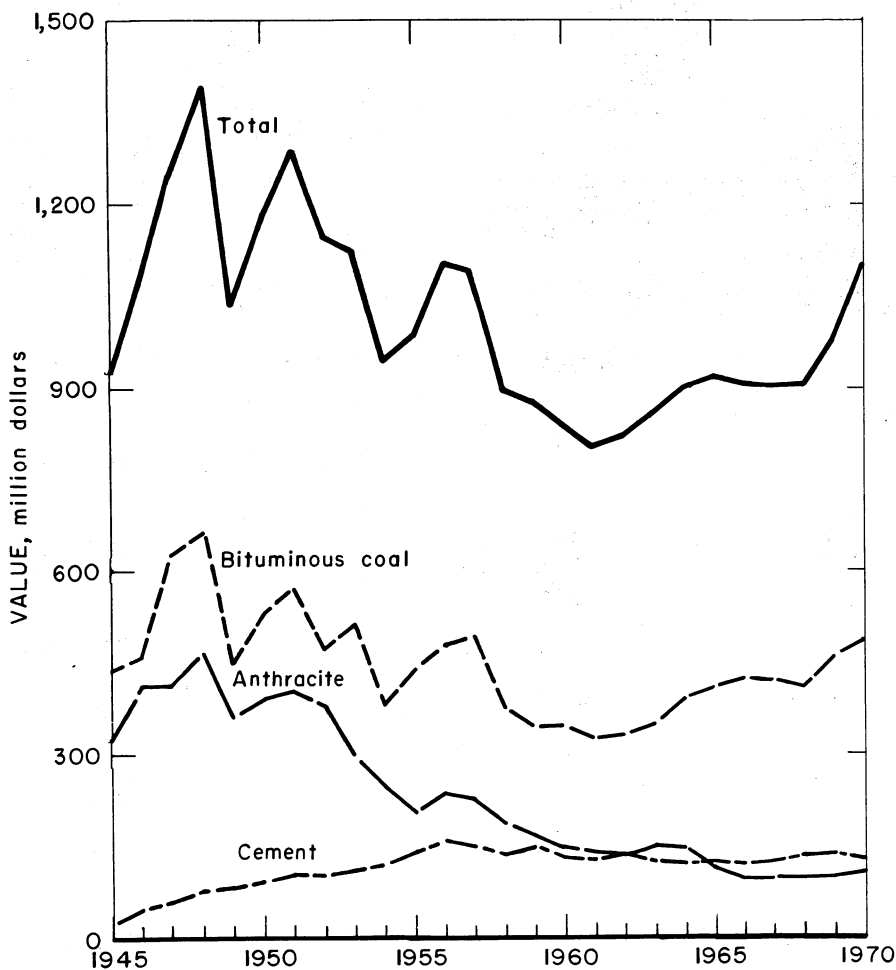


Figure 1.—Value of bituminous coal, anthracite, cement, and total value of mineral production in Pennsylvania.

Consolidation Coal Co.'s formate process for the removal of sulfur dioxide from stack gases. The first part of the project, the construction and operation of a small pilot unit at Library, will require 18 to 20 months to complete. The second part will require the installation of a semi-works scrubber at the Phoenixville Station of the Philadelphia Electric Co. to test the scrubbing part of the circuit.

Universal Atlas Cement Division at Northampton replaced electrostatic precipitators installed in 1948 with a \$2 million dust-collector system comprising two baghouses, each containing 936 glass bags, capable of cleaning 150,000 cubic feet per minute of effluent gases up to 550° F. The Whitehall Cement Mfg. Co. contracted for the installation of a \$500,000 baghouse-dust collection system at its Cementon plant to augment similar equipment installed in 1966 on the larger of two kilns.

The Allegheny County Health Department, Bureau of Air Pollution Control, used an IBM-1800 computer as the key element in the Pittsburgh area's air-pollution monitoring system. The on-line device gathered 18 parameters of data from three stations in the county. Eventually, a total of 17 stations will be linked with the computer.

A new \$2.4 million stack-gas cleaning system was put into operation at the Bethlehem sintering plant of the Bethlehem Steel Corp. Each of two electrostatic precipitators in the system can clean up to 290,000 cubic feet per minute of effluent gases from two of the four sinter machines in the plant.

The United States Steel Corp. at its Clairton Works installed a cyclone dust collector on a pelleted-pitch drying unit and also experimentally operated a continuous coke-quenching facility which reportedly removed as much as 85 percent of the particulates and most of the water droplets discharged to the atmosphere from a quenching tower. A third baghouse was installed at the Saxonburg sintering plant of the Homestead Works. The boiler house of the Ellwood plant of the Gary-Ellwood Works was converted from coal to natural gas. The corporation installed electrostatic precipitators rated at 720,000 standard cubic feet per minute in the open-hearth shops at the Fairless Works.

The Alan Wood Steel Co. at Conshohocken completed the installation of sepa-

rate collection systems for flux dust and kish in its basic oxygen furnace shop.

Air and water pollution abatement programs were completed at Brackenridge by the Allegheny Ludlum Steel Division. Similar projects were in progress at Washington by the Jessop Steel Co., at Coatesville by the Lukens Steel Co., and at Allenport and Monessen by the Wheeling-Pittsburgh Steel Corp.

Local sulfur oxide control regulations limited the sulfur content of fuels during 1970. In Allegheny County, bituminous coal was limited to 1.7 percent and oil to 2.3 percent, both effective December 17, 1969. In Philadelphia County, bituminous coal was limited to 2.0 percent, anthracite to 0.7 percent, No. 2 oil to 0.3 percent, No. 4 oil to 0.7 percent, and No. 5 and No. 6 oils to 1.0 percent, all effective May 1, 1970.

In May, the Grays Ferry Slag Corp. at Swedeland installed a second pelletizer that eliminated the emission of yellow smoke and hydrogen sulfide during the conversion of molten blast furnace slag into aggregates.

Section 12 of the Air Pollution Control Act of Jan. 8, 1960, Public Law 2119, as amended through 1968, section 4,001 et seq., provided for powers reserved to a political subdivision having an approved air-pollution control agency. Allegheny and Philadelphia Counties had such agencies in 1970, but the State's other 65 counties were regulated by the former Air Pollution Commission prior to Jan. 19, 1971. Air pollution abatement installations either completed in 1970 or planned to be completed in the 1970-71 period in compliance with requirements of the three regulating agencies are listed in table 5.

*Water Pollution.*—Because nearly 3,000 of the State's 50,000 miles of streams and rivers have been polluted by the uncontrolled flow of acid water from abandoned solid fuels mines, a portion of a massive State program, known as Operation Scarlift, which is funded with \$200 million for a 10-year period, was directed to control or abate water pollution.

The Federal Water Pollution Control Administration (FWPCA) provided research grants and contracts totaling over \$2 million for studies of ways to prevent and control pollution. The Hi-Hills Ranch, Inc., of Waynesburg received some of these funds for a project to demonstrate



Table 5.—Air pollution abatement installations in 1970

Industry and county	Number of process compliances	Emission reduction, <sup>1</sup> 2 tons per year	Estimated cost of equipment and controls	
			Thousands	Dollar per-ton-emission reduction per year
<b>Ferrous metals:</b>				
Allegheny <sup>3</sup> .....	10	2,400	\$5,300	\$2,208
Philadelphia <sup>4</sup> .....	5	<sup>5</sup> 1,773	360	203
All other <sup>3</sup> .....	8	25,801	10,805	419
Subtotal .....	23	29,974	16,465	553
<b>Non-ferrous metals:</b>				
Allegheny <sup>3</sup> .....	1	3,300	1,060	321
Philadelphia <sup>4</sup> .....	3	<sup>6</sup> 728	1,100	1,511
All other <sup>3</sup> .....	1	700	80	114
Subtotal .....	5	4,728	2,240	474
<b>Nonmetallic minerals:<sup>7</sup></b>				
Allegheny <sup>3</sup> .....	8	100	400	4,000
Philadelphia <sup>4</sup> .....	2	<sup>8</sup> 350	225	643
All other <sup>3</sup> .....	7	12,960	965	75
Subtotal .....	17	13,410	1,590	118
<b>Coal and petroleum:</b>				
Allegheny <sup>3</sup> .....	NA	NA	NA	NA
Philadelphia <sup>4</sup> .....	3	<sup>9</sup> 2,119	5,190	2,448
All other <sup>3</sup> .....	<sup>10</sup> 8	47,760	3,855	81
Subtotal .....	11	49,879	9,045	181
<b>Total:</b>				
Allegheny <sup>3</sup> .....	19	5,800	6,760	1,161
Philadelphia <sup>4</sup> .....	13	4,970	6,875	1,383
All other <sup>3</sup> .....	24	87,221	15,705	180
State, all counties .....	56	97,991	29,340	299

NA Not available.

<sup>1</sup> Rated design capacity for pollutants including particulates, hydrocarbons and carbon monoxide.

<sup>2</sup> Based on specific but varied numbers of operating days per year.

<sup>3</sup> Installed in calendar year 1970; types of emissions not available.

<sup>4</sup> Actual and planned to be completed in the 1970-71 period.

<sup>5</sup> Comprises 1,143 tons particulates and 630 tons carbon monoxide.

<sup>6</sup> Comprises 464 tons particulates and 264 tons carbon monoxide.

<sup>7</sup> Rock products, plantmix asphalt, and other nonmetals but excluding fuels.

<sup>8</sup> Particulates only.

<sup>9</sup> Comprises 586 tons particulates and 1,533 tons petroleum hydrocarbons.

<sup>10</sup> Does not include numerous small fuel conversions rated at 2,000-ton-per-year emission reduction and costing an estimated \$6 million.

whether sludge from an acid-mine-drainage neutralization plant could be dispersed into surface soil without polluting streams and groundwater. A \$1 million laboratory, sponsored by the FWPCA and the State, was dedicated at Hollywood in October. The laboratory will be used for a long-term study of bacterial oxidation in relation to the neutralization of acid mine water.

The Office of Saline Water (OSW) signed a 2-year agreement with the State to study the potential of desalting processes to treat acid mine drainage thereby providing supplemental supplies of fresh water for municipal and industrial users.

The Pennsylvania Department of Mines

and Mineral Industries (PDMMI) was studying many watersheds in the State to locate major sources of pollution before deciding on the most feasible elimination action.

The PDMMI and the Westinghouse Electric Corp., following 5 years of research, broke ground near the Susquehanna River at Wilkes-Barre for a \$14.2 million mine-water demineralization plant. The plant, scheduled for completion in mid-1972, will employ flash distillation to produce 5 million gallons per day of ultra-pure water suitable for fine chemical or textile manufacture.

An \$800,000 treatment plant, designed to convert 500,000 gallons per day of brackish

(high sulfate) mine water into potable water suitable for residential or industrial uses was ready for shakedown operation at yearend near Burgettstown, Washington County. This first-of-its-kind municipal water plant was designed to use the SulbiSul ion-exchange process developed by The Dow Chemical Co. In this process calcium hydroxide can be used as a regenerating agent instead of sodium hydroxide.

The PDDMMI started work on a \$1,589,000 mine-drainage treatment plant near Valley View in Schuylkill County. This plant, the first of its kind in the anthracite-producing regions, was designed to process and neutralize 10 million gallons per day of acid mine water.

An \$800,000 plant built by the State for the lime treatment of mine water was dedicated at Slippery Rock in Butler County. The resultant iron precipitates after thickening were stored in an abandoned strip mine.

The Swindell-Dressler Co. signed a \$1.9 million contract with the PDDMMI to build a mine-water treatment plant near Philipsburg in Clearfield County, to provide an additional 500,000 gallons per day of potable water to the area.

A number of industrial plants in the State installed water pollution control facilities during the year. Armco Steel Corp. completed spent-solution neutralization facilities at its steel pickling operations in Butler. Construction was in progress on two settling basins to trap mill scale and oil at the Homestead Works of the United States Steel Corp.

A retention dam and holding basin were completed to recover oil from effluent water at Sun Oil Co.'s Marcus Hook refinery complex. This construction was phase one of a \$7 million to \$8 million water-quality control program.

The Commonwealth's coal industry set the pace for the country with about 200 industry-operated mine-water treatment plants. These plants, in full operation at yearend, used lime for neutralization.

A unique project based on the injection of an inert gas was being studied in one mine in Pennsylvania and in another in West Virginia. The premise offered was that, if oxygen was displaced from a mine atmosphere, pyrite and marcasite would not be converted into soluble forms and

mine drainage pollution programs would be reduced or eliminated.

*Solid Wastes.*—After compaction at a central location in Pittsburgh, 600 tons per day of solid wastes were trucked to a coal strip pit where the waste was covered with backfill. This landfill operation turned reclamation and waste disposal problems into an asset by producing an industrial or recreation area.<sup>2</sup>

In June 1970, the Duquesne Light Co., from its Cheswick generating station near Pittsburgh, started pumping 750 tons per day of fly ash and bottom ash slurried in 3 million gallons of water through three, 130-foot-deep, 24-inch bore holes into its abandoned Harwick mine near Springdale. Normal mine drainage and water from the settled slurry recovered from the mine was treated, starting in February 1971, in a \$300,000 5-million-gallons-per-day plant using lime slurry, aeration, and a mechanical clarifier before discharging the water into Little Deer Creek. Sludge from the clarifier was pumped back into the mine.

About 100 tons of crushed and burned-out anthracite mine refuse was used as aggregate in repaving a haul road as part of a test by the State's Highway Dept. An estimated 50,000 tons of burned-out bituminous mine refuse was used for berm maintenance and ice control in 1970.

A \$589,000 contract was awarded to Glasgow Inc. by Montgomery County to prepare a depleted 125-foot-deep limestone quarry at Merion Station for use as a sanitary landfill. The contract called for sealing the quarry to prevent the leakage of toxic fluids. Reportedly, the quarry can accept 400 tons per day of trash for a 5-year period.

The Reading Railroad Company was reported as having dumped and covered solid industrial wastes in a landfill enterprise in Delano Township, Schuylkill County.

Pursuant to provisions of the Coal Land Improvement Act of 1965 that was initially supported by a \$1 million revolving fund, the State, as part of the Operation Scarlift program of the 1968-70 period, purchased 605 acres in privately-owned abandoned strip mined lands for reclamation and pol-

<sup>2</sup> Sheffer, H. W., E. C. Baker, and G. C. Evans. Case Studies of Municipal Waste Disposal Systems. BuMines Inf. Circ. 8498, 1971, 36 pp.

lution abatement purposes. Land agreements to attain the necessary access roads totaled 535. An amendment to the Act provided for the sale of such lands, after improvement by the State, to the highest bidders at no less than the cost of acquisition and restoration with the proceeds returned to the Land Acquisition Fund.

The Second Ash Utilization Symposium was held in Pittsburgh in March 1970. The symposium, which was jointly sponsored by the Bureau of Mines, the National Coal Association, the American Public Power Association, Inc., the Edison Electric Institute, and the National Ash Association, Inc., dealt with the problems and uses of ash from power-generating plants.<sup>3</sup>

Seven of the State's largest coal-burning electric utilities produced 3.2 million tons of fly ash and 1.6 million tons of slag and bottom ash, according to the National Ash Association.

**Legislation and Government Programs.**—Major conservation legislation dealing with the mineral industries was passed during the 1969–70 session of the General Assembly in 1970.

Act 38, an amendment to the Gas Operations Well-Drilling Petroleum and Coal Mining Act, declared a public policy for regulating additional gas storage pools; required the periodic inspection of all underground gas storage sites within the State by State personnel; and required the operators of all gas storages to furnish complete data to the Oil and Gas Division of the Department of Mines and Mineral Industries.

Act 50 authorized the acquisition either amicably or by condemnation of certain lands affected by open pit or strip mines and provided for the reclamation, use, and disposal of such lands.

Act 57 granted the Secretary of Mines and Mineral Industries the right to enter and restore abandoned strip mine areas and provided for liens upon such lands.

Act 187 amended the "Pennsylvania Solid Waste Management Act" by specifically providing for the regulation of disposal and transportation of solid wastes in mines.

Act 222 amended the Clean Streams Law by further regulating the discharge of sew-

age and industrial waste and the operation of coal mines and coal preparation plants, and imposed certain powers on the Sanitary Water Board, the Department of Health, and the Department of Mines and Mineral Industries. Regulatory powers were extended over all potential and actual sources of water pollution under provisions previously relating only to coal mining. This Act, by defining sediments as pollutants, provided for the regulation by permit of all impoundments exceeding 250,000 gallons. The Act also required that waters discharged into a receiving stream be within a pH range of 6 to 9, that they contain no acid, and no more than 7 parts per million of iron content.

Act 225 authorized a 10-cent-per-ton royalty on sand and gravel in or beneath certain rivers, streams, or other bodies of water.

Act 275, passed November 19, abolished the Department of Forests and Waters, the Sanitary Water Board, the Air Pollution Control Commission, and the State Soil and Water Conservation Commission. The Act created the Department of Environmental Protection and defined its functions, powers, and duties; transferred certain boards and commissions to the department; and repealed inconsistent acts.

H/B 1297 and H/B 1320, respectively, further regulated planting on the surfaces of spoil banks and backfills at bituminous and anthracite strip mines.

The Bureau of Mines awarded a \$95,245 research grant to Pennsylvania State University to investigate safer and more efficient electrical systems for underground coal mines.

The Philadelphia Interstate Air Quality Control Region's standards adopted by Pennsylvania, Delaware, and New Jersey were the first to be approved by the Secretary of Health, Education, and Welfare (HEW) under the Air Quality Act of 1967. According to HEW spokesmen, the air quality in the Pennsylvania portion of the region would be improved because of a 70-percent reduction in sulfur oxides and a 56-percent reduction in particulate matter.

<sup>3</sup> Faber, John H., Neil H. Coates, and John D. Spencer. Ash Utilization: Proceedings Second Ash Utilization Symposium. BuMines Inf. Circ. 8488, 1970, 351 pp.

A Federal-State cooperative project was approved by the Department of the Interior for the installation of instrumented stations to monitor the level and acidity of water in abandoned anthracite mines. This project will provide a factual basis for future efforts to abate pollution in the watersheds of the Susquehanna and Schuylkill rivers, to prevent surface subsidence, and to eliminate flooding of low-lying urban areas.

Personnel from the FWPCA were assigned to the Pennsylvania Bureau of Sanitary Engineering for 2 days per month to promote a greater exchange of ideas and data to give more impetus and precision to control activities.

The Department of the Interior approved a Federal-State cooperative project to control a fire in the abandoned Larimer bituminous coal mine near Irwin in Westmoreland County. Under terms of the Appalachian Regional Development Act of 1965, the Federal Government will pay 75 percent of the project's cost.

The Southwestern Pennsylvania region, comprised of six counties centering on Pittsburgh, was designated by the Department of the Interior as one of six metropolitan areas in the United States for a comprehensive study of environmental and resource factors affecting growth and redevelopment. The detailed work of the \$2 million, 4-year project will be conducted jointly by staff members of the U.S. Geological Survey and the Pennsylvania Department of Environmental Resources. Federal funds will cover 85 percent of the cost of the project that will study landslides on unstable slopes, subsidence related to mined-out areas, water pollution by industrial waste and acid water, flash floods, and limited construction resources.

The total costs of projects underway or authorized for the Interstate highway system in 1970 totaled \$780.1 million, \$101.3 million more than in 1969, while projects for primary, secondary, and urban highway extensions totaled \$402.1 million, \$8.4 million less than in 1969. The total cost of Interstate highway projects completed during the year was \$129.3 million, while the total cost of primary, secondary, and urban highway extensions completed was \$76.2 million. Interstate highway mileage opened to traffic since July 1, 1956, increased

108.66 miles to 1361.33 miles; at yearend 92.45 miles were under construction and 79.98 miles were in the design stage.<sup>4</sup>

During calendar year 1970, the Pennsylvania Department of Transportation awarded contracts for highway construction in the amount of \$355.9 million. Expenditures in 1970 for highway construction in million dollars totaled 417.0 and was distributed as follows: Interstate, 97.3; primary, 42.0; secondary, 36.2; urban, 33.3; Appalachian, 22.8; and 100 percent State, 185.4. The total expenditures for highway construction were \$3.9 million more than in 1969. In 1970 the total cost of maintenance work and snow and ice removal, all performed by State forces, was \$147.3 million or \$11.2 million more than in 1969.

The State's toll-free 313-mile portion of Interstate 80 was unofficially opened to traffic August 26 when the final sections in three counties were completed. The total project, built over a 12-year period, cost an estimated \$424.3 million.

Pursuant to the Appalachian Regional Development Act of 1965, as amended, environmental activities completed or in progress during 1970 and their final cost or estimated value of contracts in force included 10 mine-fire control projects, three of which were completed in three counties at a cost of \$4,432,000. Seven other such projects costing \$6,586,000 were in progress in four counties. Additionally, one well-sealing project costing \$160,000 was in progress, one subsidence control project costing \$1,316,000 was completed, and another subsidence control project estimated at \$1,480,000 was in progress. All of these projects had 75 percent Federal funding and 25 percent State funding. Another project, under Public Law 87-818 and funded equally by the Federal and State Governments, included the completion of backfilling of one hazardous anthracite mine opening at a cost of \$21,000. Work similarly financed was in progress under Public Law 162 on mine-water monitoring stations, all in the anthracite region, at a total cost of \$750,000. No surface mine reclamation projects were completed or in progress.

<sup>4</sup> Federal Highway Administration. Quarterly Reports on the Federal-Aid Highway Program. Dec. 31, 1969 and Dec. 31, 1970. Press Release FHWA-422, Feb. 10, 1970; Press Release FHWA-563, Feb. 17, 1971.

Eight Bureau of Mines publications released in 1970 discuss problems relating to the mineral industry of Pennsylvania.<sup>5</sup>

The Pennsylvania Geological Survey<sup>6</sup> and the U.S. Geological Survey also released relevant material.<sup>7</sup>

## REVIEW BY MINERAL COMMODITIES

### MINERAL FUELS

**Coal (Anthracite).**—The production of 9,729,000 short tons was the smallest in 8 consecutive years and was less than 10 percent of the production in 1917, the record year. The \$105.3 million total value was 4.5 percent more than in 1969 because of a \$1.21-per-ton increase in average f.o.b. mine value, to \$10.83.

Commercial exports, principally to Canada and Western Europe, totaled 789,499 tons, 161,318 tons more than in 1969, and were valued at \$11.2 million. Exports of anthracite through Philadelphia totaled 558,458 tons. The Federal Government continued purchasing anthracite to supply most of the solid-fuel needs of the U.S. Armed Forces in West Germany. Such shipments in 1970 totaled 692,060 tons compared with 992,647 tons in 1969.

Domestic consumption in tons by U.S. consumer categories follows: 4,042,000, residential and commercial heating; 1,357,000, miscellaneous industrial uses; 1,897,000, electric utilities; 472,000, coke plants; 464,000 sintering and pelletizing; and 16,000 colliery fuel.

Production came from 209 underground mines, 179 strip pits, 97 culm banks, and five dredges. The sources and tonnages comprising the total production included underground mines, 1,742,000; strip pits, 4,542,000; culm banks and silt basins, 3,036,000; and river bottoms, 409,000. The major producing countries, accounting for 81 percent of the total State production, were Schuylkill, Luzerne, and Northumberland.

The salable production, except that produced by dredging, totaled 9,320,000 tons and came from 72 breakers, 16 washeries, and 12 cleaning plants employing 1,655 persons. Nearly all of the washing and cleaning operations used dense-medium vessels or cyclones, or Wemco-type cones. The average f.o.b. mine value of this production was \$11.03 a ton.

Solids dredged from river bottoms, after processing by launder screens, yielded 409,000 tons of small sized fuel having an average value of \$6.09 per ton.

Shipments and average values of the total salable production included 3,926,000 tons shipped by railroads at \$10.47 per ton and 5,787,000 tons shipped by truck at \$11.06 per ton. The remainder, 16,000 tons at \$12.19 per ton, was used as colliery fuel.

Underground mines produced 17.9 percent of the State's total production. The 1970 underground production was 17.3 percent less than that in 1969. Output from the one large mine that remained in operation accounted for about 32 percent of

<sup>5</sup> Andreuzzi, Frank C. A Method for Extinguishing and Removing Burning Coal Refuse Banks. BuMines Inf. Circ. 8485, 1970, 29 pp.

Baker, E. C. Estimated Costs of Steel Slag Disposal. BuMines Inf. Circ. 8440, 1970, 18 pp.

Gait, G. B. Microfilming Maps of Abandoned Anthracite Mines. Mines in the Lackawanna Basin, Northern Anthracite Field. BuMines Inf. Circ. 8453, March 1970, 11 pp.

Glover, T. O., M. E. Hinkle, and H. L. Riley. Unit Train Transportation of Coal, Technology and Description of Nine Representative Operations. BuMines Inf. Circ. 8444, 1970, 109 pp.

Irani, M. C., and J. W. Hartwell. Mineral Materials for Chemical Industry in the Ohio River Basin of Ohio, Pennsylvania, and West Virginia. BuMines Inf. Circ. 8457, 1970, 86 pp.

McNay, Lewis M. Surface Mine Reclamation, Moraine State Park, Pennsylvania. BuMines Inf. Circ. 8456, 1970, 28 pp.

Rough, R. L., and W. K. Overbey, Jr. Lithologic Descriptions of Appalachian Area Oil-Producing Formations. BuMines Inf. Circ. 8473, June 1970, 133 pp.

Zeilinger, J. E., and A. W. Duerbrouck. Preparation Characteristics of Pennsylvania Anthracite From the Kidney Seam, Northern Field. BuMines Rept. of Inv. 7364, 1970, 19 pp.

<sup>6</sup> Kelley, D. R. and others. The Petroleum Industry and the Future Petroleum Province in Pennsylvania. Pa. Geol. Survey Pub. M65, 1970, 39 pp.

Lytle, W. S., and J. H. Goth. Oil and Gas Geology of the Kinzua Quadrangle. Pa. Geol. Survey Bull. M62, 1970, 99 pp.

Pennsylvania Geological Survey. Oil and Gas Developments in Pennsylvania in 1969 With Ten-Year Review and Forecast. Prog. Rept. 181, 1970, 65 pp.

Rose, A. W. Metal Mines and Occurrences in Pennsylvania. Pa. Geol. Survey Pub. M50, pt. 3, 1970, 14 pp.

Store, G. W., and A. I. Jonas. Geology and Mineral Resources of York County. Pa. Geol. Survey Pub. C67, (2nd printing), 1970, 195 pp.

<sup>7</sup> Cameron, C. C. Peat Deposits of Northeastern Pennsylvania. U.S. Geol. Survey Bull. 1317-A, 1970, pp A-1 to A-90.

Kent, B. H. Geologic Map of Part of the Carmichael Quadrangle, Southwestern Pennsylvania. U.S. Geol. Survey 1-588, 1969-70, 1 p.

Kent, B. H. Geologic Map of the Mather Quadrangle, Southwestern Pennsylvania. U.S. Geol. Survey GQ-826, 1969-70, 1 p.

Roen, J. B. Geologic Map of the Waynesburg Quadrangle, Southwestern Pennsylvania. U.S. Geol. Survey GQ-838, 1970, 1 p.

Table 6.—Pennsylvania: Anthracite production and value by counties

County	Production (thousand short tons)				Total value, (thousands)
	Underground	Strip	Bank	Total <sup>1</sup>	
Carbon.....	21	253	190	464	\$4,530
Columbia.....	21	257	111	389	4,119
Dauphin.....	22	---	66	88	425
Lackawanna.....	(?)	---	109	402	5,132
Luzerne.....	572	1,384	892	2,848	33,004
Northumberland.....	230	484	293	1,007	10,741
Schuylkill.....	876	1,756	1,374	4,006	43,934
Sullivan.....	---	116	---	116	964
Subtotal <sup>1, 3</sup> .....	1,742	4,542	3,036	9,320	102,843
Dredged production, total <sup>4</sup> .....	---	---	---	409	2,493
Total, State.....	1,742	4,542	3,036	9,729	105,341

<sup>1</sup> Data may not add to totals shown because of independent rounding.

<sup>2</sup> Less than ½ unit.

<sup>3</sup> Excludes dredged production.

<sup>4</sup> For Berks, Dauphin, Lancaster, and Snyder Counties.

the total underground production. No significant changes were made in underground mining practices other than in complying with the safe working conditions and dust-control-limit requirements of the Federal Coal Mine Health and Safety Act of 1969, effective March 30 and June 30, 1970, respectively.

Two West German longwall shearer-loader machines, designed to operate on a short face, were compared under similar operating conditions in the 8-foot-thick Bottom Red Ash vein of No. 14 Plane in the Blue Coal Corporations Wanamie No. 19 Colliery. The cooperative research project was sponsored by the Coal Research Board of PDMMI with Blue Coal providing the site and the major funding of the equipment purchases. A Monninghoff Miniko machine was installed on Apr. 8, 1969, and an Eickhoff Mini-Ranger machine, obtained through the U.S. marketer, started work Mar. 26, 1970. The Miniko averaged 110 tons per operating shift with a 14.5-foot-wide cut and 18-foot advance, while the Mini-Ranger with a 21-foot-wide face produced about three times as much as the Miniko.

Run-of-mine material containing 1,151,000 tons of salable product, 66.1 percent of the total underground production, was mechanically loaded by 103 scraper loaders, 20 mobile loaders, 147 conveyor and pit car loaders, duckbills and other self-loading conveyors. An average of 40.2 million gallons of water per day was delivered to the surface by 179 pumps at active mines and at a few inactive mines in which uncontrolled high water levels caused local surface flooding unless pumping was performed.

One mine, whose production was 72,085 tons, installed 2,050 new roof bolts.

Strip pits produced 46.7 percent of the total State production. The 1970 strip pit production was 0.8 percent less than in 1969. Equipment used in strip pit and culm bank operations totaled 94 power shovels, 72 of which were diesel powered; 146 draglines, 104 of which were diesel powered; 10 payloaders; and unknown numbers of haulage trucks, scraper loaders and bulldozers. Since 1964, the active anthracite stripping industry has reclaimed about 380 acres annually. Water removed by seven pumps located in strip pits average 22.7 million gallons per day.

Salable products recovered from culm bank material and silt basins accounted for 31.2 percent of the State's total production of anthracite in 1970, and were 6.7 percent less than in 1969.

Anthracite recovered by river dredging accounted for 4.2 percent of the State's total anthracite production and 2.4 percent of its total value. The dredged production was about 23.6 percent less than in 1969. About 78 percent of the dredged production came from the Susquehanna river area and the remainder from the Schuylkill river area.

The anthracite industry consumed 44.95 million pounds of explosives. 65.2 percent of which was classed as permissibles and the remainder as dynamites. Deep mines used 1,299,000 pounds of permissibles, strip mines used 28,023,000 pounds of processed and unprocessed ammonium nitrate and 15,577,400 pounds of dynamites, and blasting at culm banks used 49,000 pounds of dynamites.

Based on preliminary data the anthracite industry averaged 241 days worked in 1970

with an average of 6,000 men working daily, 73 men more than in 1969. Productivity for all activities, excluding dredging, averaged 6.53 tons per man day compared with 7.31 tons per man day in 1969, while productivity, only for dredging, average 21.76 tons compared with 29.92 tons per man day in 1969. The overall average productivity for the entire anthracite industry was 6.72 tons, 0.99 ton per man day less than the 7.61-ton average in 1969.

Work deaths totaled five compared with 13 in 1969. The frequency rate of fatalities per million man hours was 0.47 in 1970 and 1.29 in 1969. The causes of the 1970 fatalities follow: one, underground by blasting; one each, by outside haulage and by another cause at cleaning plants; and one each, by machinery and electricity in strip mines. Nonfatal, lost-time injuries totaled 485 in 1970 and 492 in 1969; the frequency rate of lost-time injuries per million man hours of exposure was 46.71 in 1970 and 50.14 in 1969.

Innovations in mining methods were described in three publications.<sup>8</sup>

The United Gas Improvement Co. shipped 800 tons of 40-percent-ash and 7,500- to 8,000-Btu content culm-bank solids to a factory in La Rochette, France, where it was tested in a full-scale Ignifluid combustor furnace. Based on the successful test, the company planned to have a 250 megawatt commercial power station on line in 1975. Reportedly this proposed station will be located within 40 miles of culm banks containing 100 million tons of solids. The fuel for the proposed station will be obtained from culm-bank material crushed to 2-inch maximum size and floated at 2.0 specific gravity by heavy media separation to produce fuel comprising 60 percent of the raw feed. The 95-percent-ash content sink solids will be used as fill in existing open pits.

**Coal (Bituminous).**—The total production of 80.5 million short tons was valued at \$585.1 million compared with 78.6 million tons valued at \$461.6 million in 1969 and 178.6 million tons in the record-production year of 1918. The average f.o.b. mine value of 1 ton increased to \$7.27 from \$5.87 in 1969. Open market sales totaled 51.0 million tons and averaged \$6.32 per ton at the mine while 29.5 million tons of captive coal averaged \$8.90 per ton at the mine.

Thirteen groups or companies produced 47.6 million tons. Six of the groups or companies were captive operations with a total output of 25.2 million tons from deep mines and 0.3 million tons from strip mines. The other seven groups or companies produced 18.4 million tons from deep mines and 3.7 million tons from strip mines, all of which was sold on the open market.<sup>9</sup>

The quantity of product in million tons shipped by type of transportation follows: 56.5, by rail or water; 17.5, by truck; and 5.85, to mine-mouth electric utilities principally by belt conveyor. Unit-train shipments totaled 21.3 million tons, 6.5 percent more than in 1969. On-site consumption totaled 337,224 tons for colliery fuel and miscellaneous uses and 273,519 tons were shipped to adjacent beehive coke ovens. Exports through Philadelphia totaled 297,393 tons.

Active mines totaled 807; 198 were underground, 30 fewer than in 1969; 555 were strip mines, 26 more than in 1969; and 54 were auger mines, seven fewer than in 1969. The new plus-100,000-ton-per-year mines that began production in 1970 eventually will produce 6.2 million tons annually. Productivity for the entire bituminous coal industry averaged 14.42 tons per man day compared with 15.21 tons in 1969.

The number of underground mines by types and their approximate production follows: eight shaft mines, 6,529,000 tons; 43 slope mines, 28,455,000 tons; and 147 drift mines, 20,398,000 tons. Production in 1,000 tons was distributed by seams as follows: Pittsburgh, 26,339; Lower Kittaning, 10,970; Upper Freeport, 9,725; Lower Freeport, 4,459 Sewickley, 1,391; Upper Kittaning, 616; Middle Kittaning, 452; Clarion, C Prime, Brookville, and Redstone seams, 1,024; and unaccounted for, 406.

Mechanical cleaning plants totaling 74, three fewer than in 1969, produced 51.3 million tons of product and 16.9 million tons of refuse. The percentages of cleaned product by origin follows: 81.9, under-

<sup>8</sup> Coal Mining and Processing. Is Automated Semi-longwall Production of Anthracite the Answer? V. 7, No. 8, August 1970, pp. 34-38.

Jones, Donald C. Mammoth Stripping Job Gets Underway. Coal Mining & Processing, v. 7, No. 10, October 1970, pp. 74-76.

Stefanko, Robert, and Edmund H. Watkins. Monorail Haulage System. Min. Cong. J., v. 56, June, 1970, pp. 45-49.

<sup>9</sup> Keystone News Bull. V. 29, No. 2, Feb. 26, 1971, pp. 19-24.

**Table 7.—Pennsylvania: Bituminous coal production by type of mine and county**

(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines				Production (thousand short tons)				Value (thousands) <sup>2</sup>
	Under-ground	Strip	Auger	Total	Under-ground	Strip	Auger	Total <sup>1</sup>	
Allegheny	10	13	---	23	3,912	731	---	4,642	\$34,970
Armstrong	21	44	10	75	5,796	1,818	182	7,795	48,311
Beaver	W	W	W	7	W	W	W	219	1,244
Bedford	W	W	---	6	W	W	---	18	106
Butler	W	W	W	36	1,047	901	36	1,984	10,229
Cambria	29	22	---	51	5,764	795	---	6,559	66,919
Centre	W	W	---	22	539	803	---	1,342	7,459
Clarion	W	W	W	67	W	W	W	4,383	21,971
Clearfield	13	81	7	101	1,234	4,537	107	5,879	30,744
Clinton	---	6	---	6	---	451	---	451	2,642
Elk	W	W	W	18	15	345	42	402	2,392
Fayette	W	W	W	35	W	W	W	1,825	13,754
Greene	13	8	---	26	11,324	263	---	11,586	102,235
Indiana	35	31	8	74	7,145	1,116	128	8,389	60,525
Jefferson	7	51	12	70	235	1,336	92	1,663	10,973
Lawrence	---	W	W	23	---	853	30	883	4,645
Lycoming	---	W	---	W	---	66	---	66	287
Mercer	---	W	---	W	---	226	---	226	1,130
Somerset	W	W	W	89	1,264	2,457	22	3,743	24,774
Tioga	---	8	---	8	---	885	---	885	4,525
Venango	---	10	---	10	---	477	---	477	2,110
Washington	W	W	W	31	13,707	753	4	14,464	115,438
Westmoreland	7	22	---	29	2,397	213	---	2,610	17,663
Total <sup>1</sup>	198	555	54	807	55,382	24,447	661	80,491	585,057

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

<sup>1</sup> Data may not add to totals shown because of independent rounding.<sup>2</sup> Value received or charged for coal f.o.b. mine. Includes a value for coal not sold but used by producers, such as mine fuel and coal coked, as estimated by producers at average prices that might have been received if such coal had been sold commercially.

ground mines; 18.0, strip mines; and 0.1, auger mines. Wet washing equipment other than jigs produced 30.9 million tons distributed approximately in million tons as follows: tables, 6.0; launders, 2.1; froth flotation, 2.1; dense medium, 19.5; and classifiers, 1.2. Jigs accounted for 12.3 million tons; and pneumatic-type equipment produced 8.2 million tons. The annual capacity of all bituminous-coal mechanical-cleaning equipment purchased in 1970 for use in the State was 3,272,500 net tons based on a 7-hour day and 220 days per year. This capacity equals 2,125 tons per operating hour. The salable product from preparation plants averaged 135.3 tons per man day compared with 142.7 tons in 1969.

Dried coal totaling 6.14 million tons was produced by 11 thermal drying units in nine plants.

Crushed coal totaling 37.0 million tons came from 154 plants.

Underground mines produced 55.38 million tons, 1.2 percent less than in 1969. Continuous mining machines totaling 464, six more than in 1969, produced 46.12 million tons, 0.89 million tons more than in 1969. These machines included ripper, boring, oscillating-disc-head, and rotary drum

types. Because some continuous mining machines were not capable of loading raw coal, 63 mobile loaders were teamed with them to load 2.06 million tons from mine floors. The other continuous mining machines loaded 5.20 million tons onto feeder conveyors and 38.85 million tons into shuttle cars and rubber-tired mine cars.

One planer longwall and nine shearer-loader installations mined and loaded 1.92 million tons, 0.05 million tons less than in 1969. These 10 installations were operated by five companies in seams ranging from 43 to 78 inches in thickness under 200 to 800 feet of cover. The blocks of coal mined ranged from 400 to 600 feet in face length and from 2,550 to 2,880 feet in panel depth. The number of men for one crew shift ranged from seven to 10, and run-of-mine coal mined during one crew shift ranged from 700 to 1,277 tons.

Four mobile loaders discharged 48,374 tons directly into mine cars or onto conveyors, and 6,871,843 tons were dumped into shuttle cars by 85 mobile loaders. The remainder of the mechanically loaded coal (79,322 tons) was handled by duckbills and scraper conveyors.

A total of 154 cutting machines, 55 fewer than in 1969, were used to cut



7,608,642 tons. Coal shot from the solid or cut by hand totaled 11,854 tons, 82 percent less than in 1969.

Coal drilling by 128 hand-held or post-mounted drills, 32 fewer than in 1969, was used to produce 4,762,232 tons, while 12 mobile drills, 23 fewer than in 1969, were used to produce 1,942,557 tons. Roof bolting employed 271 rotary drills, 33 fewer than in 1969, and 291 percussion drills, 18 more than in 1969. Roof or rock drills used for other purposes included 23 rotary drills, six more than in 1969, and 44 percussion drills, 11 more than in 1969.

Approximately 1,126,000 pounds of permissible explosives were consumed in underground mines for blasting 6.7 million tons of coal and for other purposes.

Eighty mines installed 9,650,140 roof bolts, all new, as either the sole method of roof support or in conjunction with other support materials. These 80 mines produced 61,629,940 tons of coal including 54,162,940 tons produced under roof supported only by bolts.

Less than half the haulage of raw coal and operating supplies was done by 975 trolley locomotives, five more than in 1969, by 50 battery locomotives, five more than in 1969, together with 13,311 mine cars of 3.3-ton average capacity, 565 fewer than in 1969, operating on 668 total miles of track, the same mileage as in 1969.

The larger part of the haulage was performed by 562 gathering and haulage conveyors, 12 fewer than in 1969, totaling 199.6 miles in length compared with 206.1 total miles in 1969. Considerable intermediate haulage was done using 1,013 cable-reel and 27 battery shuttle cars, 13 smaller capacity shuttle buggies, 126 rubber-tired tractors, 286 rubber-tired trailers, and 187 rubber-tired mine cars averaging 1.8 tons capacity.

Shipments of new equipment to the State's deep mines in 1970 included seven mobile loaders, 54 continuous mining machines, two longwall units, 102 shuttle cars, 77 gathering and haulage conveyors, and unknown numbers of rubber-tired tractors, trailers, and roof drills.

The 55.4 million-ton underground production averaged \$8.12 per ton f.o.b. mine compared with the 56.0-million-ton production at \$6.53 per ton f.o.b. mine value in 1969. Washington and Greene Counties produced 25.0 million tons or 45.2 percent

of the State's underground production. About 19.5 million tons of the deep mined coal produced in these counties was captive.

Productivity at underground mines averaged 12.28 tons per man day compared with 13.92 tons in 1969.

A world record in coal production from a longwall face was achieved at the Cambria Division's Mine 33 of the Bethlehem Mines Corp. In one 24-hour period, 7,050 tons were produced from a 600-foot face in the 54-inch-thick Lower Kittanning "B" seam under 800 feet of cover.

The Helvetia Coal Co.'s Lucerne No. 6 mine was the first in the State to receive approval for nominal 1,000-volt AC power for both longwall and continuous miners.

A portable device for the continuous measurement of coal dust particles was developed by a Pennsylvania State University scientist under contract with the State's Coal Research Board.

Gray and Myers gave a detailed discussion of support methods successfully used for preventing subsidence in the case of new construction over shallow-depth mine workings in the Pittsburgh area.<sup>10</sup>

Strip mining equipment included 570 power shovels, the same number as in 1969, and 364 draglines, 49 more than in 1969. About 97 percent of the shovels and draglines were diesel powered and 79 percent had capacities of 5 cubic yards or less. Of the 10 carryall scrapers in use, 18 fewer than in 1969, nine had capacities of 5 cubic yards or less. Other equipment included 705 bulldozers, 40 horizontal drills, 138 vertical drills, 177 front-end loaders, 11 wheel-excavators, six power brooms, 41 motor graders; and one coal drill. No data were available for the truck haulage of raw coal.

Productivity at strip mines averaged 23.26 tons per man day compared with 22.66 tons in 1969.

The 24.4-million-ton strip mined production averaged \$5.38 per ton f.o.b. mine compared with the \$4.24-per-ton value for the 22.0-million-ton production in 1969. About 3.5 percent of the production was captive. Clearfield and Clarion Counties produced 8.9 million tons, or 36.5 percent

<sup>10</sup> Gray, Richard E., and J. F. Myers. Mine Subsidence and Support Methods in the Pittsburgh Area. J. Soil Mechanics and Foundations Div. Proc., American Soc. Civil Eng., v. 96, No. SM4, July 1970, pp. 1267-1287.

of the State's total strip mined production. The Fox mine of the C & K Coal Co. was the largest producer with 2,014,000 tons.

According to the Pennsylvania Dept. of Environmental Resources, the area of lands reclaimed annually since 1964 by active bituminous coal strip mining operators has averaged about 10,000 acres in a range of 9,500 to 10,900 acres. Most of the reclamation was classed as terrace backfilling. In 1970 about 7.5 million trees were planted on about 6,500 acres, while grasses were planted on about 4,000 acres using as much as 400 pounds of 10-20-10 fertilizer per acre. Reportedly, the total cost for grading and backfilling strip mined land in recent years averaged \$486 per acre in 108 projects totaling 3,736 acres.

Strip production in 1,000 tons was distributed by seams as follows: Kittaning, 9,424; Freeport, 4,655; Clarion, 2,970; Pittsburgh, 1,635; Brookville, 1,137; Redstone, 365; and Bakertown, Big A, Brush Creek, C-Prine, Clay Rider, Fulton, Miller B, Seymour-Bloss, Uniontown, Walters, and Waynesburg seams and unaccounted for, 4,261.

Strip and auger mining consumed 7.9 million pounds of permissible explosives, 6.2 million pounds of dynamites, and 69.3 million pounds of processed and unprocessed ammonium nitrate for blasting purposes.

Active equipment for auger mining included 48 augers, three bulldozers, five horizontal drills, three diesel shovels rated at less than 5-cubic-yard capacity, two front-end loaders and one wheel excavator. Auger mines owned 55 coal-recovery augers in 1970.

The 661,000-ton auger-mined production averaged \$5.51 per ton f.o.b. mine compared with the \$4.04 per ton f.o.b. mine value for the 622,000-ton production in 1969. Armstrong and Indiana Counties produced about 310,000 tons or 47 percent of the State's auger-mined production. Only 2.9 percent of the total auger production was captive. Production in 1,000 tons was distributed by seams as follows: Freeport, 453; Kittaning, 197; and Miller B, Clarion, and Pittsburgh, 11.

Productivity at auger mines averaged 34.08 tons per man day compared with 43.25 in 1969.

The State's electric utilities received 28,381,000 tons of bituminous coal in 1970. A long-term contract made Greenwich Col-

lieries Co. the sole supplier of coal to be hauled in 13,000-ton unit trains from the new Lancashire No. 26 mine to the 765-megawatt Pennsylvania Power and Light Co. powerplant near Washingtonville in Montour County. The combined investment in the new mine and powerplant was \$264 million. At yearend the mine was producing 4,000 tons per day, with production planned to reach 17,000 tons per day by 1975.

The North American Coal Corp. contracted to deliver 20 million tons of coal from its Johnstown-area reserves to several Pennsylvania Power and Light Co. plants. The Oneida Mining Co., an affiliate of North American, will own and operate the mine from which coal will be shipped in the utility's fleet train.

The Florence Mining Co. simultaneously operated two mines in two seams of the same underground property in Indiana County to supply about 2 million tons of coal by belt conveyor to the partially completed Conemaugh steam-electric plant at Huff. This plant, owned by nine power companies will have two rail-mounted, bucketwheel, coal-stacker reclaimers. The 12,200-Btu coal delivered was prepared using scalping screens, rotary breakers, and air tables. It was planned for this mining company to supply 80 to 100 percent of the 5-million-ton annual requirement for the Conemaugh plant when it is completed.

The first two of three 540,000-kilowatt generating units were in operation at yearend at the Hatfield's Ferry power station near Masontown. When in full operation in 1971, the 1,620,000-kilowatt station will require 4.5 million tons of coal annually.

Two developments were in progress during 1970 that could affect the future pattern of coal-fueled power generation in the State. First, the investigation of a reliable technique for the underground transmission of electricity at voltages as high as 750-kilovolts was the specific objective of the Electric Research Council's research program conducted at Waltz Mill by Westinghouse Electric Corp. under contract with Edison Electric Institute. Because accelerated life tests and other evaluations required a 1,100-kilovolt energy source, the project also was a test of the technical and economic feasibility of million-volt over-

head transmission. Second, two nuclear-powered experimental plants commissioned before mid-1967 at Shippingport and Delta had a total generating-capacity of 130 megawatts (MWe) and five units with a total generating capacity of 4,618 MWe were under construction and scheduled for commercial operation in the 1972-73 period. This amount of generating capacity, if fueled by bituminous coal, would require 11 to 13 million tons annually. The Peach Bottom plant at Delta, owned by the Philadelphia Electric Co., was the only operating gas-cooled reactor in the United States.

Safe-working-condition regulations and dust-control limits of the Federal Coal Mine and Safety Act of 1969 became effective March 30 and June 30, respectively.

Accidents incurred by the State's bituminous coal industry included 31 fatalities, five more than in 1969, and 1,170 nonfatal lost-time injuries, 97 more than in 1969. Injury rates for one million man hours of exposure were 0.70 fatal compared with 0.63 fatal in 1969, and 26.50 nonfatal compared with 25.90 nonfatal in 1969.

On a million-ton-production basis, injury rates were 0.38 fatal compared with 0.33 in 1969, while the nonfatal rate was 14.53 compared with 13.64 in 1969.

In 1970, underground mine fatalities totaled 27; 15 by falls of roof, one by the fall of face, side, rib or pillar, five by haulage, one by gas and dust explosion, one by electricity, three by machinery, and one by surface haulage related to underground mining. Strip mines had two fatalities, one of which was caused by machinery. Auger mines had no fatalities. Preparation plants had two fatalities, one of which was caused by machinery.

The trophy winner in the 1970 underground coal mine contest of the 46th National Safety Competition was the Robena No. 1 Mine, United States Steel Corp., Carmichaels, Greene County, for 671,438 man hours without a disabling work injury.

**Coke.**—Eight companies operated 11 oven-coke plants, one classified as merchant and 10 as furnace. Collectively, these 11 plants carbonized 26,352,000 short tons of coal, including 14,830,000 tons of bituminous coal and 71,200 tons of anthracite produced in the State, to produce 18,212,000 short tons of breeze-free metallurgical coke, 95.6 percent of which was blast furnace grade valued at \$32.57 (aver-

age) per ton, and coproducts and byproducts comprising coke breeze, gas, nitrogen fertilizers, tar, pitch, naphthalene, and crude light oil and its derivatives.

Four beehive-coke plants in two counties produced 444,069 tons of coke, principally for blast furnaces, using 745,654 tons of coal of which 472,135 tons were not mined by the beehive-oven operating companies.

Ten iron and steel works operated by seven companies, had integral oven-coke plants with a total of 3,361 slot-type ovens, 1,375 of which were in the world's largest coke plant at Clairton. Another raw iron and steel producer obtained blast furnace coke from the parent company's oven-coke at Fairmont, W.Va., and from a subsidiary's 264 beehive ovens at Templeton, Pa. Coal used in the beehive oven plant was handled through a gravity flow bin installation developed by Bituminous Coal Research, Inc. This type of bin is the second one installed at U.S. beehive coke plants. Pennsylvania ranked first in U.S. oven-coke production with 28.04 percent of the total.

Exports of coke through Philadelphia totaled 465,180 tons.

A 10,000 square-foot facility employing 25 persons for the processing of coke was announced by Limewood Inc., at Boyers in Butler County.

**Natural Gas Liquids.**—Production of natural gas liquids decreased 7 percent below that of 1969, to 53,000 barrels. Of the total production, 19,000 barrels were natural gasoline and cycle products and 34,000 barrels were liquefied petroleum (LP) gas. LP gases averaged \$2.56 per barrel compared with \$2.23 in 1969, and natural gasoline and cycle products averaged \$2.63 per barrel compared with \$2.77 in 1969.

According to the Oil and Gas Division, Pennsylvania Bureau of Topographic and Geologic Survey, proved reserves of natural gas liquids totaled 896,000 barrels at yearend 1970 compared with 974,000 barrels at yearend 1969. Two natural gas processing plants processed 3.3 million cubic feet of gas and recovered 150 barrels of liquid daily.

The Statistical Committee of the Natural Gas Processors Association in its 1971 LP-gas (LPG) storage survey reported the State's total capacity for underground LPG storage as 1,091,000 barrels. One company in Delaware County used caverns mined in granite to store 500,000 barrels of butane,

400,000 barrels of propane, and 75,000 barrels of propylene. In Westmoreland County, one company used a mined cavern for storing 116,000 barrels of n-butane. One gas works in Philadelphia County had 54 aboveground tanks for storing 1,620,000 barrels LPG.<sup>11</sup>

**Peat.**—Eleven operations in seven counties reported a total production of 49,284 short tons, 24.4 percent more than in 1969. The total production comprised 1,863 tons unprepared, 45,171 tons shredded only, and 2,250 tons kiln-dried only. Lackawanna County was the leading producer with 15,000 tons followed by Luzerne County with 11,928 tons. The other producing counties were Columbia, Erie, Lawrence, Monroe, and Wayne.

Sales, totaling 43,793 tons at an average value of \$11.81 per ton, were 23.5 percent greater and averaged 5 cents per ton more than in 1969. Sales of bulk peat for general soil improvement totaled 26,159 tons and averaged \$10.20 per ton. Total sales by type included 7,775 tons of moss, 17,628 tons of reed sedge, and 18,390 tons of humus.

Research findings on existing peat accumulations by Given emphasized the importance of ecology in the conversion of peat to Pennsylvania coals differing considerably in properties.<sup>12</sup>

**Petroleum and Natural Gas.**—Crude petroleum production was 8.0 percent less than in 1969 despite the startup of several new water-flood projects. The average value, \$4.52 per barrel at the well, was the same as in 1969. In 1970, as in the last 7 years, because the production of Pennsylvania-grade crude petroleum exceeded the producing companies' refining capacity, some of this crude oil was sold at unfavorable prices to other refiners. However, the current expansion of refining capacity and a sales program, making Pennsylvania-crude-based lubricants available throughout the United States, was expected to balance the excess production.

The number of petroleum-producing wells, all of which were strippers on 632,034 acres, decreased to 36,801 from the 37,625 total in 1969.

The State's crude petroleum production comprised 4,028,000 barrels of Pennsylvania grade valued at \$18,302,750, and 65,000 barrels of Corning grade valued at \$197,250 produced in Crawford and Erie

Counties from the Medina (Lower Silurian) Sandstone.

Proved reserves of crude oil decreased 3.4 million barrels during 1970, to 51.3 million barrels at yearend. Indicated reserves of crude oil economically available by fluid injection totaled 32.8 million barrels.<sup>13</sup>

Natural gas production totaled 76.8 billion cubic feet, a decrease of 2.9 percent from that of 1969, while its average value increased 3 mills, to 27.9 cents per thousand cubic feet. A total of 61.7 billion cubic feet of gas was produced from the shallow (Upper Devonian or younger) reservoirs, while production from the deep (Middle Devonian or older) reservoirs, totaled 15.1 billion cubic feet. The estimated total number of producing gas wells decreased from 16,600 in 1969 to 16,548 in 1970. Estimated proved reserves of natural gas totaled 1,378 billion cubic feet, including 585 billion cubic feet in storage at yearend in 65 pools, serviced by 2,139 wells and equal to approximately 14 percent of the U.S. reservoir capacity. This was an increase in all reserves of 74 billion cubic feet above those of 1969.

The American Petroleum Institute reported that 774 new wells were drilled during 1970 for a total of 1,433,248 feet.<sup>14</sup> Of these, 441 were oil wells with 435,697 feet, 250 were gas wells with 829,090 feet, 32 were dry wells with 91,376 feet, eight were stratigraphic or core wells with 11,884 feet, and 43 were service wells with 65,201 feet. Exploratory well drilling totaled 152,061 feet for 40 wells distributed among two oil wells with 1,950 feet, 21 gas wells with 91,625 feet, and 17 dry wells with 58,486 feet. Development well drilling totaled 1,204,102 feet for 683 wells distributed among 439 oil wells with 433,747 feet, 229 gas wells with 737,465 feet, and 15 dry wells with 32,890 feet. Wells completed as multiple completions included 17 exploratory wells in 57 zones with 62,970 feet and 254 development wells in 741 zones with 610,070 feet. Seven new-field wildcat wells were drilled; one was a gas well with 3,990

<sup>11</sup> Oil and Gas Journal. V. 69, No. 10, Mar. 8, 1971, pp. 87-92.

<sup>12</sup> Given, Peter H. The Mysterious Peat—Precursor of Coal. Coal Mining & Processing, v. 7, No. 8, August 1970, pp. 47-48.

<sup>13</sup> Oil and Gas Journal. V. 69, No. 14, Apr. 5, 1971, pp. 38-39.

<sup>14</sup> American Petroleum Institute. Review of Drilling Statistics—Annual Survey, 1969. V. III, No. 4, March 1970, p. 19. Annual Survey, 1970. V. IV, No. 4, March 1971, pp. 14-17, 19, 21, 22.

Table 8.—Pennsylvania: Oil and gas well drilling completions by county

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
Armstrong.....	0	29	2	0	3	0	34	95,872
Blair.....	-----	-----	-----	0	0	2	2	9,173
Beaver.....	1	0	0	-----	-----	-----	1	1,732
Butler.....	3	2	0	0	0	2	7	17,570
Cambria.....	0	4	1	-----	-----	-----	5	34,097
Clarion.....	3	10	0	-----	-----	-----	13	20,327
Clearfield.....	0	11	0	0	3	3	17	56,958
Crawford.....	2	14	0	-----	-----	-----	16	57,896
Elk.....	3	4	0	-----	-----	-----	7	12,653
Erie.....	0	3	0	-----	-----	-----	3	9,698
Fayette.....	0	1	0	0	0	1	2	7,225
Forest.....	30	4	1	1	0	1	37	27,177
Greene.....	-----	-----	-----	0	1	0	1	845
Indiana.....	0	119	1	0	8	1	129	456,713
Jefferson.....	0	20	4	0	4	1	29	85,164
Lycoming.....	-----	-----	-----	0	1	0	1	3,990
McKean.....	84	2	1	-----	-----	-----	87	157,968
Potter.....	3	0	0	-----	-----	-----	3	3,965
Somerset.....	-----	-----	-----	0	0	1	1	4,498
Venango.....	141	0	1	-----	-----	-----	142	100,798
Warren.....	168	0	1	1	0	3	173	152,808
Washington.....	1	0	1	0	1	1	4	11,062
Westmoreland.....	0	5	2	0	0	1	3	26,575
Wyoming.....	0	1	0	-----	-----	-----	1	1,399
Total.....	439	229	15	2	21	17	723	1,356,163

Source: American Petroleum Institute.

feet and six were dry wells with 18,982 feet. The total number of exploratory and development wells drilled was 723, compared with 895 wells drilled in 1969, and the total footage drilled in such wells in 1970 was 298,418 feet less than the 1,654,581 feet drilled in 1969. In late January one rotary drill was active, and from late September to mid-November, 15 were active. Active rotary-drill weeks totaled 367.

New field discoveries of natural gas totaled 500 million cubic feet while new reservoir discoveries in old fields totaled 2,400 million cubic feet. New field discoveries of petroleum totaled 558,000 barrels.

Of the 62 wells drilled deeper, 30 were gas wells, 12 were oil wells, two were dry wells, and 18 were gas storage wells.

Deep drilling (Middle Devonian or older) increased from 43 wells in 1969 to 90 wells in 1970, including 18 wells drilled deeper. Most of the deep development drilling was in the Medina gas area of Crawford County where 14 gas wells were drilled in the Indian Springs field. Most of the activity in the shallow gas reservoirs was in Indiana, Armstrong, and Jefferson Counties, where development continued in the Big Run and Marchand fields. Shallow-oil drilling was carried on in the Bradford field of McKean County in the Bradford and associated sandstones. Oil

wells totaling 161 were drilled in the Red Valley and Venango Second sand areas of Venango and Forest Counties. Warren County was the most active oil area, with 169 successful wells completed in 1970. Indiana County was the most active gas area with 119 successful wells completed. Seismic crews put in 45 crew weeks during the year compared with 39 crew weeks in 1969. State Forest lands totaling 10,458 acres were leased through competitive bidding in a range of \$2.08 to \$5.11 per acre. A total bonus of \$37,211.52 was received. The yearly rental on this land was \$1.00 per acre. At yearend there were 126,152 acres of State Forest lands under lease for oil and gas exploration development, including 59,109 acres in gas storage. No new tracts of State Game lands were leased during 1970. At yearend 27 leases were active, totaling 12,727.5 acres. There were 39 productive wells on 20 leases of State Game lands.<sup>15</sup>

The Peoples Natural Gas Company and seven participators drilled the No. 1 Martin Well to a depth of 15,573 feet in Wayne Township, Armstrong County. The well was plugged back to a depth of 6,850 feet and completed as a discovery in the Gohensville field of the Snydersville

<sup>15</sup> The Oil and Gas Division, Pennsylvania Bureau of Topographic and Geologic Survey.

Chert-Oriskany Pool. The discovery well's open flow after fracturing was 1.1 million cubic feet per day at a 7-day shut-in rock pressure of 3,325 pounds per square inch.

The first Maraflood project in the State was being expanded to 50 acres by Penzoil United, Inc., and the Kendall Refining Co. A second project, covering 40 acres, was started in May by the Quaker State Oil Refining Corp. in Warren County in the Goodwill Hill field at a 600-foot depth.

The improved recovery of Pennsylvania crude oil by gas flooding was described by Frohne.<sup>16</sup>

Any chance for oil exploration on the U.S. side of Lake Erie was eliminated by Pennsylvania's cancellation of agreements on a 4,877-acre block in the lake. Pan American Petroleum Corp. of Tulsa, Okla., in June, and Ranger Oil Ltd. of Alberta, Canada, in December, released their rights. New York and Ohio dropped plans for holding lease sales on their portions of the lake owing to antipollutionist opposition.

The United Refining Co. awarded a \$7.5 million contract to Williams Bros. Eng. Co., Tulsa, Okla., to build a new 12-inch crude oil pipeline from Buffalo, N.Y., to its Warren refinery. This line, connecting with the Interprovincial Pipe Line Co. of Canada's system, will replace an obsolete 30-mile, 8-inch section of a common-carrier system owned by the Buckeye Pipe Line Co.

The Sun Oil Co. awarded Stone & Webster Engineering Corp. a \$100 million contract to design, engineer, and construct a giant petrochemical complex at Marcus Hook. When completed, this complex will require 34,000 barrels per day of naphtha and gas-oil feedstocks obtained from the company's refinery and domestic purchases. Built-in flexibility will offer the optional use of imported feedstocks.

Eleven companies operated 13 petroleum refineries, four in eastern Pennsylvania adjacent to the Delaware river and nine in six northwestern counties. The four eastern refineries and the one at Warren were rated at 616,000-barrels of total crude-feed capacity per calendar day. These five refineries processed about 225 million barrels of interstate and foreign, asphalt-base crude oils, principally into liquid fuels, and about 6.8 million barrels of lubricants. Lubricants were produced at two of the eastern refineries in a quantity equal to about

6 volume percent of their crude run to stills.

The other eight refineries in Northwestern Pennsylvania continued operations quite small in scale compared with most other refineries in the United States. Collectively, these refineries were rated at 35,200 barrels of crude-feed capacity per calendar day. Their 12.8-million-barrel feed, 5.4 percent of the State's total, was paraffin-base Pennsylvania-grade crude only, of which 4.0 million barrels came from wells in the State and 8.8 million barrels from wells in western New York, Ohio, and West Virginia. The Bradford field alone, in Pennsylvania and New York, produced 2.9 million barrels. One of the eight refineries, a white oil producer at Franklin, was severely damaged by fire and explosion in June and terminated all activities in October. Collectively, these eight refineries produced about 4.0 million barrels of lubricants equaling six percent of the U.S. production, and about 8.6 million barrels of other petroleum products. Expansions were in either the planning or construction stage at the Pennzoil United, Inc., refinery at Rouseville, where a hydrogenation unit will be built, and at the Witco Chemical Corporation's Kendall division at Bradford, where a dewaxing unit requiring 51,000 square feet and 35 employees was completed.

#### NONMETALS

**Cement.**—A decline in building and construction activities, particularly near the eastern seaboard, contributed to decreased production of portland and masonry cements compared with those of 1969.

Portland cement production at 22 plants was down 8.9 percent and its value was 4.6 percent less despite an average increase in value of 13.2 cents per 376-pound barrel. Masonry cement production at 20 plants was 9.1 percent less and its value decreased 2.1 percent despite an average increase in value of 21.2 cents per 280-pound barrel.

For the purpose of cement surveys, Pennsylvania is divided into western and eastern producing districts which are separated by the eastern boundaries of Potter, Clinton, Centre, Huntingdon, and Franklin Counties.

<sup>16</sup> Frohne, K. H. Gasflood Improved Appalachian Recovery. *Petrol. Eng.*, v. 42, No. 7, July 1970, pp. 79, 82, 84.

The five plants in the western district shipped 10.0 million barrels of all types of portland cement, at an average value of \$3.13 per barrel, of which 96 percent was type I-II (general use and moderate heat); 3 percent was type III (high early strength); and 1 percent comprised water-proof-portland, slag, expansive, and white types. Shipments in million barrels by methods follow: 9.0, by truck in bulk; 0.5, by truck in containers; and 0.5, by railroad in bulk. Stocks of all types of portland cement at yearend totaled 2.0 million barrels. Purchases of western district portland cement in percentage follow: 95, by ready-mixed concrete companies; 3, by highway contractors; and 2, by miscellaneous. One million barrels of masonry cement shipped had an average value of \$2.92 per 280-pound barrel. Although no white cement was produced by the western district plants, they did purchase some from eastern district plants.

Production of portland cement exceeded shipments by 296,000 barrels in the western district and 448,000 barrels in the eastern district. Production of masonry cement exceeded shipments by 1,000 barrels in the western district and 47,000 barrels in the eastern district.

The State's apparent consumption of portland cement was 17.25 million barrels (42 percent of the total production) while the apparent consumption of masonry cement was 964,000 barrels (34 percent of the total production).

A total of 17 plants in the eastern district produced 30.9 million barrels of all types of portland cement at an average value of \$2.90 per barrel, of which 89 percent was type I-II (general use and moderate heat); 6 percent was type III (high early strength); and 5 percent was water-proof-portland, white, block, portland-pozzolan, and expansive. Shipments in million barrels by methods follow: 19, by truck in bulk; three, by truck in containers; eight, by railroad in bulk; and one, by railroad in containers. Stocks of all types of portland cement at yearend totaled 2.0 million barrels. Purchases of eastern district portland cement in percentages follow: 93, by ready-mixed concrete companies; 5, by highway contractors; and 2, miscellaneous. Shipments of masonry cement totaled 2.0 million 280-pound barrels at an average value of \$2.99 per barrel. White cement

was produced by two plants in the eastern district.

Western district plants consumed 421,940 short tons of cement rock and 2,533,310 tons of limestone, and eastern district plants consumed 7,114,874 short tons of cement rock and 1,872,135 tons of limestone. Collectively, all plants in both districts consumed 1,004,771 short tons of other raw materials, including shale, clay, sand, gypsum, iron ore, kaolin, and mill scale. All plants in the State consumed 12,977,030 short tons of raw materials to produce 8,083,452 short tons of portland and masonry cements. Shipments of pyrite cinders for cement manufacture from one chemical plant in Fayette County were about 78 percent less both in quantity and value compared with 1969.

Electricity purchased, in million kilowatt-hours, totaled 285 in western district plants and 742 in eastern district plants. Eastern district plants generated 99 million kilowatt-hours.

Northampton County was the major shipper of portland cement with 44 percent of the State's total, followed by Lehigh County. Other counties shipping portland cement were Allegheny, Butler, and Lawrence in the western district, and Berks, Montgomery, and York in the eastern district. Northampton County led in the shipment of masonry cement with 30 percent of the State's shipments.

The conversion of kiln firing from coal to Bunker C fuel oil was completed at the Cementon plant of The Whitehall Cement Mfg. Co.

The Allentown Portland Cement Co. at its Evansville plant completed a modernization program that included the installation of 6,000 feet of belt conveyors and 1,400 feet of bucket elevators.

The Medusa Portland Cement Co. in a \$11-million expansion program at its Wampum plant installed a 250,000-barrel-capacity clinker-storage building, a new kiln larger than the other two at the plant, a finishing mill building, three new silos, and an enlarged electric substation. The plant's annual production capacity was increased from 2.7 to 4.1 million barrels.

The Lehigh Portland Cement Co.'s plant at Fogelsville and the Giant Portland Cement Co.'s plant at Egypt were reportedly shut down. The high cost of bringing these plants up to air-pollution-control standards

and a high labor requirement were major reasons for closing the plants.

Two plants in Northampton County were among the six recipients of the 1970 R. Emmett Doherty Award presented to publicly commend air-pollution-control leaders in the cement industry. The two plants receiving the Award were operated by the Dragon Cement Co. of New Brunswick, N.J., and Universal Atlas Cement of Pittsburgh.

**Clays.**—Excluding kaolin and compared with 1969, the total production of clays and shales decreased 2.3 percent in tonnage and 19.3 percent in value.

Common clay production, equaling 3.4 percent of total production, was 56 percent less and its value was 41 percent less, despite an average increase in value of 8 cents per short ton.

The production of shale and undifferentiated clay declined 4.2 percent in tonnage and 27.0 percent in value, and accounted for 51.2 percent of the total clay production, the same as in 1969. The average value per short ton declined to \$3.43 from \$4.62 in 1969.

Fireclay production increased 0.2 percent in tonnage but decreased 18.4 percent in value because the average value per short ton declined from \$10.71 in 1969 to \$8.72. Fireclay production was 45.4 percent of the total production, compared with 44.2 percent of the total production in 1969.

The State's clay industry operated 84 mines in 29 counties.

The leading counties in the production of all clays and shales, with 52.0 percent of the State's total were Lawrence, Clearfield, Berks, Armstrong, and York.

Berks, Luzerne, York, Lawrence, and Northumberland Counties were the leading producers of shale and undifferentiated clays with 59.8 percent of the State's total production.

Leading counties in fireclay production, with 86.8 percent of the total, were Clearfield, Lawrence, Armstrong, Jefferson, and Fayette.

Kaolin was produced only in Cumberland County by the Philadelphia Clay Co. Production and value were about 9 percent greater than in 1969.

Nearly 79 percent of the production of shale and undifferentiated clay went into the manufacture of vitrified clay products. The remainder was used in the production of cement, lightweight aggregates, refractories, and mortars.

The manufacture of refractories and mortars accounted for 60.6 percent of the fireclay produced. Vitrified clay products used 38.0 percent and the remainder was used in the manufacture of cement, fillers, and pottery.

The Watsonstown Brick Co. plant in Northumberland County was updated by the installation of automatic pug mills and gas-firing equipment. Scrap-and-waste production during pugmilling was minimized, and desirable color control was maintained despite the shift from coal firing.

Table 9.—Pennsylvania: Clays sold or used by producers, by kinds and uses <sup>1</sup>  
(Thousand short tons)

Use	Fire clay		Miscellaneous clay	
	1969	1970	1969	1970
Refractories:				
Firebrick and block.....	665	645	-----	-----
High-alumina brick.....	W	38	-----	-----
Other.....	298	249	W	W
Heavy clay products:				
Building brick.....	393	413	1,177	1,062
Vitrified sewer pipe.....	W	W	64	55
Drain tile.....	-----	-----	33	25
Undistributed.....	350	363	4246	4314
Total <sup>2</sup> .....	1,206	1,209	1,520	1,456

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

<sup>1</sup> Excludes kaolin.

<sup>2</sup> Includes mortar, foundries and steelworks (bulk), and other refractories (1969).

<sup>3</sup> Includes pottery, floor and wall tile, portland and other hydraulic cements, filler (1970), and other uses (1969).

<sup>4</sup> Includes other heavy clay products, lightweight aggregate, filler, foundries and steelworks (bulk), portland and other hydraulic cements, and other uses.

<sup>5</sup> Data may not add to totals shown because of independent rounding.



A deposit of aluminum silicate, the only one of commercial size north of North Carolina, was strip mined by the Narvon Mining and Chemical Co. near New Holland in Lancaster County. The mined product, after drying and screening, was finally graded into a 325-mesh product using air classification. The product was sold in bulk or bags for use as a filler; as an extender; as a diluent and carrier in the manufacture of paints, rubber products, and crop dusting materials; and as parting agents in the rubber and foundry industries. The most important use was for the flocculation treatment of potable and waste waters.

**Gem Stones.**—Amateur lapidarists and 15 clubs and societies collected mineral specimens principally as a hobby. There was a resurgence in the use of anthracite for decorative carvings. Other semiprecious materials collected were copper-rhyolite, williamsite, a red triassic conglomerate used for book ends and tabletops, and quartz crystals for earrings and pendants.

**Glass.**—Announcements of additional glass producing facilities were made by Diamond Glass Co., Royersford, Montgomery County, and by the C. E. Glass Co. Inc., Floreffe, Allegheny County.

**Graphite.**—Artificial graphite was manufactured at three plants in two counties. The output, in the form of anodes, electric motor brushes and brush stock, electrodes for the electrical discharge machining process, and miscellaneous items, was produced from petroleum coke, lamp black, pitch coke, hydrocarbon gases, and other raw materials. Compared with 1969, the quantity of graphite produced was 16 percent greater and its value was 20 percent greater.

**Gypsum.**—Gypsum was calcined by the U.S. Gypsum Co. in Philadelphia County. The production was 24 percent less and its value was 21 percent less than in 1969.

**Iron Oxide Pigments.**—Finished natural and manufactured iron-oxide pigments were shipped from one plant in Carbon County and two in Northampton County. Compared with 1969, the production was 3 percent greater and its value was about 1 percent greater. Conversely, the nationwide production of finished iron-oxide pigments

was 13 percent less both in quantity and value than in 1969.

Yellow iron oxide pigments in the form of sulfur mud were not mined at an open pit in Cambria County.

**Lime.**—The total production of quicklime and hydrated lime decreased 6.1 percent in tonnage and increased 1.1 percent in value compared with 1969 statistics. The average value of all production increased from \$14.41 in 1969 to \$15.52 per ton in 1970. The average value of quicklime increased from \$14.09 to \$15.19 per ton, and that of hydrated lime increased from \$16.29 to \$17.09 per ton. The steel industry consumed nearly 60 percent of the total production, and chemical and refractory uses consumed about 17 percent. The remainder of the production was distributed among construction, water and sewage treatment, paper, agricultural, and leather tanning markets. Of the 13 plants operated in 10 counties, nine sold or used both quick and hydrated lime, three only quicklime, and one only hydrated lime. Of the total lime sold or used, 63 percent was consumed in Pennsylvania, 18 percent in Maryland, 5 percent each in New Jersey and New York, and 6 percent in other States.

Centre County led in production with three large plants each producing quicklime and hydrated lime.

A 200-ton-per-day expansion of lime-producing facilities was completed at the Cedar Hollow plant of the Warner Co. The expansion included the installation of a 300-ton-per-day rotary-kiln to replace a much smaller unit reportedly one of the first rotary lime-kilns in the United States. The new kiln was provided with a high-temperature glass-fiber baghouse.

The Bethlehem Steel Corp. put into operation a 650-ton-per-day kiln at Annville, Pa., to produce lime for use in basic oxygen furnaces.

**Mica.**—Residual crude mica occurring as a deposit on schist was mined and processed using dry grinding by the Micalith Mining Co., Inc., at its Hokes mine near Glenville in York County. The air-separated flake mica was used in paints, roofing, greases, electrically insulated welding rods, and rubber and textile coatings. The demand for roofing mica decreased mainly because

of the greater use of higher density talc and sand in roofing formulations.

Mica production remained the same as in 1969, while its value increased about 9 percent. The State was seventh in the national production of mica.

Drilling and trenching were begun at the Aguda Mining Corp. of Pittsburgh at a deposit of fine flake muscovite (mica) on Pequea Creek near Lancaster. Drill holes on the Corporation's 77-acre property went 115 feet into the deposit estimated to contain 35 million tons.

**Mullite (Synthetic).**—The Remmey Division of A. P. Green Refractory Co. in Philadelphia produced synthetic mullite that was 13 percent less in quantity and 22 percent less in value compared with 1969 figures.

**Perlite (Expanded).**—Crude perlite shipped into the State was expanded by six companies in seven plants, one each in Allegheny, Delaware, Lancaster, Lehigh, Luzerne, Montgomery, and York Counties. Compared with 1969 figures, the total quantity sold or increased 41.7 percent and its total value increased only 16 percent. The average price in 1970 was \$55.98 per short ton compared with \$68.19 in 1969. Expanded perlite was sold and used chiefly for building plaster, with other uses being loose fill insulation, concrete aggregate, filler, soil conditioning, filter, cryogenic applications, charbase, refractory, castable insulation, bonding mortars, fire extinguishing powder, a carrier for pesticides, and oil absorbent.

**Pyrites.**—Pyritic concentrates containing cobalt, some copper, and about 46 percent sulfur were shipped to Bethlehem Steel Corp.'s Sparrows Point, Md., works from the Corporation's Grace and Cornwall magnetic iron ore concentrators in Berks and Lebanon Counties.

At Sparrows Point, Md., the pyritic concentrates were processed to recover sulfur as sulfuric acid and the iron oxide residue was sintered and used with other iron ore as blast furnace feed. The cobalt and copper values were recovered as a sulfate solution devoid of gold and silver during the sulfur-recovery process. The sulfate solution was further processed by the Pyrites Co. Inc., Wilmington, Del. for recovery of cobalt and copper.

Compared with 1969 figures, the quantity of pyrites produced decreased about 35

percent but its value increased about 39 percent.

**Quartz (Manufactured).**—The P. R. Hoffman Co. in Carlisle prepared quartz crystals for its own uses and sale to other quartz crystal cutters. The quartz crystal was synthesized by growth in autoclaves at pressures in the range of 1,500 to 20,000 pounds per square inch at temperatures ranging from 250° to 450° C, using soda ash solution as the process solvent and Brazilian lasca and defective quartz crystals as the nutrient material. Growth of crystals occurs on natural or manufactured quartz seed plates in a predetermined crystallographic plane. Pennsylvania was one of the large producers of cut quartz crystals for the electronic industry.

**Sand and Gravel.**—As in 1969, no sand or gravel was produced by crew-contractor or Government-and-contractor operations. Commercial operators totaling 94 used 85 stationary plants, 17 portable plants, and eight dredges. The quantities of sand and gravel in million tons transported from the producing operations included 13.5, by truck; 0.6, by railroad; and 4.4, by waterway.

Compared with the 1969 situation, the total production of sand and gravel increased 2.2 percent, and its value increased 7.8 percent because of a 9.6-cent-per-ton-average increase in value.

The total sand production in 1970 was 0.7 percent less, but its value was 3.2 percent more owing to a 7.4 cent-per-ton-average increase in value. Sand used for building and paving purposes decreased 8 percent in tonnage and 3.4 cents per ton in value in 1970. Ground and unground sands for industrial uses classed as molding, fire and furnace, glass, grinding and polishing, blast, engine, filtration, hydrofract, enamel, fillers, foundry, pottery, and miscellaneous totaled 2,466,000 short tons and were valued at \$7,015,000 compared with 1,859,000 tons valued at \$5,921,000 in 1969. The average value of all industrial sands was 34 cents per ton less than in 1969.

The total production of gravel increased 6.2 percent, and its value was 15.2 percent more than in 1969 because of a 13.4-cent-per-ton-average increase in value. All but 13.1 percent of the total gravel production was used for construction purposes.

**Table 10.—Pennsylvania: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	5,094	\$7,811	4,700	\$7,749
Fill.....	89	138	85	113
Fire or furnace.....	38	132	36	123
Molding.....	r 158	r 499	102	401
Paving.....	3,443	5,473	3,158	5,088
Other uses <sup>1</sup> .....	r 1,663	r 5,290	2,328	6,491
<b>Total <sup>2</sup>.....</b>	<b>10,487</b>	<b>r 19,343</b>	<b>10,409</b>	<b>19,965</b>
<b>Gravel:</b>				
Building.....	3,630	5,900	3,501	5,897
Paving.....	3,476	5,714	3,531	6,523
Miscellaneous.....	93	157	127	195
Other uses <sup>3</sup> .....	420	336	935	1,335
<b>Total <sup>2</sup>.....</b>	<b>7,619</b>	<b>12,108</b>	<b>8,095</b>	<b>13,951</b>
<b>Grand total <sup>2</sup>.....</b>	<b>18,105</b>	<b>31,451</b>	<b>18,504</b>	<b>33,915</b>

r Revised.

<sup>1</sup> Includes glass, grinding and polishing, blast, engine, filtration (1970), oil (hydrafrac), ground, and other sands.

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

<sup>3</sup> Includes railroad ballast, fill, and other gravel.

Based on the total production of all sand and gravel, sand in 1970 accounted for 56.2 percent of the total tonnage and 58.9 percent of the total value compared with 57.9 percent of the total tonnage and 61.5 percent of the total value in 1969.

Sand and gravel was produced in 38 counties. Bucks County led the State in production with 18.7 percent of the total commercial tonnage and 17.4 percent of the value. Other leading producers were Westmoreland, Erie, Beaver, Wyoming, and Luzerne Counties.

In the 1970 National Sand and Gravel Association safety contest, covering the period from July 1, 1969, to June 30, 1970, Pennsylvania had six plants reporting no accidents. The companies and their plants awarded the Certificate of Achievement in Safety were the following: Appalachian Stone Div., Martin Marietta Corp., Mercersburg; Burlington, Milton, and Utica Sand and Gravel plants; George F. Pettinos, Inc., Bala Cynwyd; New Freedom plant; Central Builders Supply Co., Sunbury; Selinsgrove sand plant; and Tionesta Sand & Gravel Inc., Hawthorn; and the Tidioute and Tionesta plants.<sup>17</sup>

**Stone.**—Major stone producing counties were Montgomery, Northampton, Lancaster, Bucks, York, Adams, Berks, Centre, Chester, and Lawrence.

Total production was 1.1 percent less

but its value was 2.1 percent more than in 1969 because of a 5.8-cent-per-ton-average increase in value.

Dimension stone produced at 45 operations in 11 counties equaled 1.8 percent of the total stone production and 4.9 percent of its total value. The average value per short ton of all dimension stone decreased from \$50.35 in 1969 to \$48.19 in 1970. The number of operations in sandstone was 24; in slate, nine; in granite, four; in other stone, four; and in quartzite and traprock, two each. Dimension quartzite, sandstone, traprock (basalt), and other stone were used primarily for irregular shapes and sawed stone; granite for rubble; and slate for blackboards and flagging. Slate accounted for nearly 52 percent of the total production of dimension stone and 68 percent of its total value.

Crushed and broken stone produced at 227 operations in 50 counties equaled 99.8 percent of the total stone production and 95.1 percent of its total value. The average value of this product increased to \$1.73 per short ton from \$1.67 in 1969. The number of operations in limestone was 158; in sandstone, 31; in traprock, 15; in quartzite, nine; in other stone, eight; in dolomite and slate two each; and in granite, shell, and quartz one each.

<sup>17</sup> Pit and Quarry. V. 63, No. 9, March 1971, pp. 114-115.

Table 11.—Pennsylvania: Stone sold or used by producers, by counties  
(Thousand short tons and thousand dollars)

County	1969			1970			Kind of stone produced in 1970
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value	
Allegheny	1	W	W	1	54	W	Sandstone.
Armstrong	5	226	\$483	5	249	\$562	Limestone.
Berks	13	3,893	5,345	13	3,863	5,659	Limestone, sandstone, shell, traprock.
Blair	12	1,221	2,123	11	1,210	2,110	Limestone, quartzite.
Bucks	22	4,351	6,312	18	4,133	6,430	Limestone, other stone, sandstone, traprock.
Butler	7	1,684	3,640	5	1,738	4,680	Limestone.
Centre	9	3,809	6,263	9	3,278	5,974	Dolomite, limestone.
Chester	12	3,251	5,722	12	2,950	5,153	Granite, limestone, quartzite, sandstone, traprock.
Clinton	3	607	854	2	W	W	Limestone.
Cumberland	6	1,414	2,337	6	1,483	2,443	Limestone.
Dauphin	4	1,348	2,152	4	950	1,465	Limestone, sandstone.
Franklin	5	W	W	5	W	990	Limestone, sandstone.
Huntingdon	5	W	1,283	5	W	1,042	Limestone, quartzite.
Lancaster	15	4,712	7,742	15	4,817	7,685	Limestone.
Lawrence	5	3,217	4,260	5	2,881	3,895	Limestone.
Lebanon	5	2,388	4,165	4	1,039	1,801	Limestone.
Lehigh	10	2,564	3,010	10	2,663	3,951	Limestone, slate.
Luzerne	4	575	878	4	451	W	Quartzite, sandstone.
McKean	1	W	30	1	W	W	Sandstone.
Mercer	2	277	W	2	W	W	Limestone, sandstone.
Mifflin	4	W	462	4	286	380	Limestone.
Montgomery	16	5,423	9,446	16	5,277	9,377	Granite, limestone, other stone, quartzite, sandstone, traprock.
Northampton	19	5,417	10,453	20	5,826	10,637	Limestone, quartzite, slate.
Northumberland	3	260	407	3	306	498	Limestone, sandstone.
Potter	6	3	107	5	3	93	Sandstone.
Schuylkill	3	W	701	4	1,091	1,641	Limestone, quartzite, sand- stone.
Somerset	5	961	2,253	5	564	1,593	Limestone, sandstone.
Susquehanna	9	W	W	8	W	606	Sandstone.
Venango	1	W	W	1	W	4	Limestone.
Wayne	2	W	W	2	W	407	Sandstone.
Westmoreland	11	1,527	2,775	11	1,445	2,879	Limestone, other stone, sandstone.
York	10	4,121	8,953	11	4,025	9,312	Dolomite, limestone, slate.
Undistributed <sup>1</sup>	44	13,754	25,565	44	16,259	28,923	
Total <sup>2</sup>	279	66,992	117,726	271	66,241	120,187	

W Withheld to avoid disclosing individual company confidential data.

<sup>1</sup> Includes production for Adams, Bedford, Cambria, Carbon, Clarion, Columbia, Delaware, Elk, Fayette, Fulton, Jefferson, Lycoming, Monroe, Montour, Perry, Snyder, Union, Washington, and Wyoming (1969) Counties, and data indicated by symbol W.

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

In crushed and broken form the major use of granite, limestone, quartzite, sandstone, traprock, and other stone was for road aggregates and road base stone; dolomite for calcined products; and slate, for flour and granules. Crushed and broken limestone accounted for about 75 percent of the production and value of the total crushed and broken stone production. The distribution of the total crushed and broken limestone production by percent and uses follows: 58.8, road aggregates and road base stone; 20.5, cement manufacture; 9.8, flux stone; 3.4, lime manufacture; 3.0, agricultural uses; and 4.5 for 19 other uses.

In both 1969 and 1970 four companies at four operations produced rock dust. The 1970 production totaled 255,127 short

tons, 35.8 percent more than the 187,878-ton production in 1969. This increase in rock-dust production is attributed to a requirement of the Federal Coal Mine and Safety Act of 1969 that the amount of noncombustibles in return-air course dust deposits be increased to 80 from 65 weight percent. Also, according to the Bureau's Health and Safety personnel, gassy deep bituminous mines in 1970 were using 20 to 30 pounds of rock dust for each ton of coal produced in lieu of the 15 to 20 pounds used in 1969.

One operation at Delta in York County produced roofing aggregates and fillers from slate.

The York Stone Co. at its York plant installed an air-swept roller mill complete

**Table 12.—Pennsylvania: Stone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension stone:</b>				
Building stone.....	72	\$1,781	68	\$1,432
Curbing and flagging.....	22	754	25	758
Other uses <sup>1</sup> .....	31	3,759	29	3,688
Total <sup>2</sup> .....	125	6,294	122	5,879
<b>Crushed and broken stone:</b>				
Bituminous aggregate.....	4,831	7,872	4,276	7,709
Concrete aggregate.....	5,886	8,561	10,150	16,293
Dense graded road base stone.....	13,268	19,928	9,224	13,386
Macadam aggregate.....	1,575	2,355	1,667	2,549
Surface treatment aggregate.....	2,371	3,535	2,526	3,471
Unspecified aggregate and roadstone.....	14,650	23,680	13,481	22,102
Agricultural limestone.....	1,423	3,776	1,825	5,711
Filler stone.....	W	W	<sup>3</sup> 670	<sup>3</sup> 1,342
Flux.....	5,075	9,740	5,681	10,953
Railroad ballast.....	576	987	775	1,237
Refractory stone.....	W	W	252	1,732
Riprap and jetty stone.....	132	192	122	194
Other uses <sup>4</sup> .....	17,079	30,804	15,470	27,629
Total <sup>2</sup> .....	66,866	111,432	66,119	114,908
Grand total <sup>2</sup> .....	66,992	117,726	66,241	120,187

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

<sup>1</sup> Includes monumental, roofing slate, millstock, and uses not listed or unspecified.

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

<sup>3</sup> Includes sandstone.

<sup>4</sup> Includes stone used in cement and lime manufacture, filler, chemical, whiting (1970) roofing aggregates (1970), mine dusting (1970), refractory (1969), and other uses in smaller quantities.

with air heater, automatic controls, and dust-collection equipment. The plant produced bituminous paving chips, coal-mine rock dust, agricultural limestone, fertilizer filler, and silica sand from quartz.

Several geologists investigated the musical ring produced by some Bucks County rocks when tapped with a hammer. The phenomenon was attributed to elastic strain and abnormal stress resulting from slow mineralogical alterations induced by environmental changes that prevent moisture retention and subject the rocks to wide temperature variations.<sup>18</sup>

Sales of all types of explosives to the State's stone producing industry totaled 39.0 million pounds, nearly half of which was processed and unprocessed ammonium nitrate.

The three runners-up without a disabling work injury in the 1970 quarries contest of the 46th National Safety Competition were the following: McCoy Quarry, Bethlehem Mines Corp., Bridgeport, Montgomery County, for 220,229 man-hours; Hillsville Quarry, United States Steel Corp., Eastern Limestone Operations, Lawrence County, for 197,291 man-hours;

and Charmian Quarry, GAF Corp., Industrial Products Div., Blue Ridge Summit, Adams County for 167,651 man-hours.

**Sulfur.**—Sulfur and hydrogen sulfide were recovered from gases at four oil refineries in two counties. The Claus or modified Claus process was used to recover the sulfur and one plant also recovered hydrogen sulfide using monoethanolamine in a Girdler system. Sulfur recovery was 5 percent less and its value was about 21 percent less than in 1969. Stocks of sulfur at yearend were 72 percent less than at the beginning of the year. Hydrogen sulfide production was 23 percent less and shipments were 21 percent less than in 1969.

Two occurrences of native sulfur found in the State during 1970 were of unusual interest. Near Columbia in Lancaster County, large pyrite crystals altered to limonite cubes contained pale yellowish-green masses of sulfur belonging to the orthorhombic crystal system as shown by an X-ray pattern. The other occurrence was at the Kehley's Run Mines near Shenandoah Heights in Schuylkill County. There,

<sup>18</sup> Science News. V. 98, No. 24, Dec. 12, 1970, p. 453.

fumes escaping from burning underground coal deposited sulfur crystals at the surface. The crystals were pale yellow to pale greenish yellow, very small, and in groups of needle like aggregates.<sup>19</sup>

**Talc (Sericite-Schist).**—A small tonnage of sericite schist, which resembles talc mineralogically and is suitable for many of the same uses because of similar chemical and physical properties, was mined from an open pit and processed near Aspers in Adams County by Summit Industries. Schist is used as a mineral filler and as an ingredient in insecticides, joint cement, and enamel coating.

Some prospecting and core-drilling for talc were performed near Jenkins Corners, Lancaster County, along a serpentinite contact with schist. The prospecting was done by Aguda Mining Corp. of Pittsburgh.

**Tripoli (Rottenstone).**—Crude tripoli, mined and processed by two companies in Lycoming County, was 15 percent less in quantity and 27 percent less in value compared with 1969 statistics. The material was prepared for use as a filler by one plant near Muncy. The other company near Oriole employed drying, crushing, and roller-mill grinding to produce abrasives and fillers. Pennsylvania ranked fourth among U.S. producers.

**Vermiculite (Exfoliated).**—Hyzer & Lewellen in Berks County and the W. R. Grace & Co., Zonolite Division, in Lawrence County exfoliated vermiculite shipped into the State. The major use was for building insulation and cryogenic insulation. The product was also used in plaster aggregate, concrete aggregate, soil conditioning, horticulture, fire-resistant cementitious compounds, and carriers and conditioners for agricultural chemicals and fertilizers.

## METALS

**Aluminum.**—A \$3 million modernization program was completed at the Cressona Works of the Aluminum Co. of America. Included was a 3,000-ton extrusion press that helped the company expand its output of building products.

The R. D. Werner Co., Inc., announced plans for a 40,000-square-foot plant to produce aluminum extrusions at Greenville, Mercer County.

**Beryllium.**—A \$7.5 million expansion program requiring an additional 25,000

square feet and 25 employees was completed at the Hazleton plant of Kawecki Berylco Industries, Inc. The doubling of melt capacity was achieved by the installation of induction furnaces for beryllium-copper, beryllium-aluminum, beryllium-nickel, and other alloys. A new rolling mill capable of producing beryllium and its alloys in sheets with 180-inch lengths and 48-inch widths was installed as was a new isostatic press capable of forming complex shapes directly from beryllium powder.

**Cerium.**—A new solvent-extraction process for producing 99.9-percent cerium oxide was started at the York chemical plant of Molybdenum Corp. of America using cerium concentrate feedstock from the corporation's bastnäsite (cerium fluorocarbonate) mining and separation complex at Mountain Pass, Calif. New applications predicted for using cerium's unique catalytic and reactive properties include the following: The improvement of properties of glasses, enamels, paper, textiles, zirconia refractories, and light-fast pigments; for the catalytic oxidation of hydrocarbons in exhaust-gas purification and self-cleaning ovens; and to provide better yield strength and elongation of ductile iron while combating tramp elements.

**Cobalt.**—The quantity and value of cobalt produced was about 31 percent less than in 1969.

Magnetic iron ore mined by the Bethlehem Steel Corp. in Berks and Lebanon Counties was the only U.S. domestic source of cobalt. The Lebanon County ore contained about two-thirds of the recoverable cobalt. Cobaltic pyrite concentrates recovered by the flotation of magnetic separator tailings were shipped to Sparrows Point, Md., for use in sulfuric acid manufacture. There the calcine from the acid plant was leached to recover cobalt and copper as a liquid sulfate concentrate, containing no gold or silver, that was processed into cobalt metal, oxide and hydrate, and electrolytic copper or copper chemicals by the Pyrites Co., Inc., Wilmington, Del.

In April, solvent extraction was introduced at this plant, marking a transition from the previous obsolete techniques to modern recovery methods. Cobalt production in the United States in 1970 was esti-

<sup>19</sup> The Pennsylvania State Geological Survey. *Pennsylvania Geology*. V. 2, No. 1, February 1971, p. 14.

mated as 220 short tons while consumption was forecast as 8,417 short tons.<sup>20</sup>

**Copper, Gold, and Silver.**—Compared with 1969 figure, the respective production of these metals was 25, 25, and 30 percent less and their respective value was 9, 35, and 27 percent less.

These metals were contained in a chalcopyrite concentrate produced during the processing of iron ore from the Cornwall mine of the Bethlehem Steel Corp. The chalcopyrite concentrate contained about 28 percent copper and was shipped to a western smelter.

Plans were announced in March by Ag-Met., Inc., for a new \$1 million secondary silver refinery, at Lofty, with a capacity of 60,000 ounces of silver per week and smaller quantities of platinum and gold.

The new \$10 million world headquarters of The Franklin Mint was dedicated at Franklin Center. This facility, the world's largest private mint, produced commemorative medals valued at \$45.8 million for collectors, and coins for the Bahamas, Jamaica, Panama, and Tunisia.

**Iron Ore.**—The Bethlehem Steel Corp. produced magnetic iron ores at the Grace underground mine in Berks County and at the Cornwall underground mine and a small open pit operation in Lebanon County. Explosives consumed at these three mines totaled 1.84 million pounds comprising 550,000 pounds of dynamites and 1.29 million pounds of bagged and bulk ammonium nitrate. Both underground mines used the block caving mining method. All operations of the Cornwall Division will cease at the end of 1972. The crude ores were beneficiated and processed into pellets in two plants nearby. The pellets were shipped to the Corporation's iron and steel works.

Pellet shipments were about 9 percent less in quantity and about 5 percent less in value than those of 1969.

**Iron and Steel.**—Of the 90 iron and steel establishments in the State, 14 operated by eight companies were classed as producers of raw iron and steel. Raw steel production was 30,031,000 short tons compared with 32,791,000 short tons in 1969. Pig iron and hot metal production totaled 20.8 million tons, 6.7 percent less than in 1969. Of the pig iron and hot metal produced, 94.2 percent was basic, 3.8 percent was Bessemer, and 2.0 percent was mallea-

ble and direct casting. The ferroalloys production was 395,000 tons compared with 448,000 tons in 1969, according to the American Iron and Steel Institute.

Of the 22.2 million tons of ores and concentrates consumed (excluding agglomerates), 53.5 percent went to agglomerating plants, 43.0 percent to blast furnaces, and 3.5 percent to steel furnaces. Receipts of iron ore, including 84,447 tons of manganese ores, totaled 23.9 million tons, 36.4 percent from U.S. sources and 63.6 percent from foreign countries. The 10.0-million-ton iron ore stock on January 1 decreased to 9.4 million tons at yearend, while on the same date consumers had 1,625,000 tons of scrap and 315,000 tons of pig iron in stock.

Agglomerating plants consumed 11.9 million tons of iron ores, 988,611 tons of limestone, 1,113,924 tons of dolomite, 154,676 tons of other fluxes, 928,453 tons of mill cinder and roll scale, 887,886 tons of raw flue dust, 194,265 tons of steel furnace slags, 706,689 tons of coke breeze, and 236,139 tons of Pennsylvania anthracite.

Although there were 41 active blast furnaces on January 1, there were only 33 at yearend. Idle blast furnaces totaled 15 on January 1 and 22 on December 31. Blast furnaces consumed 9.6 million tons of iron ores, 3.9 million tons of regular U.S. sinter, 10.9 million tons of semi- and self-fluxing sinter, 5.1 million tons of regular iron ore pellets, 885,331 tons of limestone, 1,396,989 tons of dolomite, 286,602 tons of other fluxes, 368,038 tons of mill cinder and roll scale, 1,345,313 tons of steel furnace slags, 13,132,085 tons of breeze-free coke, 23,396 tons of coke breeze, 27,042 tons of pig iron, 879,159 tons of home and purchased scrap, 151,467 tons of slag scrap, and 246 tons of alloys and miscellaneous solids. Blast furnaces produced 174,093 tons of scrap, 6,605,674 tons of slag, and recovered 754,301 tons of flue dust. Blast furnace coke consumption averaged 1,263 pounds for each short ton of hot metal produced.

Open-hearth, basic oxygen furnaces, and Bessemer steel furnaces consumed 789,432 tons of iron ores, 11,762 tons of semi- and self-fluxing sinter, 50,695 tons of regular iron ore pellets, 653,672 tons of limestone, 429,347 tons of dolomite, 679,603 tons of other fluxes, 30,711 tons of mill cinder and

<sup>20</sup> Pearce, R. F. *Cobalt. Eng. and Min. J.*, v. 172, No. 3, March 1971, pp. 113-114.

roll scale, 1,420 tons of Pennsylvania anthracite, 19.7 million tons of pig iron and hot metal, 10.0 million tons of home and purchased scrap, 101,598 tons of slag scrap, and 85,839 tons of alloys and miscellaneous solids.

Supplemental fuels consumed in blast furnaces by injection through tuyeres only included 44,695 million cubic feet of natural gas, 3,899 million cubic feet of coke oven gas, 28,952 tons of bituminous coal, 37,959,217 gallons of tar and pitch, and 155,427,484 gallons of other liquid fuels.

The No. 1 furnace of the United States Steel Corp. at Duquesne started producing ferromanganese to meet a current shortage.

The United States Steel Corp. announced plans for a 5,600-square-foot facility employing 50 persons for manufacturing silicon steel at Vandergrift in Westmoreland County.

The Bethlehem Steel Corp. at Steelton completed its electric furnace shop by the addition of a third electric furnace rated at an annual capacity of 315,000-tons.

In April, the Bethlehem Steel Corp. announced plans to construct a new 50,000-ton-per-year capacity mineral-wool plant near its Northampton coke plant for converting blast-furnace slag into mineral wool by a heating-and-spinning process. This wool plant, to be operated by the stone and slag division of Bethlehem's mining department, will be a 30,000-square-foot facility employing 30 to 40 persons.

The Allegheny Ludlum Steel Division placed in operation two four-pit batteries of ingot-heating furnaces at Brackenridge and a continuous bright annealing line at West Leechburg.

The largest and most versatile luminous wall heat-treating furnace in the forging industry was installed by the Edgewater Corp. at Oakmont. The 125-ton capacity car-type furnace can operate at temperatures ranging from 500° to 1,950° F. The 36-foot-long furnace, rated at a 12-million-Btu-per-hour heat-input capacity, can be heated quickly and cooled within minutes instead of hours as for conventional equipment. Scale formation on work pieces is minimized by atmosphere control.

At the Butler Works of the Armco Steel Corp., phasing out of open hearths was

completed. Steelmaking, by this largest U.S. producer of electrical (silicon) steels, then depended solely on electric furnaces equipped with wet-scrubber dust collectors. The Butler Works was the first in the State to attain continuous casting on a commercial scale when a 20,000-ton-per-month, \$16 million, 2-strand, slab caster was put on a production basis in April. The installation of two special furnaces was in progress, one for curing various coatings and the other for the thermal flattening of silicon steel.

**Platinum.**—A new platinum-melting, rolling, and drawing plant was put into operation by Matthey Bishop, Inc., at West Whiteland. Products included platinum sheet, wire and tubing, oxidation gauze, melting pots for laser materials, laboratory ware, fume-abatement equipment, and hydrogen purifiers.

**Powdered Metals.**—Announcements were made by five powdered metal companies for new facilities totaling more than 46,400 square feet and requiring more than 76 employees. Three of the facilities were for Domtar Chemicals, Inc., and Exotic Metals, Inc., Ridgway; and Carbon City Products, Inc., St. Marys in Elk County. The other two facilities were for the St. Marys Carbon Co. Galeton, Potter County, and Dimatics, Inc., Tarentum, Allegheny County.

**Uranium.**—The Metropolitan Edison Co., at Reading, contracted to purchase from the Kerr-McGee Corp. 126,500 kilograms of uranium hexafluoride enriched to about 2.6 percent U-235 and valued at \$16.7 million. This material, after processing into pellets and fabrication into nuclear fuel elements, will fuel the Three Mile Island Unit No. 1 power reactor under construction near Harrisburg. The hexafluoride will be produced by Kerr-McGee at its new Sequoyah facility in Oklahoma by the conversion of about 1 million pounds of uranium concentrate from its mining and milling operations near Grants, N. Mex.

**Zinc.**—Zinc ore, principally sphalerite, was mined and concentrated at Friedensville in Lehigh County. Based on the quantity of recoverable zinc metal, the mine output of zinc was 10.6 percent less and the value of production was 6.2 percent less than in 1969. The zinc concen-



trates were shipped to the New Jersey Zinc Co.'s vertical-retort smelter at Palmerton, where anthracite silt was used in the sintering operation. The smelter's products

included rolled zinc, slab zinc, zinc die casting alloys, dry battery shells, zinc oxide, spiegeleisen, cadmium, and sulfuric acid.

Table 13.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Abrasives:</b>			
Nonmetallic: Satellite Alloy Corp.	9800 McKnight Rd. Pittsburgh, Pa. 15237	Plant.....	Allegheny.
Metallic:			
Abrasive Metals Co....	26th & B. & O. RR Pittsburgh, Pa. 15222	....do.....	Do.
Durasteel Abrasive Co.	2601 Smallman St. Pittsburgh, Pa. 15222	....do.....	Westmoreland.
Industeel Corp.....	37th & A. V. RR Pittsburgh, Pa. 15222	....do.....	Allegheny.
Pangborn Div., the Carborundum Co.	P.O. Box 380 Hagerstown, Md. 21740	....do.....	Butler
<b>Cement:</b>			
Allentown Portland Cement Co., Div.	7th St. at Thruway Allentown, Pa. 18101	....do.....	Berks.
National Gypsum Co. <sup>1</sup>	.....do.....	....do.....	Montgomery.
Allentown Portland Cement Co., Div.	.....do.....	....do.....	Lawrence.
Bessemer Cement Co., subsidiary of Louisville Cement Co.	510 Hanna Bldg. Cleveland, Ohio 44115	....do.....	Lehigh.
Coplay Cement Manufacturing Co. <sup>1</sup>	North 2nd St. Coplay, Pa. 18037	....do.....	Northampton.
Do.....	Easton Rd. Coplay, Pa. 18037	....do.....	Do.
Dragon Cement Co., div. of Martin-Marietta Corp. <sup>1</sup>	5A Joyce Kilmer Ave. New Brunswick, N.J. 08903	....do.....	Allegheny.
Green Bag Cement Co., div. of Marquette Cement Manufacturing Co.	20 North Wacker Dr. Chicago, Ill. 60606	....do.....	Northampton.
Hereules Cement Co., div. of American Cement Corp. <sup>1</sup>	555 City Line Ave. Bala-Cynwyd, Pa. 19004	....do.....	Do.
Keystone Portland Cement Co. <sup>1</sup>	2200 Hamilton St. Allentown, Pa. 18105	....do.....	Do.
Lone Star Cement Corp. <sup>1</sup> ..	F.O. Box 6237 West End Br. Richmond, Va. 23230	....do.....	Lawrence.
Medusa Portland Cement Co. <sup>2</sup>	P.O. Box 5668 Cleveland, Ohio 44101	....do.....	York.
Medusa Portland Cement Co. <sup>3,4</sup>	.....do.....	....do.....	Northampton.
National Portland Cement Co. <sup>1</sup>	1023 West St. George Ave. Linden, N.J. 07036	....do.....	Butler.
Penn-Dixie Cement Corp. <sup>5</sup>	P.O. Box 152 Nazareth, Pa. 18064	....do.....	Northampton.
Penn-Dixie Cement Corp. <sup>1</sup>	.....do.....	....do.....	Allegheny.
Universal Atlas Cement Div., U.S. Steel Corp.	600 Grant St. U.S. Steel Bldg. Pittsburgh, Pa. 15230	....do.....	Northampton.
The Whitehall Cement Manufacturing Co. <sup>1</sup>	.....do.....	....do.....	Lehigh.
<b>Clay and shale:</b>			
<b>Fire:</b>			
Drexel Refractories Div., Drexel Dynamics Corp.	P.O. Box 50 Kittanning, Pa. 16201	Underground.....	Armstrong.
Freeport Brick Co.....	Drawer F Freeport, Pa. 16229	....do.....	Do.
Freeport Brick Co., Kittanning Brick Div.	R.D. 1 Adrian, Pa. 16210	....do.....	Do.
Hanley Co.....	28 Kennedy St. Bradford, Pa. 16701	....do.....	Jefferson.
Harbison Walker Refractories Co.	2 Gateway Center Pittsburgh, Pa. 15222	....do.....	Armstrong.
Do.....	.....do.....	Pit.....	Cambria, Centre, Clearfield, Fayette, Somerset.

See footnotes at end of table.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Clay and shale—Continued			
Fire—Continued			
Ralph A. Veon, Inc.	Darlington, Pa. 16115	Pit	Lawrence.
Kaolin: The Philadelphia Clay Co.	236 West North St. Carlisle, Pa. 17013	Pit	Cumberland.
Common clay and shale:			
Alwine Brick Co., subsidiary of Glen-Gery Corp.	New Oxford, Pa. 17350	Pit	Adams.
Bylite Corp.	P.O. Box 1628, North End Station Wilkes-Barre, Pa. 18705	Pit	Luzerne.
Fenati Brick Co., Inc.	New Castle, Pa. 16101	Pit	Lawrence.
Glen-Gery Corp.	227 North 5th St. Reading, Pa. 19601	Pit	Berks, Dauphin, Lancaster, Northumberland, York.
Hanley Co.	28 Kennedy St. Bradford, Pa. 16701	Pit	McKean.
McAvoy Vitrified Brick Co.	Phoenixville, Pa. 19460	Pit	Chester.
McQuiston Coal Co.	109 East Moody Ave. New Castle, Pa. 16101	Pit	Lawrence.
Milliken Brick Co., Inc.	2100 Montier St. Pittsburgh, Pa. 15221	Pit	Allegheny.
The Robinson Clay Product Co.	65 West State St. Akron, Ohio 44309	Pit	Montgomery.
Coal:			
Anthracite:			
Blue Coal Corp. <sup>4</sup>	101 South Main St. Ashley, Pa. 18706	Underground	Luzerne.
Blue Coal Corp. <sup>7</sup>	do	Culm bank	Do.
Blue Coal Corp. <sup>8</sup>	do	Strip	Do.
Carbondale Coal Co., Inc. <sup>4</sup>	78 Cottage St. Carbondale, Pa. 18407	do	Lackawanna.
Gangloff Brothers <sup>4</sup>	New Ringold, Pa. 17960	Culm bank	Northumberland.
Glen-Nan Coal Co., Inc.	St. Mary's and River Road Wilkes-Barre, Pa. 18702	Underground	Luzerne.
Greenwood Stripping Corp.	1 Venice St. Nesquehoning, Pa. 18240	Strip	Carbon, Schuylkill.
Jeddo-Highland Coal Co. <sup>8</sup>	800 Exeter Ave. West Pittston, Pa. 18643	do	Luzerne.
Jeddo-Highland Coal Co. <sup>4</sup>	do	Culm bank	Do.
Kerris & Helfrick, Inc.	Lehigh & Popular St. Mount Carmel, Pa. 18751	Strip	Columbia, Northumberland, Schuylkill.
Lehigh Valley Anthracite, Inc.	800 Exeter Ave. West Pittston, Pa. 18643	Culm bank	Carbon, Schuylkill, Luzerne.
Do	do	Strip	Columbia, Luzerne, Schuylkill, Lancaster.
Pennsylvania Power & Light Co.	901 Hamilton St. Allentown, Pa. 18101	Dredge	Lancaster.
Ken Pollock, Inc. <sup>4</sup>	Route 11 Hunlock Creek, Pa. 18621	Culm bank	Luzerne.
Reading Anthracite Co.	200 Mahantongo St. Pottsville, Pa. 17901	do	Northumberland, Schuylkill.
Do	do	Strip	Do.
Bituminous:			
Barnes & Tucker Co.	357 Lancaster Ave. Haverford, Pa. 19041	Underground	Cambria, Indiana.
Bethlehem Mines Corp.	701 East 3d St. Bethlehem, Pa. 18016	do	Cambria, Washington.
Buckeye Coal Co.	P.O. Box 900 Youngstown, Ohio 44501	do	Greene.
Gateway Coal Co. for J & L.	Box 608 California, Pa. 15419	do	Do.
Harmar Coal Co. <sup>4</sup>	Box 500 Library, Pa. 15129	do	Allegheny.
Jones & Laughlin Steel Corp.	Box 608 California, Pa. 15419	do	Greene.
Mathies Coal Co.	Box 500 Library, Pa. 15129	do	Washington.
Pittsburgh Coal Co. <sup>4</sup>	do	do	Do.
United States Steel Corp.	525 Wm. Penn Pl. Pittsburgh, Pa. 15219	do	Greene, Washington.
Graphite (synthetic):			
Aircro Speer Carbon Products, div. of Air Reduction Co., Inc.	Theresa St. St. Marys, Pa. 15857	Plant	Elk.

See footnotes at end of table.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Graphite (synthetic)—Continued			
Chas. Pfizer & Co., Inc., MPM Division.	235 East 42d St. New York, N.Y. 10017	Plant	Northampton.
Stackpole Carbon Co.	St. Marys, Pa. 15857	do	Elk.
Gypsum (calcined): United States Gypsum Co. <sup>9</sup>	101 South Wacker Dr. Chicago, Ill. 60606	do	Philadelphia.
Iron ore:			
Bethlehem Mines Corp. <sup>10</sup>	701 East 3d St. Bethlehem, Pa. 18016	Underground	Berks.
Bethlehem Mines Corp. <sup>11</sup>	do	do	Lebanon.
Iron oxide pigments:			
Crude:			
Allegheny Ludlum Steel Corp.	2000 Oliver Bldg. Pittsburgh, Pa. 15222	Plant	Allegheny.
Lanzendorfer Minerals Co.	Twin Rocks, Pa. 15960	Pit	Cambria
Finished:			
Minerals, Pigments, & Metals Div., Chas. Pfizer & Co., Inc.	640 North 13th St. Easton, Pa. 18042	Plant	Northampton.
The Prince Manu- facturing Co.	Bowmanstown, Pa. 18030	do	Carbon.
Reichard-Coulston, Inc.	15 East 26th St. New York, N.Y. 10010	do	Northampton.
Lime:			
The J. E. Baker Co. <sup>1</sup>	P.O. Box 1189 York, Pa. 17405	do	York.
Mercer Lime & Stone Co.	1640 Oliver Bldg. Pittsburgh, Pa. 15222	do	Butler.
National Gypsum Co. <sup>1</sup>	325 Delaware Ave. Buffalo, N.Y. 14202	do	Centre.
Standard Lime & Refrac. Co., div. Martin- Marietta Corp. <sup>1</sup>	2000 First National Bank Bldg. Baltimore, Md. 21203	do	Do.
Warner Company <sup>1</sup>	1721 Arch St. Philadelphia, Pa. 19103	do	Centre, Chester.
Mica (crude): Micalith Mining Co., Inc.	P.O. Box 1671 Phoenix, Ariz. 85001	Pit	York.
Peat:			
Benton Peat	Benton, Pa. 17814	Bog	Columbia.
Blue Ridge Industries, Inc.	Box 128, R.D. 2 White Haven, Pa. 18661	Bog	Luzerne.
D. M. Boyd Co.	226 Francis St. New Wilmington, Pa. 16142	Bog	Lawrence.
Corry Peat Products Co.	515 West Columbus Ave. Corry, Pa. 16407	Bog	Erie.
International Peat, Inc.	R.D. 1 White Haven, Pa. 18661	Bog	Luzerne.
Lake Benton Peat Moss	1418 North Main St. Scranton, Pa. 18508	Bog	Lackawanna.
Pennsylvania Peat Moss, Inc.	21st & Laurel Sts. Hazleton, Pa. 18201	Bog	Luzerne, Monroe.
Stillers Blue Ridge Peat Co.	R.D. White Haven, Pa. 18661	Bog	Luzerne.
Wayne Peat Humus Co., Inc.	P.O. Box 315 Gouldsboro, Pa. 18424	Bog	Wayne.
Welker's Greenhouse, Inc.	New Castle, Pa. 16101	Bog	Lawrence.
Perlite (expanded):			
Armstrong Cork Co.	Lancaster, Pa. 17603	Plant	Lancaster.
The Celotex Corp.	1500 North Dale Mabry Tampa, Fla. 33607	do	Luzerne.
Insul-Fil Manufacturing Co.	Box 325 Primos, Pa. 19018	do	Delaware.
Pennsylvania Perlite Corp.	P.O. Box 2002 Lehigh Valley, Pa. 18001	do	Lehigh, York.
Perlite Manufacturing Co.	P.O. Box 478 Carnegie, Pa. 15106	do	Allegheny.
Petroleum refineries:			
Atlantic Richfield Co.	260 South Broad St. Philadelphia, Pa. 19102	do	Philadelphia.
BP Oil Corp.	600 Fifth Ave. New York, N.Y. 10001	do	Delaware.
Gulf Oil Corp.	P.O. Box 7408 Philadelphia, Pa. 19101	do	Erie.
Kendall Refining Co., div. of Witco Chemical Co.	Bradford, Pa. 16701	do	McKean.
Pennsylvania Refining Co.	Karns City, Pa. 16041	do	Butler.
Pennzoil United, Inc.	Oil City, Pa. 16301	do	Venango.
Quaker State Oil Refining Corp.	Farmers Valley, Pa. 16749	do	McKean, Venango.
Sun Oil Company	1608 Walnut St. Philadelphia, Pa. 19101	do	Do.

See footnotes at end of table.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Petroleum refineries—Continued			
United Refining Co.....	Warren, Pa. 16365.....	Plant.....	Warren.
Valvoline Oil Co., div. of Ashland Oil and Refining Co.	Freedom, Pa. 15042.....	.....do.....	Beaver.
Wolf's Head Oil Refining Co., Inc.	Reno, Pa. 16343.....	.....do.....	Venango.
Sand and gravel:			
Davison Sand & Gravel Co.	34th Ave. & 4th St. New Kensington, Pa. 15068	Dredge.....	Westmoreland.
East Falls Sand & Gravel..	R.D. 1 Falls, Pa. 18615	Pit.....	Wyoming.
Erie Sand Steamship Co...	Erie, Pa. 16500.....	Dredge.....	Erie.
Glacial Sand & Gravel Co..	P.O. Box 10 Kittanning, Pa. 16201	Pit.....	Armstrong.
Hunlock Sand & Gravel Co.	Box 275—A R.D. 1 Hunlock Creek, Pa. 18621	Pit & Plant.....	Luzerne.
Lycoming Silica Sand Co...	401 Broad St., Box 159 Montoursville, Pa. 17754	Pit.....	Lycoming.
Mahoning Valley Sand Co..	Box 1236 New Castle, Pa. 16102	Pit & Plant.....	Lawrence.
Manorville Sand Co.....	Box 251 Manorville, Pa. 16238	Pit.....	Armstrong.
Mount Cydonia Sand Co., Inc.	R.D. 1 Fayetteville, Pa. 17222	Pit.....	Franklin.
Pennsylvania Glass Sand Corp.	Berkeley Springs, W.Va. 25411	Pit.....	Huntingdon, Mifflin.
Penny Supply, Inc.....	1001 Paxton St. Harrisburg, Pa. 17104	Pit.....	Perry.
Seidle Sand & Gravel, Inc..	R.D. 4 Mercer, Pa. 16137	Pit.....	Mercer.
State Aggregates, Inc.....	635 Lucknow Lane Harrisburg, Pa. 17110	Pit.....	Bradford.
Warner Company.....	1721 Arch St. Philadelphia, Pa. 19103	Pit.....	Bucks.
Wyoming Sand & Stone Co.	Falls, Pa. 18615.....	Pit.....	Wyoming.
Smelters:			
The New Jersey Zinc Co..	Palmerton, Pa. 18071.....	Plant.....	Carbon.
St. Joe Minerals Corp.....	Josephtown, Pa. 15061.....	.....do.....	Beaver.
Stone:			
Limestone and dolomite— crushed:			
Appalachian Stone Div., Martin- Marietta Corp.	Box 120 Mercersburg, Pa. 17236	Quarry.....	Centre, Chester, Fayette, Franklin.
Bethlehem Mines Corp. <sup>12</sup>	701 East 3d St. Bethlehem, Pa. 18016	.....do.....	Adams.
Bethlehem Mines Corp.	.....do.....	.....do.....	Dauphin, Mifflin, Montgomery, Northampton.
Bradford Hills Quarries, Inc.	Box 231 Easton, Pa. 18042	.....do.....	Chester, Lancaster, Montgomery, Perry.
G. & W. H. Corson, Inc. <sup>12</sup>	Plymouth Meeting, Pa. 19462	.....do.....	Montgomery.
Eureka Stone Quarry, Inc.	Lower State & Pickertown Rds. Eureka, Pa. 18914	.....do.....	Bucks.
Eastern Industries Inc.	Box 188 Wescosville, Pa. 18090	.....do.....	Berks, Lehigh.
Lycoming Silica Sand Co.	P.O. Box 159 Montoursville, Pa. 17754	.....do.....	Clinton, Columbia, Lycoming, Montour.
National Gypsum Co...	325 Delaware Ave. Buffalo, N.Y. 14202	.....do.....	York, Centre.
New Enterprise Stone & Lime.	New Enterprise, Pa. 16664..	.....do.....	Bedford, Blair, Franklin, Huntingdon.
United States Steel Corp.	Hillsville, Pa. 16132.....	.....do.....	Lawrence.
Miscellaneous—crushed & broken:			
Better Materials Corp..	Route 232 & Swamp Rd. Penny Park, Pa. 18943	.....do.....	Bucks.
Gill Quarries, Inc.....	P.O. Box 187 Fairview Village, Pa. 19434	.....do.....	Bucks, Montgomery.
M & M Stone Co.....	Harleysville, Pa. 19438.....	.....do.....	Do.

See footnotes at end of table.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Miscellaneous—dimension:			
Burdo & Burdo-----	29 Washington Ave. Belmont Heights Philadelphia, Pa. 19100	Quarry-----	Do.
F. Cantono & Sons---	454 Germantown Pike Lafayette Hill, Pa. 19444	-----do-----	Delaware.
Di Bonaventura Quarries, Inc.-----	4989 West Thompson St. Philadelphia, Pa. 19131	-----do-----	Do.
Oystershell—crushed:			
Reading Poultry Food Co.-----	Orrton & Noble Sts. Reading, Pa. 19600	Plant-----	Berks.
Sandstone and quartzite— crushed:			
American Asphalt Paving Co.-----	Box 95, R.D. 5 Shavertown, Pa. 18700	Quarry-----	Luzerne.
Bear Gap Stone Inc.---	R.D. 1 Elysburg, Pa. 17824	-----do-----	Northumberland.
Coolbaugh Sand & Stone, Inc.-----	32 Railroad Ave. Scranton, Pa. 18505	-----do-----	Luzerne.
Detwilers Industries, Inc., subsidiary of New Enterprise Stone & Lime Co., Inc.-----	New Enterprise, Pa. 16664	-----do-----	Bedford, Somerset.
Eidemiller Enter- prises, Inc.-----	Greensburg, Pa. 15601	-----do-----	Westmoreland.
Faylor Lime & Stone Co.-----	Winfield, Pa. 17889	-----do-----	Dauphin, Northampton.
Keeler Supply Co., Inc.-----	Box 12 Clifford, Pa. 18413	-----do-----	Susquehanna.
Latrobe Construction Co.-----	P.O. Box 150 Latrobe, Pa. 15650	Underground-----	Westmoreland.
No. 1 Contracting Corp. of Delaware.	Box 460 Pittston, Pa. 18640	Quarry-----	Northampton, Schuylkill.
Summit Quarries, Div. of J. Robert Bazley, Inc.-----	P.O. Box 298 Pottsville, Pa. 17901	-----do-----	Schuylkill.
Sandstone and quartzite— dimension:			
Caln Building Stone Corp.-----	R.D. 1 Zion Grove, Pa. 17985	-----do-----	Chester.
Delaware Quarries----	Lumberville, Pa. 18933	-----do-----	Bucks.
Firestone Products Co., Inc.-----	300 Willow Grove Ave. Glenside, Pa. 19038	-----do-----	Montgomery.
Media Quarry Co.----	131 East 2d St. Media, Pa. 19063	-----do-----	Delaware.
Paul Tompkins Estate Valley Forge Building Stone.-----	Hancock, N.Y. 13783 P.O. Box 195 Morgantown, Pa. 19543	-----do-----	Wayne. Chester.
Slate—crushed:			
GAF Corp., Building, Industrial & Floor Products Div.-----	140 West 51st St. New York, N.Y. 10020	-----do-----	York.
Pennsylvania Light- weight Aggregate, Inc.	Bangor, Pa. 18013	-----do-----	Northampton.
Slate—dimension:			
Capitol Slate Co., Inc.	P.O. Box 281 East Bangor, Pa. 18040	-----do-----	Do.
Anthony Dally & Sons, Inc.-----	Robinson Ave. Pen Argyl, Pa. 18072	-----do-----	Do.
Doney Slate Co.-----	Pen Argyl, Pa. 18072	-----do-----	Do.
Emerald Slate Corp.---	Alpha Road Wind Gap, Pa. 18091	-----do-----	Do.
North Bangor Slate Co.-----	Bangor, Pa. 18013	-----do-----	Do.
Penn Big Bed Slate Co., Inc.-----	446 Main St. Slatington, Pa. 18080	-----do-----	Lehigh.
Stephens-Jackson Co.---	Main St. & Schanck Ave. Pen Argyl, Pa. 18072	-----do-----	Northampton.
D. Stoddard & Sons, Inc.-----	Bangor, Pa. 18013	-----do-----	Do.
Traprock (basalt)— crushed and broken:			
Bucks County Crushed Stone, Inc.	Ottsville, Pa. 18942	-----do-----	Bucks.
V. Di Francesco & Sons.-----	17 Mifflin Ave. Havertown, Pa. 19083	-----do-----	Chester.
Do.-----		-----do-----	Delaware.

See footnotes at end of table.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Traprock (basalt)—crushed and broken—Continued			
GAF Corp., Building, Industrial & Floor Products Div.	140 West 51st St. New York, N.Y. 10020	Quarry-----	Adams.
The General Crushed Stone Co.	712 Drake Bldg. Easton, Pa. 18042	----do-----	Bucks, Delaware.
Vernon B. Horn-----	R.D. Chalfont, Pa. 18914	----do-----	Bucks.
Kibblehouse Quarries, Inc.	Perkiomenville, Pa. 18074	----do-----	Montgomery.
Montgomery Stone Co., Inc. <sup>13</sup>	Montgomeryville, Pa. 18936	----do-----	Do.
Pottstown Trap Rock Quarries, Inc.	R.D. 1 Douglasville, Pa. 19518	----do-----	Berks, Montgomery.
Tohickon Quarry Co.	Quakertown, Pa. 18951	----do-----	Bucks.
Warner Company-----	1721 Arch St. Philadelphia, Pa. 19103	----do-----	Berks.
Traprock (basalt)—dimension: Coopersburg Granite Co.	Coopersburg, Pa. 18036	----do-----	Bucks.
Granite—crushed: Mignatti Constr. Co., Inc.	2310 Terwood Ave. Bethayres, Pa. 19006	----do-----	Montgomery.
Granite—dimension: French Creek Granite Co.	St. Peters, Pa. 19470	----do-----	Chester.
Carl Galantino, Inc.---	42 Hirst Ave. East Lansdowne, Pa. 19050	----do-----	Delaware.
Sulfur:			
Atlantic Richfield Co.---	3144 Passyunk Ave. Philadelphia, Pa. 19145	Plant-----	Philadelphia.
Gulf Oil Corp.-----	P.O. Box 7408 Philadelphia, Pa. 19101	----do-----	Do.
BP Oil Corp., subsidiary of British Petroleum Corp. Ltd.	P.O. Box 428 Marcus Hook, Pa. 19061	----do-----	Delaware.
Sun Oil Co.-----	1608 Walnut St. Philadelphia, Pa. 19103	----do-----	Do.
Talc (sericite-schist): Summit Industries, Inc.	Drawer C Aspers, Pa. 17304	Pit-----	Adams.
Tripoli (rottenstone): Keystone Filler & Manufacturing Co.	Muncy, Pa. 17756	Pit-----	Lycoming.
Penn Paint & Filler Co.---	Antes Fort, Pa. 17720	Pit-----	Do.
Vermiculite (exfoliated):			
Hyzer & Wellen-----	P.O. Box 155 Southampton, Pa. 18966	Plant-----	Bucks.
W. R. Grace & Company, Zonolite Div.	62 Whittemore Ave. Cambridge, Mass. 02140	----do-----	Lawrence.

<sup>1</sup> Also limestone.<sup>2</sup> Also limestone and shale.<sup>3</sup> Also limestone and clay.<sup>4</sup> 2 operations.<sup>5</sup> Also limestone and sand and gravel.<sup>6</sup> Also fire clay.<sup>7</sup> 3 operations.<sup>8</sup> 4 operations.<sup>9</sup> Also expanded perlite.<sup>10</sup> Also byproduct cobalt and pyrites.<sup>11</sup> Also byproduct gold, silver, copper, cobalt, and pyrites.<sup>12</sup> Also lime.<sup>13</sup> Also dimension.



# The Mineral Industry of Puerto Rico, the Panama Canal Zone, the Virgin Islands, Pacific Island Possessions, and Trust Territory of the Pacific Islands

The Puerto Rico section of this chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Mineralogy and Geology Section, Industrial Research, Economic Development Administration, Commonwealth of Puerto Rico, for collecting information on all minerals.

By Charles D. Hoyt <sup>1</sup> and Samuel A. Gustavson <sup>2</sup>

## PUERTO RICO <sup>3</sup>

During 1970 there were no significant developments in the Puerto Rican Government-company negotiations concerning the exploitation of three porphyry copper deposits in west-central Puerto Rico. In early December 1969, American Metal Climax, Inc. (Amax), and Kennecott Copper Corp. submitted a proposal to jointly mine the deposits. It was proposed to mine the two Amax deposits near the Rio Vivi first and then exploit the other deposit near the Rio Tanamá. Combined surface reserves total almost 244 million tons averaging about 0.73 percent copper. Many Puerto Ricans view this potential large-scale mining project as an ecological threat to the island. There has been much opposition to the proposal. An excellent summary of the current situation through 1970 was presented in a mining trade journal.<sup>4</sup>

The Mining Commission of Puerto Rico reported that at the end of 1970 there were nine exclusive exploration concessions in effect, four of which had been granted in 1970. Details concerning this exploration activity are presented in table 3.

In January 1970, a new laboratory, the Geological Laboratory of Natural Resources, began operation in the Department of Public Works' central complex in

San Juan. The 4,000-square-foot laboratory is staffed and operated jointly by the Area of Natural Resources, Department of Public Works, and the U.S. Geological Survey. The laboratory will provide analytical services to support geologic investigations within the Commonwealth. The laboratory is equipped with modern atomic absorption and spectrophotometer instruments as well as a complete wet chemistry section. Facilities are also available to perform thin section examinations for petrographic and mineralogic studies. Analytic data from the laboratory units are coded and fed to a computerized data storage and retrieval system maintained by the Department of Public Works.

The Geologic Division of the U.S. Geological Survey continued its work of preparing 7½-minute geologic quadrangle maps under a cooperative agreement with the Puerto Rican Economic Development Administration (Fomento). During 1970

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<sup>3</sup> Prepared by Charles D. Hoyt.

<sup>4</sup> Lutjen, George P. The Curious Case of the Puerto Rican Copper Mines. Eng. and Min. J., v. 172, No. 2, February 1971, pp. 74-84.



Table 1.—Mineral production in Puerto Rico <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement.....thousand 376-pound barrels..	8,943	\$27,920	9,460	\$29,515
Clays.....thousand short tons..	438	454	429	486
Lime.....do..	41	1,505	41	W
Salt.....do..	32	395	32	395
Sand and gravel.....do..	9,432	23,296	* 9,432	* 23,296
Stone.....do..	6,985	13,550	7,296	13,947
Total <sup>2</sup> .....	XX	67,120	XX	67,639
Total 1967 constant dollars.....	XX	63,381	XX	W 61,213

\* Estimate. W Withheld to avoid disclosing individual company confidential information. 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 withheld.

three geologic maps,<sup>5</sup> one metallogenic map,<sup>6</sup> and two published reports<sup>7</sup> were completed as part of this cooperative work.

The U.S. Geological Survey's marine geologists in cooperation with the Industrial Development Administration of Puerto Rico, continued their geological studies of the seafloor off the Puerto Rican coast. In 1970 studies were conducted in the south central area near Ponce and extending almost to Vieques Island in the east.

Two members of the Department of Geology, University of Puerto Rico at Mayagüez, published a paper revising Mid-Tertiary stratigraphy of southwestern Puerto Rico.<sup>8</sup> In the paper, the current stratigraphic terminology is reviewed and evidence of discrepancies presented. It is concluded that further regional stratigraphic and paleontologic studies are needed.

#### REVIEW BY MINERAL COMMODITIES

**Nonmetals.—Cement.**—The Puerto Rican cement industry had a difficult year in 1970. The major producer, the Puerto

Rican Cement Co., Inc., lost money for the first time since it began operations in 1938. Total sales of cement in Puerto Rico by the Puerto Rican Cement Co., Inc., increased slightly in 1970, but total sales, which include exports, declined about 2 percent. A new producer, the San Juan Cement Co., entered the scene in mid-1970.

The basic problem has been a cost-price squeeze. In Puerto Rico there has been a

<sup>5</sup> Briggs, R. P. Geologic Map of the Orocoivis Quadrangle, Puerto Rico. Misc. Geol. Inv. Map No. I-615. U.S. Geol. Survey.

<sup>6</sup> McIntyre, D. H. Geologic Map of the Central La Plata Quadrangle, Puerto Rico. Misc. Geol. Inv. Map No. I-660. U.S. Geol. Survey.

<sup>7</sup> Tobisch, O. T. Geologic Map of the San Sebastián Quadrangle, Puerto Rico. Misc. Geol. Inv. Map No. I-661. U.S. Geol. Survey.

<sup>8</sup> Cox, D. P., and R. P. Briggs. Metallogenic Map of Puerto Rico. Mineral Inv. Res. Map. U.S. Geol. Survey.

<sup>7</sup> McIntyre, D. H., J. M. Aaron, and O. T. Tobisch. Cretaceous and Lower Tertiary Stratigraphy of Northwestern Puerto Rico. U.S. Geol. Survey Bull. 1294-D, 1970, pp. 1-16.

Monroe, W. H. A Glossary of Karst Terminology. U.S. Geol. Survey Water-Supply Paper 1899-K, 1970, pp. K1-K26.

<sup>8</sup> Moussa, Mounir T., and George A. Seigle. Revision of Mid-Tertiary Stratigraphy of Southwestern Puerto Rico. Am. Assn. of Petrol. Geol. Bull., v. 54, No. 10, October 1970, pp. 1887-1893.

Table 2.—Value of mineral production in Puerto Rico, by districts

(Thousands)

Senatorial district	1969	1970 <sup>1</sup>	Minerals produced in 1970 in order of value
Aguadilla.....	\$2,935	\$2,934	Sand and gravel, stone.
Arecibo.....	3,810	3,810	Do.
Guayama.....	2,356	2,356	Stone, sand and gravel.
Humacao.....	1,741	1,741	Sand and gravel, stone.
Mayaguez.....	3,922	3,921	Sand and gravel, stone, salt.
Ponce.....	25,385	25,025	Cement, sand and gravel, stone, clays.
San Juan.....	26,971	27,850	Do.
Total <sup>2</sup> .....	67,120	67,639	

<sup>1</sup> Excludes value of lime, which is being withheld to avoid disclosing company confidential information.

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

**Table 3.—Exclusive prospecting permits in Puerto Rico**  
(February 28, 1971)

Permit holder	Date	Subsidiary	Minerals
O. D. Weaver.....	Aug. 20, 1968	-----	Gas and petroleum.
Cobre Caribe, S.A. <sup>1</sup> .....	Aug. 5, 1958	Kennecott Copper Corp.....	Copper and associated minerals.
Ponce Mining Co. <sup>1</sup> .....	May 15, 1961	American Metal Climax, Inc.	Do.
Caribe Sun Oil Co.....	Sept. 11, 1969	Sun Oil Co.....	Gas and petroleum.
Puerto Rico Petroleum Exploration Corp.....	July 14, 1968	-----	Do.
Ocean Dynamics Corp.....	Apr. 8, 1970	Ocean Dynamic Corp.....	Ilmenite and associated minerals.
North American Exploration.....	Oct. 27, 1970	Agents of Parnasse Delaware Co.	Copper and associated minerals.
Oceanic Exploration Co.....	Oct. 27, 1970	Eastman Dillon Union Securities & Co.	Do.
Anthony Rojas.....	Oct. 27, 1970	Strauss Exploration Co.....	Do.
Puerto Rican Cement Co. <sup>2</sup> .....	Aug. 30, 1968	-----	Kaolin and pyrophyllite.

<sup>1</sup> Application has been made for a mining lease.  
<sup>2</sup> Mining lease.

fixed price of \$1.10 per 94-pound bag for 23 years on retail sales, which represent 45 percent of total cement revenue. Since bulk cement prices are not regulated, these were increased by the Puerto Rican Cement Co., Inc., from \$1.00 to \$1.10 per bag, in October 1970. Another price increase by the company for bulk cement to \$1.25 per bag was scheduled for April 1, 1971. The cement industry is currently seeking price adjustments at the retail level. The Puerto Rican Consumers Services Administration and a special advisory committee appointed by the Governor were studying the industry and the pricing situation.

The Puerto Rican Cement Co., Inc., also continued its successful marketing of a ready-mix mortar, Mezcla-Lista. Output of this product in 1970 was up 15 percent over 1969, to 51,090 tons. Retail distribution of Mezcla-Lista in 80-pound bags was started in 1970. In 1971, a similar product is to be produced in Florida at a 500-ton-per-day plant operated by a wholly owned subsidiary, Instant Crete of Florida, Inc.

In December 1970 the Puerto Rican Cement Co., Inc., purchased a 50-percent interest in the Caribbean Material Supply

Co. of St. Croix, V.I. This company operates a ready-mix plant, a block manufacturing plant, a rock quarry, and a sand-dredging operation.

Rapid growth of the construction industry continued in 1970 as shown in table 5. This large growth primarily reflects inflation and the expansion of petrochemical facilities, rather than actual building unit increases. Therefore cement markets, which usually represent about 3 percent of building project costs, are expanding modestly rather than very rapidly as might be indicated by an analysis of gross construction statistics.

*Lime.*—Output of lime by the Puerto Rican Cement Co., Inc., which is distributed by its subsidiary, the Florida Lime Corp., decreased slightly. Construction uses consumed 65 percent of the output; the balance was used in the chemical industry. Almost 90 percent of the lime produced was consumed in Puerto Rico, and the remainder was exported to the Virgin Islands.

*Sand and Gravel.*—A joint seminar on the manufacture and use of sands, sponsored by the Department of Public Works and the Aggregate Producers Association of Puerto Rico, was held in San Juan February 24–26, 1970. The purpose of the seminar was to focus the attention of government and private industry on the acute shortage of fine natural aggregates on the island and to convey to the construction industry the opportunities presented by the use of manufactured sands in Puerto Rico. Fifteen technical papers were presented during the seminar. Puerto Rico has limited natural sand resources; these

**Table 4.—Puerto Rico: Portland cement salient statistics**

(Thousand 376-pound barrels and thousand dollars)

	1969	1970
Number of active plants.....	2	3
Rated capacity, Dec. 31.....	11,500	14,000
Production.....	8,945	9,523
Shipments from mills:		
Quantity.....	8,943	9,460
Value.....	\$27,920	\$29,515
Stocks at mills, Dec. 31.....	154	217

**Table 5.—Construction activity in Puerto Rico**  
(Million dollars)

Type of construction	1968	1969	1970
<b>Dwellings:</b>			
Private.....	258.1	281.5	276.3
Public.....	57.9	66.3	60.3
<b>Total.....</b>	<b>316.0</b>	<b>347.8</b>	<b>336.6</b>
<b>Industrial and commercial:</b>			
Private.....	172.8	162.4	343.9
Public.....	130.4	142.8	158.9
<b>Total.....</b>	<b>303.2</b>	<b>305.2</b>	<b>502.8</b>
<b>Roads, schools, other public works:</b>			
Puerto Rican Government.....	68.9	84.5	138.5
Municipalities.....	16.9	22.1	15.9
<b>Total.....</b>	<b>85.8</b>	<b>106.6</b>	<b>154.4</b>
<b>Grand total.....</b>	<b>705.0</b>	<b>759.6</b>	<b>993.8</b>

have been heavily exploited to support the rapidly growing construction industry whose total activity expanded from \$227 million in 1960 to almost \$1 billion in 1970. Suggested alternative sources for natural sands included mining submarine deposits, using byproducts of manufacturing operations, importing sand from neighboring islands, and the direct production of aggregate from existing stone resources. Because of limited sand resources, governmental restrictions on beach exploitation, and a burgeoning construction and tourism industry, the availability of aggregate is one of Puerto Rico's most pressing problems and one that requires a solution in this decade.

A report by U.S. Bureau of Mines engineers on the sand resources of Puerto Rico was presented to the Secretary of Public Works during the February 24–26, 1970, joint seminar on sands.<sup>9</sup> Based on field investigations conducted in June and July 1969, the report concluded that conventional sand supplies were decreasing rapidly, while demand continued in a strong upward trend. Alternate supply sources must be developed or severe shortages probably will develop during the 1970's.

**Building Stone.**—Marble from various parts of Puerto Rico was processed to make slabs and shapes by Marmoles de Puerto Rico, Inc. (Cienne), in a plant west of Bayamon. Another marble facility in the same general area is operated by Puerto Rican Marble Industries, Inc., which produces marble-chip floor tiles. Plant capacity is 5,000 to 6,000 square yards of tile per day.

**Mineral Fuels.**—In 1970, crude and unfinished oil imports into Puerto Rico, as feedstock for the petrochemical industry, increased 19 percent over that of the previous year. The average of crude and unfinished oil imports was almost 234,000 barrels per day. Small amounts of residual and finished products (2,744 barrels per day) were also imported.

**Petrochemicals.**—In 1970, Commonwealth Oil Refining Co., Inc. (CORCO), the dominant refining and petrochemical processor in Puerto Rico, processed nearly 55 million barrels (150.5 thousand barrels per day) of raw materials in its refinery and six petrochemical plants in the CORCO complex, compared with 47 million barrels in 1969. A \$10 million refinery expansion program was completed in 1970.

CORCO operates a 115,000-barrel-per-day oil refinery and the world's largest aromatic-organic plant. The latter is operated by a 100-percent-owned subsidiary, Commonwealth Petrochemicals, Inc. The aromatic plant annually produces the following products; in million gallons: Benzene, 160; toluene, 10; orthoxylyene, 19; mixed xylenes, 85; aromatic solvents, 10. CORCO and W. R. Grace & Co. jointly constructed a \$40 million oxo-alcohols plant with an annual capacity of 250 million pounds. The plant went on stream in late 1970. In another joint venture, CORCO and PPG Industries each own half of a large \$100

<sup>9</sup> Christiansen, Carl, H. F. Robertson, and P. A. Hamilton. Sand Resources and Production in Puerto Rico. Report to the Secretary of Public Works, Commonwealth of Puerto Rico, San Juan, P.R. 1970, 64 pp.

**Table 6.—Puerto Rico: Sand and gravel sold or used by producers, by classes of operations and uses**  
(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970 <sup>1</sup>	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building .....	2,726	\$6,730	2,726	\$6,730
Fill .....	1,012	1,205	1,012	1,205
Paving .....	1,945	4,445	1,945	4,445
Total .....	5,683	12,379	5,683	12,379
Gravel:				
Building .....	1,760	5,839	1,760	5,839
Fill .....	675	776	675	776
Paving .....	1,147	3,779	1,147	3,779
Total .....	3,582	10,395	3,582	10,395
<b>Government-and-contractor operations:</b>				
Sand:				
Building .....	137	425	137	425
Paving .....	30	98	30	98
Total .....	167	522	167	522
Total sand and gravel <sup>2</sup> .....	9,432	23,296	9,432	23,296

<sup>1</sup> Estimated for 1970.

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

million olefins plant, which was under construction and scheduled for completion in mid-1971. The plant, one of the world's largest, will have an annual capacity of 1 billion pounds of ethylene, 600 million pounds of propylene, and 200 million pounds of butadiene.

Puerto Rican Sun Oil Co. completed dredging of the harbor at Yabucoa, which is needed for the construction of its new \$125 million petrochemical complex and oil refinery. The construction pier was completed and began operating in July 1970. The facility, which will process 66,000 barrels-per-day of imported crude

oil, is scheduled to go on stream in 1971. The refinery will include a 5,000-barrel-per-day lube oil plant.

Union Carbide Corp., which has operated in Puerto Rico since 1955, continued a major expansion of its olefins petrochemical facilities, but no major new units were completed during 1970. Some of the expanded capacity will be on stream in late 1971, others during 1972, and one unit in early 1973.

PPG Industries continued construction of a \$79 million plant that will produce chlorine (185,000 tons per year), caustic soda (200,000 tons per year), vinyl chlo-

**Table 7.—Puerto Rico: Stone sold or used by producers**  
(Thousand short tons and thousand dollars)

Year	Dimension limestone		Crushed limestone	
	Quantity	Value	Quantity	Value
1966 .....	88	\$231	4,416	\$7,555
1967 .....	101	293	5,578	8,767
1968 .....	101	293	5,619	9,408
1969 .....	101	292	5,238	9,380
1970 .....	101	292	5,549	9,777
	Miscellaneous stone <sup>1</sup>		Total	
	Quantity	Value	Quantity	Value
1966 .....	1,228	\$2,755	5,732	\$10,541
1967 .....	1,590	3,735	7,269	12,795
1968 .....	1,647	3,879	7,367	13,580
1969 .....	1,646	3,878	6,985	13,550
1970 .....	1,646	3,878	7,296	13,947

<sup>1</sup> Includes granite, marble, and other stone.

ride monomer (500 million pounds per year), and ethylene glycol (400 million pounds per year). The olefin feedstock will come from Puerto Rico Olefins new facility.

A subsidiary of Phillips Petroleum Co., Phillips Puerto Rico Core Inc., operates a \$70 million petrochemical plant at Guayama, which had an average daily throughput in 1970 of 50,100 barrels. The plant produces benzene, cyclohexane, orthoxylylene, paraxylylene, ethylbenzene, and a paraffinic fraction. Phillips has entered a joint venture with Rhône-Poulenc, France's largest privately held corporation, and has formed Fibers International Corp. Fibers International operates a nylon "66" plant with a capacity of 20 million pounds per year. Expansions are scheduled to triple

the capacity and produce denier and carpet yarns, as well as small amounts of polyester fiber.

Air Products & Chemicals, Inc., has completed a \$10 million air separation plant, which will produce 400,000 tons per year of oxygen and 300,000 tons per year of nitrogen. The oxygen is to be used by PPG Industries to produce ethylene oxide, an important petrochemical intermediate.

A subsidiary of Hooker Chemical Corp., Puerto Rico Chemical Co., recently expanded its output and now operates an \$11 million plant producing 90 million pounds of phthalic anhydride per year. Commonwealth Oil Refining Co. Inc. (CORCO) and Phillips Puerto Rico Core, Inc. provide the orthoxylylene feedstock for the plant.

### PANAMA CANAL ZONE <sup>10</sup>

Minerals produced in the Panama Canal Zone in 1970 were sand and gravel, basalt, and andesite, used as aggregate in concrete, roadstone, railroad ballast, and riprap. Production decreased slightly from the previous year. The Panama Canal Co., Canal Zone Government, in its Annual Report for fiscal year ending June 30, 1970, reported that during the year the last stages

of the Gaillard Cut widening program were completed. This completes a program to widen the canal that was started shortly after its opening in 1914. The navigable channel now has a minimum width of 500 feet along its entire length. The Panama Canal Co. also announced the beginning of a campaign to eliminate oil pollution in the Canal Zone.

### VIRGIN ISLANDS <sup>11</sup>

The U.S. Virgin Islands are a part of the Antilles, which form the dividing line between the Caribbean Sea and the Atlantic Ocean. There are about 50 islands and cays of volcanic origin; only St. Croix, St. Thomas, and St. John, are of significant size, having any population or commercial significance. Mineral production consists chiefly of basalt, which is crushed or ground for use as concrete aggregate or roadstone or is quarried in larger sizes for riprap. Quarries on St. Croix and St. Thomas accounted for the total production. On St. Croix, Caribbean Material Supply Co. and Springfield Crusher Division of Masonry Products, Inc. produced aggregates and riprap. On St. Thomas, Controlled Concrete Inc. operated a portable and a stationary crushing unit, producing coarse aggregate for concrete.

Owing to an accelerated program of highway construction and maintenance and an increase in housing construction, mineral output was up from 1969.

The 1970 Annual Report—Virgin Islands, to the Secretary of the Interior, indicated that during the fiscal year 1970, the construction of totally new sewage systems for St. Croix and St. Thomas was started as part of an antipollution campaign. The two systems are planned to have sufficient capacity to meet needs of the islands until the year 2015. The report also indicated that improved operational capabilities of their potable water system through desalination made it possible to eliminate the costly barging of water from San Juan, P.R.

<sup>10</sup> Prepared by Samuel A. Gustavson.

<sup>11</sup> Prepared by Samuel A. Gustavson.

Table 8.—Mineral production in the Panama Canal Zone and Virgin Islands <sup>1</sup>

Mineral	1969		1970	
	Short tons	Value	Short tons	Value
Canal Zone:				
Sand and gravel.....	59,535	\$96,803	60,000	\$97,000
Stone <sup>2</sup> .....	74,095	231,007	84,600	265,398
Total.....	XX	327,810	XX	362,398
Virgin Islands:				
Stone (basalt).....	411,358	1,682,483	513,767	2,225,988

XX Not applicable.

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

<sup>2</sup> Includes basalt.

PACIFIC ISLAND POSSESSIONS <sup>12</sup>

REVIEW BY ISLANDS

**American Samoa.**—The Territory of American Samoa consists of seven islands in the South Pacific, along 14° latitude south and about the 170° longitude west. Total land area is about 76.2 square miles. The main island is Tutuila, where Pago Pago is located. Most of the mineral production is from this island. Basalt, volcanic cinder, and coral limestone are produced for construction and road use. Output was considerably less in 1970 than in 1969. A portable crusher was idled for repairs most of the year, and much of the coral limestone used was from stocks.

**Guam.**—Coral limestone was quarried in the Barrigada, Dededo, and Malojloj areas. Commercial producers of crushed coral limestone including Hawaiian Rock Products, Perez Bros., Inc., and Pacific Rock

Corp. operated quarries and crushing plants at Agana and Oka. In total, output was slightly less than that of 1969.

**Wake.**—The Wake Island group is a "U" shaped coral atoll with islands of Wilkes and Peale comprising about one-third of each tip and connected to the main island by causeways. During 1970, coral was quarried on Wilkes Island for use as concrete aggregate in housing construction and for rehabilitation of facilities damaged by Typhoon Sarah (1967). The Typhoon Sarah projects were completed in the year, and as a result, output of coral was less than in 1969. Demand is predicted to continue at a low level.

**Other Pacific Island Possessions.**—No mineral production was reported for the islands of Canton, Enderbury, Jarvis, Johnston, Midway, and Palmyra.

TRUST TERRITORY OF THE PACIFIC ISLANDS <sup>13</sup>

Mineral production is limited to volcanic rock and coral quarried chiefly by Government crews for use in building construction and for improving roads, airfields, and harbor facilities. No production of bauxite

(Babelthaupt Island) or phosphate rock (Angaur Island) has been reported for several years.

<sup>12</sup> Prepared by Samuel A. Gustavson.

<sup>13</sup> Prepared by Samuel A. Gustavson.

Table 9.—Mineral production in the Pacific Island Possessions

Area and mineral	1969		1970	
	Short tons	Value	Short tons	Value
American Samoa:				
Pumice (volcanic cinder).....	1,565	\$5,478	1,784	\$6,224
Sand.....	7,000	7,000	26,000	25,000
Stone.....	54,183	107,739	48,642	68,952
Total.....	XX	120,217	XX	100,176
Guam: Stone.....	654,176	1,399,127	626,168	1,288,577
Wake: Stone.....	9,000	45,000	3,550	17,750

XX Not applicable.



# The Mineral Industry of Rhode Island

By Frank B. Fulkerson <sup>1</sup>

Mineral production in Rhode Island in 1970 was valued at \$4.4 million. The decrease of 1 percent from 1969 was the result of smaller output of sand and gravel. Mineral commodities produced in the State included sand and gravel, crushed miscellaneous stone, dimension granite, crushed

limestone, and a small quantity of mineral specimens.

Providence County, accounting for nearly half the State total, was again the leading producer, followed by Kent, Washington, and Newport Counties.

<sup>1</sup> Industry economist, Division of Nonmetallic Minerals.

**Table 1.—Value of mineral production in Rhode Island, by counties <sup>1</sup>**  
(Thousand dollars)

County	1969	1970	Minerals produced in 1970, in order of value
Kent.....	\$1,701	\$1,628	Sand and gravel.
Newport.....	W	W	Sand and gravel, stone.
Providence.....	2,022	2,032	Do.
Washington.....	W	W	Stone, sand and gravel.
Undistributed <sup>2</sup> .....	710	726	
Total.....	4,433	4,386	
Total 1967 constant dollars.....	4,186	<sup>p</sup> 3,969	

<sup>p</sup> Preliminary. W Withheld to avoid disclosing individual company confidential data.

<sup>1</sup> Bristol County is not listed because no production was reported.

<sup>2</sup> Includes value of gem stones and sand and gravel that cannot be assigned to specific counties and values indicated by symbol W.

**Table 2.—Indicators of Rhode Island business activity**

	1969	1970 <sup>p</sup>	Change, percent
Employment and labor force, annual average:			
Total labor force..... thousands..	346.2	341.6	-1.3
Unemployment..... percent of work force..	3.7	6.3	+70.3
Employment:			
Manufacturing..... thousands..	127.9	120.7	-5.6
Durables..... do.....	50.7	48.9	-3.6
Nondurables..... do.....	77.2	71.8	-7.0
Nonmanufacturing..... do.....	218.3	220.9	+1.2
Construction..... do.....	15.0	14.8	-1.3
Service (including mining)..... do.....	53.9	54.5	+1.1
Payroll-average weekly earnings:			
Manufacturing.....	\$107.87	\$111.72	+3.6
Personal income:			
Total..... millions..	\$3,575	\$3,772	+5.5
Per capita.....	\$3,771	\$3,920	+4.0
Construction activity:			
Cement shipments to and within Rhode Island thousand 376-pound barrels..	1,015	1,001	-1.4
Mineral production value..... thousands..	\$4,433	\$4,386	-1.1

<sup>p</sup> Preliminary.

Sources: Rhode Island Department of Labor; New England Economic Indicators, Federal Reserve Bank of Boston; Employment and Earnings, U.S. Department of Labor; Rhode Island Economic Trends; Survey of Current Business.



Table 3.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1969:								
Sand and gravel.....	182	186	34	281	-----	6	21.38	884
Stone.....	78	242	19	160	-----	3	18.80	1,579
Total <sup>1</sup> .....	260	203	53	440	-----	9	20.44	1,136
1970: <sup>p</sup>								
Sand and gravel.....	150	180	27	216	-----	3	13.87	920
Stone.....	45	246	11	89	-----	2	22.45	202
Total.....	195	195	38	305	-----	5	16.37	710

<sup>p</sup> Preliminary.<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Gem Stones.**—Gem stones were collected mainly from quarries and other exposed rock outcrops and from quarry dumps.

**Sand and Gravel.**—Sand and gravel continued to be the State's principal product and supplied 66 percent of the mineral output value. Reflecting the general decline in economic activity, production decreased from 2.5 million tons in 1969 to 2.4 million tons in 1970. Sixteen producers in Rhode Island sold 1.3 million tons of sand and gravel for building purposes, 599,000 tons for paving use, and the remainder for fill, ice control, foundry sand, and miscellaneous uses. The overall value of sand for building and paving increased from \$1.23 per ton and \$1.18 per ton, respectively, in 1969, to \$1.26 and \$1.22 in 1970. Similarly, value of gravel for building increased from \$1.49 per ton in 1969 to \$1.53 in 1970; value of gravel for paving advanced from \$1.13 per ton in 1969 to \$1.19. Kent was the leading county in sand and gravel production. Transportation was mainly by truck; a small tonnage was transported by railroad.

**Stone.**—Production of stone was unchanged from the preceding year; total value increased 4 percent owing to an increase in average value per ton. Granite,

limestone, and miscellaneous stone, con-

Table 4.—Principal uses and value of sand and gravel

Use	Sand		Gravel	
	Percent	Value (thousands)	Percent	Value (thousands)
Building construction.....	66	\$822	57	\$950
Paving.....	25	307	25	415
Other.....	9	111	18	308

sisting of granitized gneiss and conglomerate, were produced. Granite output was essentially dimension stone. Almost all limestone was crushed and used for agricultural stone, terrazzo chips, refractory stone, and other purposes; a minor quantity of dimension limestone was produced. Miscellaneous stone products were principally crushed aggregate, riprap, and mineral filler.

### MINERAL FUELS

**Petroleum.**—No petroleum or natural gas was produced in Rhode Island. Mobil Oil Corp. operated a petroleum refinery at East Providence and utilized both foreign and domestic crude oil to produce asphalt, its only product. The asphalt was marketed in the northeastern United States.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Petroleum:</b>			
Mobil Oil Corporation.....	1001 Wampanoag Trail E. Providence, R.I. 02915	Refinery.....	Providence.
<b>Sand and gravel:</b>			
A. Cardi Construction Co., Inc....	451 Arnold Road Coventry, R.I. 02816	Pit.....	Kent.
Coventry Sand & Gravel Co.....	Reservoir Road Coventry, R.I. 02816	Pit.....	Do.
Del Bonis Sand & Gravel Co.....	950 Phenix Ave. Cranston, R.I. 02920	Pit.....	Providence.
Forte Brothers, Inc.....	14 Whipple St. Berkeley, R.I. 02900	Pit.....	Do.
Lapham Sand & Gravel Co.....	R.F.D. 2, Greenville Rd. Woonsocket, R.I. 02895	Pit.....	Do.
Mack Sand & Gravel Co.....	Pawtucket, R.I. 02860.....	Pit.....	Do.
Peckham Bros. Co., Inc.....	Paradise Ave. Middletown, R.I. 02840	Pit.....	Newport.
Rhode Island Sand & Gravel Co., Inc.	Milvert St. Hills Grove, R.I. 02886	Pit.....	Kent.
J. Romanella & Sons Inc.....	Box 546, Westerly, R.I. 02891	Pit.....	Washington.
J. Santoro, Inc.....	11 Herbert Street Providence, R.I. 02909	Pit.....	Providence.
Silvestri Brothers, Inc.....	Shun Pike Johnston, R.I. 02919	Pit.....	Do.
South County Sand & Gravel Co., Inc.	North Rd. Peace Dale, R.I. 02883	Pit.....	Washington.
Tasca Sand & Gravel Co.....	Box 113, R.F.D. 4, Esmond, R.I. 02917	Pit.....	Providence.
Town Line Sand & Gravel, Inc....	Victory Highway Slatersville, R.I. 02876	Pit.....	Do.
Whitehead Bros. Co.....	60 Hanover Road Florham Park, N.J. 07932	Pit.....	Kent.
<b>Stone:</b>			
<b>Granite, dimension:</b>			
Providence Granite Co.....	210 Kingsley Ave. Providence, R.I. 02903	Quarry.....	Washington.
<b>Limestone, crushed:<sup>1</sup></b>			
The Conklin Limestone Co., Inc.	R.F.D. 1 Lincoln, R.I. 02865	---do.....	Providence.
<b>Miscellaneous stone, crushed and broken:</b>			
M.A. Gammino Construction Co.	875 Phenix Ave. Cranston, R.I. 02920	---do.....	Do.
Peckham Brothers Co., Inc....	Paradise Ave. Newport, R.I. 02840	---do.....	Newport.

<sup>1</sup> Also dimension limestone.



# The Mineral Industry of South Carolina

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the South Carolina Division of Geology, State Development Board, for collecting information on all minerals except fuels.

By Robert G. Clarke <sup>1</sup> and Norman K. Olson <sup>2</sup>

The value of South Carolina's mineral production increased 1 percent in 1970. That it was the highest on record was largely due to increases in both quantity and value of cement, feldspar, sand and gravel, stone, and vermiculite. South Carolina ranked second nationally in the production of kaolin and vermiculite and fourth in feldspar.

The State's business activity in 1970 continued to increase. Per capita income was \$2,908, an increase of 7 percent over that of 1969.

**Government Programs.**—The Division of Geology, South Carolina State Development Board, developed a reorganization plan in 1970 that created four new sections: Geologic Mapping and Research, Information and Education, Mineral Resources, and Engineering Geology.

Late in 1970, a statewide Subsurface Samples Repository was established in Columbia. Cores, drill cuttings, and similar samples are available to the general public for study, and especially to professional personnel engaged in geologic exploration or research. A small office in the Repository will be equipped with microscopes, drill logs, and other supporting data. Eventually, it is planned to computerize as much information as possible on all the samples.

During 1970, 31 projects were active, and 11 reports were published. Separate investigations were in progress on the geology and mineral resources of Edgefield, Horry, Newberry, and Orangeburg Counties. In addition, studies were being conducted on the State's peat resources and the granite

industry. Special investigations were being made on carbonate rocks in northwestern South Carolina, boundary relationships between geologic belts in the Piedmont, and the geology of the spillway area below Lake Murray Dam. Geologic mapping was also in progress on the following 7½-minute quadrangles: Avalon, Fair Play, Holly Springs, Old Pickens, Rainy Mountain, Ridgeway, Salem, Seneca, Tugaloo Lake, Walhalla, Westminster, and Whetstone.

One Master's thesis in geology, supported by the Division of Geology in 1970, was published.<sup>3</sup> Three other Master's theses were supported by the Division of Geology in 1970 but were awaiting publication.<sup>4</sup> During 1970 the Division of Geology, South Carolina, published 5 reports.<sup>5</sup>

<sup>1</sup> Physical scientist, Division of Nonmetallic Minerals.

<sup>2</sup> State geologist, Division of Geology, State Development Board, Columbia, S.C.

<sup>3</sup> Mitchell, John. Geology and Petrology of the Wateree Lake Area, Kershaw County, South Carolina. June 1970, 53 pp.

<sup>4</sup> Hornig, Carl A. Geology of the King's Creek Barite Deposit.

Morris, Samuel J. Fluvial-Marine Terrace Correlations in Upper Pee Dee River Valley.

Monrad, John. Flood Plain Development: A Cenozoic Model From South Carolina.

<sup>5</sup> Roper, Paul J. MS-16. Geology of the Tamassee, Satolah and Cashiers Quadrangles, South Carolina (map and text). 1970, 55 pp.

Wagner, H. D. MS-17. Geology of the Southern Two-Thirds of the Winnsboro 15-Minute Quadrangle, South Carolina (map and text). 1970, 34 pp.

Stock, Jr., G. W. and G. E. Siple, MR-5. Ground Water Records of South Carolina, 1966. 1969, 39 pp.

Wagner, H. D. Beach Erosion in Charleston Harbor Area. Environmental Geology Series (Env GS) 1. 1970, 11 pp.

South Carolina Mineral Producers Directory. Circular No. 1. 1970, 40 pp.

Members of the State Division of Geology contributed articles to South Carolina Geologic Notes, Volume 14. <sup>6</sup>

In September 1970, Robert B. McCormick was appointed Liaison Officer for the State of South Carolina. He is to advise, assist, and promote activities or programs in South Carolina of mutual interest to the Bureau of Mines and to State and local agencies. These include cooperative mineral resource programs and many problems relating to the environment such as air pollution, water pollution, solid waste disposal, and mined land reclamation.

<sup>6</sup> Olson, N. K. and S. H. Johnson, Jr. Geological Activities in South Carolina During 1969. No. 2, April 1970, pp. 29-34.

Acker, L. L. and R. D. Hatcher, Jr. Relationships Between Structure and Topography, Northwest South Carolina. No. 2, April 1970, pp. 35-48.

Hatcher, Jr., R. D. Geology of Long Creek Soapstone Belt, Oconee County, South Carolina. No. 2, April 1970, pp. 49-55.

McSween, Jr., H. Y. Petrology of Charlotte and Kings Mountain Belt Rocks in North Greenwood County, South Carolina. No. 3, August 1970, pp. 57-84.

Peterson, R. W. and C. J. Cazean. Lynchess River Sediments, South Carolina. No. 4, November 1970, pp. 85-96.

Griffin, Jr., W. S. A Probable Pre-Triassic Masic Intrusion in the Anderson 15-Minute Quadrangle, South Carolina. No. 4, November 1970, pp. 97-104.

Table 1.—Mineral production in South Carolina <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays.....thousand short tons.....	2,444	\$10,911	1,974	\$9,878
Sand and gravel.....do.....	5,692	8,229	5,864	7,766
Stone.....do.....	8,846	18,506	9,710	14,734
Value of items that cannot be disclosed:				
Cement, feldspar, kyanite (1969), scrap mica, peat, pyrite (1969), and vermiculite.....	XX	23,218	XX	23,987
Total.....	XX	55,864	XX	56,364
Total 1967 constant dollars.....	XX	52,752	XX	51,009

<sup>p</sup> Preliminary. XX Not applicable.

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

<sup>2</sup> Excludes value of certain dimension stone; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production, in South Carolina, by counties <sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Aiken.....	\$7,652	\$7,403	Kaolin, sand and gravel.
Anderson.....	W	30	Sand and gravel.
Berkeley.....	W	W	Limestone.
Cherokee.....	W	W	Limestone, miscellaneous clay, sand and gravel.
Chesterfield.....	W	669	Sand and gravel.
Colleton.....	W	W	Peat.
Dorchester.....	W	W	Cement, limestone, miscellaneous clay, sand and gravel.
Edgefield.....	W	W	Miscellaneous clay.
Fairfield.....	1,310	W	Granite, miscellaneous clay.
Florence.....	W	W	Sand and gravel.
Greenville.....	W	W	Granite, sand and gravel.
Greenwood.....	W	W	Granite, miscellaneous clay.
Horry.....	W	W	Sand and gravel, miscellaneous clay.
Jasper.....	W	W	Sand and gravel.
Kershaw.....	973	860	Sand and gravel, kaolin, granite, miscellaneous clay.
Lancaster.....	523	W	Mica, miscellaneous clay, sand and gravel.
Laurens.....	W	W	Vermiculite, granite.
Lexington.....	4,619	4,827	Granite, sand and gravel, miscellaneous clay, kaolin.
Marion.....	W	W	Sand and gravel, miscellaneous clay.
Marlboro.....	W	W	Sand and gravel, kaolin, miscellaneous clay.
Newberry.....	W	W	Miscellaneous clay, granite.
Orangeburg.....	W	W	Cement, marl, miscellaneous clay.
Pickens.....	W	W	Granite.
Richland.....	2,667	2,629	Granite, miscellaneous clay, sand and gravel, kaolin.
Spartanburg.....	W	W	Granite, feldspar, sand and gravel.
Sumter.....	W	W	Sand and gravel, miscellaneous clay.
York.....	W	W	Granite.
Undistributed.....	38,221	39,894	
Total <sup>2</sup> .....	55,864	56,364	

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

<sup>1</sup> The following counties are not listed because no production was reported: Abbeville, Allendale, Bamberg, Barnwell, Beaufort, Calhoun, Charleston, Chester, Clarendon, Darlington, Dillon, Georgetown, Hampton, Lee, McCormick, Oconee, Saluda, Union, and Williamsburg.

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

Table 3.—Indicators of South Carolina business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total work force.....thousands..	1,058.4	1,091.1	+3.1
Unemployment.....do.....	41.7	54.2	+30.0
All employment.....do.....	1,017.1	1,036.5	+1.9
<b>Wage and salary employment:</b>			
Mining.....do.....	1.7	1.7	-----
Contract construction.....do.....	49.1	49.5	+ .8
Transportation, communication and public utilities.....do.....	35.3	37.1	+5.1
Manufacturing.....do.....	339.2	339.1	( <sup>1</sup> )
Trade.....do.....	135.4	142.1	+4.9
Finance, insurance, and real estate.....do.....	28.3	29.5	+4.2
Services.....do.....	80.8	85.5	+5.8
Government.....do.....	139.7	149.0	+6.7
<b>Personal income:</b>			
Total.....millions..	\$7,018	\$7,549	+7.6
Per capita.....do.....	\$2,731	\$2,908	+6.5
<b>Construction activity:</b>			
Value of nonresidential construction.....millions..	\$68.6	\$68.3	-.4
Number of housing units authorized.....do.....	16,808	19,945	+18.7
Farm marketing receipts.....millions..	\$400.1	\$441.5	+10.3
Mineral production value.....do.....	\$55.9	\$56.4	+ .9

<sup>1</sup> Less than ½ of 1 percent.

Sources: South Carolina Employment Security Commission, U.S. Department of Commerce, U.S. Department of Agriculture, U.S. Bureau of Mines.

**Employment and Injuries.**—In the mineral industries, 2,065 men worked 4,664,000 man-hours, compared with 2,038 men working 4,283,000 man-hours in 1969, an increase of 9 percent in man-hours. Employment increased at stone quarries and

at sand and gravel mines but decreased at other nonmetal and peat mines.

There were 122 lost-time injuries in the mineral industries, including two fatalities, compared with 87 and one fatality in 1969.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Nonmetal and peat....	925	255	236	1,919	-----	41	21.37	460
Sand and gravel.....	352	239	84	781	1	17	23.05	10,428
Stone.....	761	263	200	1,584	-----	28	17.68	527
Total <sup>1</sup> .....	2,038	255	521	4,283	1	86	30.31	2,302
<b>1970:<sup>p</sup></b>								
Nonmetal and peat....	900	251	226	1,824	-----	94	51.52	1,215
Sand and gravel.....	355	252	89	828	-----	5	6.04	140
Stone.....	810	290	235	2,012	2	21	11.43	6,327
Total <sup>1</sup> .....	2,065	267	551	4,664	2	120	26.16	3,229

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

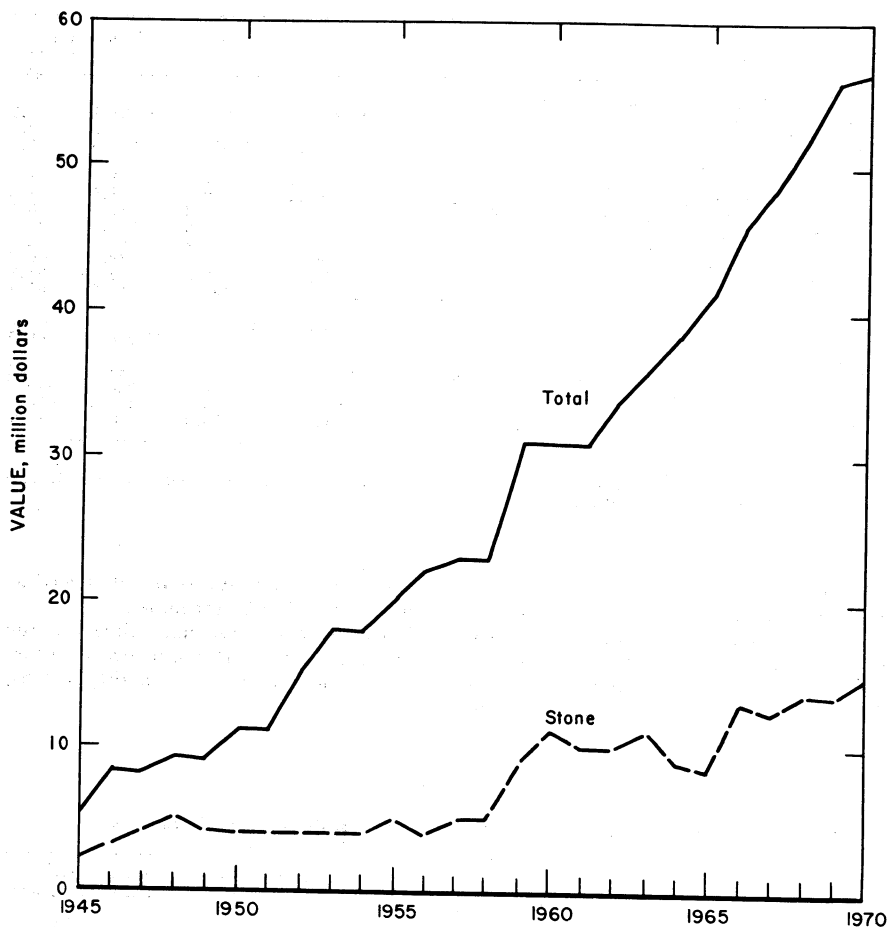


Figure 1.—Value of stone, and total value of mineral production in South Carolina.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Cement.**—Portland and masonry cement were produced by Giant Portland Cement Co. in Dorchester County and Santee Portland Cement Co. in Orangeburg County. Combined masonry and portland cement shipments increased 2 percent in quantity and 7 percent in value over those of 1969. Shipments were mostly in bulk and by truck. Out-of-State shipments were to Florida, Georgia, North Carolina, and Virginia. Most of the shipments were for ready-mix, concrete products, and building material

usage; a small percentage went into highway construction. The raw materials used consisted mostly of limestone or marl, clay, and additives such as gypsum, air-entraining compounds, and grinding aids. Natural gas and fuel oil were used as fuels depending on seasonal rates. Both plants do wet grinding only. The consumption of cement was about 5 million barrels of portland and masonry types combined, allowing for shipments into and out of the State.

**Clays.**—Overall clay production in 1970 accounted for 18 percent of South Caroli-

na's total mineral production value. Overall quantities decreased 19 percent, and values decreased 9 percent compared with those of 1969.

Kaolin production decreased 13 percent in quality, to 519,247 tons, and value decreased 10 percent, to \$8,010,838, but South Carolina maintained its national rank of second. The principal uses for kaolin were in rubber, firebrick, insecticides and fungicides, paint, building brick, and ceramics. Kaolin was produced by 11 companies at 23 mines in five counties. Aiken County was the leader in kaolin production for quantity, number of mines, and number of companies. Leading producers were J. M. Huber Corp. and Dixie Clay Co.

Miscellaneous clay production in 1970, at 1.5 million tons valued at \$1.9 million, decreased 21 percent in tonnage and 8 percent in value from 1969. Twenty-two mines were operated by 16 companies in 15 counties. Leading counties, in decreasing order of tonnage of miscellaneous shales produced, were as follows: Dorchester, Cherokee, and Richland. Leading producers were as follows: Giant Portland Cement Co. and Richtex Corp.

**Table 5.—Kaolin sold or used by producers, by uses**  
(Thousand short tons)

Use	1969	1970
Rubber.....	267	262
Firebrick.....	48	19
Insecticide and fungicide.....	15	20
Paint.....	5	5
Other uses <sup>1</sup> .....	261	213
<b>Total.....</b>	<b>596</b>	<b>519</b>

<sup>1</sup> Includes building brick, fertilizers, vitrified sewer pipe, drain tile, floor and wall tile, paper, pottery and stoneware, and other uses.

**Feldspar.**—An increase of 3 percent in quantity and 6 percent in value over 1969 levels established a new record of 1970 feld-

spar production. The State continued to rank fourth nationally in feldspar production because of one company, Spartan Minerals Co., Spartanburg County, which recovers feldspar as a byproduct silica-feldspar mixture from crushed granite fines. The recovered mixture is used primarily in the manufacture of pottery, glass, and rubber.

**Kyanite.**—No production was reported in 1970 because the only mine in the State, Commercialores, Inc., of York County, an open pit mine, ceased operations.

**Lime.**—South Carolina was not a producer of lime in 1970; however, apparent lime consumption, as measured by shipments of lime into the State, was 39,000 tons.

**Mica.**—Flake mica was produced from sericite schist at the one operation of Mineral Mining Corp. in Lancaster County. Production was 10 percent more in quantity, but decreased in value because of local market conditions. The mica was used mainly in paint, joint cement, and electronics.

**Pyrite.**—No pyrite was produced in 1970 owing to the closure of the kyanite operation in York County.

**Sand and Gravel.**—In 1970, sand and gravel was produced in 17 counties by 22 companies at 29 locations. Sand and gravel ranked fourth in value of mineral commodities produced in South Carolina. Production increased 3 percent in quantity but decreased 6 percent in value. The average value per ton decreased by \$0.13 to \$1.32. All was commercial production, and 15 operations, over 100,000, tons each, accounted for 90 percent of the total. By quantity, county ranked in descending order was Sumter, Marlboro, Lexington, Chesterfield; and, in descending order by value, Marlboro, Lexington, Sumter, and Chesterfield.

**Table 6.—South Carolina: Sand and gravel sold or used by producers, by classes of operations and uses**  
(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Blast sand.....	17	\$90	20	\$103
Building sand.....	2,908	1,967	3,310	2,012
Other sand and gravel <sup>1</sup> .....	2,767	6,172	2,534	5,651
<b>Total.....</b>	<b>5,692</b>	<b>8,229</b>	<b>5,864</b>	<b>7,766</b>

<sup>1</sup> Includes glass, molding, fire-furnace, engine, filtration, abrasives, chemical, fill, glass, pottery, paving, railroad ballast, and other sands; and building, paving, fill, and other gravel.



**Table 7.—South Carolina: Sand and gravel sold or used by producers, by counties**  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Aiken.....	1	W	W	1	83	\$91
Anderson.....	-----	-----	-----	1	54	80
Chesterfield.....	3	W	W	4	1,020	669
Lexington.....	19	1,113	\$2,169	17	1,027	2,008
Undistributed <sup>1</sup> .....	6	4,579	6,060	6	3,681	4,924
Total <sup>2</sup> .....	29	5,692	8,229	29	5,864	7,766

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

<sup>1</sup> Includes Cherokee, Dorchester, Florence, Greenville, Horry, Jasper, Kershaw, Lancaster, Marion, Marlboro, Richland, Spartanburg, and Sumter Counties.

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

**Stone.**—In 1970, the quantity of stone production increased 10 percent, and the value increased 12 percent compared with 1969. Also, of the total State mineral production value, the stone value accounted for 27 percent of the total, up from 24 percent in 1969.

Crushed granite was produced in nine counties for 10 quarries by three companies. Superior Stone Co., a Division of Martin-Marietta Corp., Vulcan Materials Co., and Palmetto Quarries Co. comprised in three producers. Pickens, Lexington, and Richland Counties, in that order, led the State in output of crushed granite. Crushed granite was used as road base stone, macadam road aggregate, bituminous road aggregate, concrete aggregate, railroad ballast, fine aggregate, riprap, and jetty stone. Twenty-five percent of the crushed granite was transported by rail and the remainder, by truck.

Dimension granite was produced by the Winnsboro Granite Corp. from one quarry in Fairfield County by the Comolli Granite Co. from one quarry in Kershaw County and by the Kershaw Granite Co. from two quarries in Kershaw County and one in Newberry County.

Crushed limestone was produced by Superior Stone Co. Division of Martin-Marietta Corp. from one quarry in Berkeley County, by Vulcan Materials Co. from one quarry in Cherokee County and in Dorchester by Giant Portland Cement Co. and Ideal Cement Co. from one quarry each. Crushed limestone was used for cement, agricultural limestone, road base stone, concrete aggregate, bituminous aggregate, macadam aggregate, surface treatment flux stone, riprap, and jetty stone. Santee Portland Cement Co. produced crushed

marl for cement from a quarry in Orangeburg County.

**Vermiculite.**—In 1970, crude vermiculite production increased about 1 percent in quantity compared with 1969 but increased about 8 percent in value. Zonolite Division, W. R. Grace & Co., produced crude in Laurens County and exfoliated vermiculite in Greenville County. Patterson Vermiculite Co. produced crude and exfoliated vermiculite in Laurens County. Fifty percent of the exfoliated vermiculite was used as a soil additive, 40 percent as lightweight concrete aggregate, and 10 percent as loose and block insulation.

Among the States, South Carolina ranked second in production of crude vermiculite.

## METALS

**Ferroalloys.**—Mobil Oil Corp., Charleston, continued to produce ferrophosphorus as a byproduct of elemental phosphorus furnace operations. Pittsburgh Metallurgical Co., Charleston, produced ferrosilicon, ferrochromium, and ferrochromium silicon.

**Zirconium.**—M & T Chemicals, Inc., operated a grinding plant near Andrews, Georgetown County, for the production of milled zircon for foundry, refractory, ceramic, and glass uses.

## MINERAL FUELS

**Peat.**—One company, Ti-Ti Peat Humus Co., Inc., produced peat from a bog near Green Pond, Colleton County. About two-thirds was sold in bulk form, and the remainder was packaged. All of the peat was used for general soil improvement. South Carolina ranked 14th in peat production in the United States.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Giant Portland Cement Co.....	150 Strafford Ave. Wayne, Pa. 19087	Plant.....	Dorchester.
Santee Portland Cement Co.....	Box 698 Holly Hill, S.C. 29059	....do.....	Orangeburg.
<b>Clays:</b>			
<b>Kaolin:</b>			
Cyprus Mines Corp.....	Box 1201 Trenton, N.J. 08618	Open-pit mine....	Aiken.
Dixie Clay Co.....	230 Park Ave. New York, N.Y. 10017	....do.....	Do.
J. M. Huber Corp.....	630 Third Ave. New York, N.Y. 10017	....do.....	Do.
National Kaolin Products Co.	Box 431 Aiken, S.C. 29801	....do.....	Do.
Southeastern Clay Co.....	Box 1022 Aiken, S.C. 29801	6 open-pit mines...	Do.
<b>Miscellaneous:</b>			
Ashe Brick Co.....	Van Wyck, S.C. 29744..	Open-pit mine....	Lancaster.
Broad River Brick Co.....	Box 550 Gaffney, S.C. 29340	....do.....	Cherokee.
Giant Portland Cement Co...	150 Strafford Ave. Wayne, Pa. 19087	....do.....	Dorchester.
Guignard Brick Co.....	Box 568 Cayce, S.C. 29033	....do.....	Lexington.
Palmetto Brick Co.....	Cheraw, S.C. 29520.....	....do.....	Marlboro.
Richtex Corp.....	Box 3307 Columbia, S.C. 29203	3 open pit mines...	Fairfield, Lexington, Richland.
Santee Portland Cement Co.	Box 698 Holly Hill, S.C. 29059	Open pit mine....	Orangeburg.
Southern Brick Co.....	Box 208 Ninety Six, S.C. 29666	2 open pit mines...	Greenwood and Newberry.
<b>Feldspar, crude:</b>			
Spartan Minerals Co.....	Route 1, Box 14A Pacolet, S.C. 29372	Plant.....	Spartanburg.
<b>Mica, scrap:</b>			
The Mineral Mining Corp.....	Kershaw, S.C. 29067....	Open pit mine....	Lancaster.
<b>Peat:</b>			
Ti-Ti Peat Humus Co., Inc.....	Box 425 Charleston, S.C. 29402	Bog.....	Colleton.
<b>Sand and gravel:</b>			
Becker Sand & Gravel Co.....	Box 848 Cheraw, S.C. 29520	5 open pit mines...	Chesterfield, Dorchester, Marlboro, Sumter.
Columbia Silica Sand Co.....	Box 1519 Columbia, S.C. 29202	2 open pit mines...	Lexington.
Palmetto Quarries Co.....	Drawer 5185 Columbia, S.C. 29205	Open pit mine....	Richland.
Pennsylvania Glass Sand Corp...	Gen. Operations Dept. Berkeley Springs, W. Va. 25411	....do.....	Lexington.
Wilson Bros. Sand Co., Inc.....	Box 945 Greenwood, S.C. 29646	....do.....	Do.
<b>Stone:</b>			
<b>Granite, crushed:</b>			
Martin-Marrieta Corp.....	Box 2568 Raleigh, N.C. 27602	3 quarries.....	Fairfield, Lexington, York.
Palmetto Quarries Co.....	Drawer 5185 Columbia, S.C. 29205	....do.....	Fairfield, Green- wood, Richland.
Vulcan Materials Co.....	Drawer 8834 Greenville, S.C. 29604	4 quarries.....	Greenville, Laurens, Pickens, Spartanburg.
<b>Granite, dimension:</b>			
Comolli Granite Co.....	Box 898 Elberton, Ga. 30635	Quarry.....	Kershaw.
Kershaw Granite Co., Inc...	Box 250 Elberton, Ga. 30635	3 quarries.....	Kershaw and Newberry.
Winnsboro Granite Co.....	Rion, S.C. 29132.....	Quarry.....	Fairfield.
<b>Limestone, crushed:</b>			
Giant Portland Cement Co...	150 Strafford Ave. Wayne, Pa. 19087	....do.....	Dorchester.
Martin-Marrieta Corp.....	Box 2568 Raleigh, N.C. 27602	....do.....	Berkeley.
Vulcan Materials Co.....	Drawer 8834 Greenville, S.C. 29604	....do.....	Cherokee.
<b>Marl, crushed:</b>			
Santee Portland Cement Co...	Box 698 Holly Hill, S.C. 29059	....do.....	Orangeburg.

Table 8.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Vermiculite:</b>			
<b>Crude:</b>			
W. R. Grace & Co.....	62 Whittemore Ave. Cambridge, Mass. 02140	Several open pit mines.	Laurens and Spartanburg.
Patterson Vermiculite Co....	Route 1 Enoree, S.C. 29335	Open pit mine.....	Laurens.
<b>Exfoliated:</b>			
W. R. Grace & Co.....	62 Whittemore Ave. Cambridge, Mass. 02140	2 expanding plants..	Greenville and Laurens.
Patterson Vermiculite Co....	Route 1 Enoree, S.C. 29335	Mill and expanding plant.	Laurens.

# The Mineral Industry of South Dakota

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

By Charles D. Hoyt <sup>1</sup>

The 1970 value of mineral production in South Dakota rose about 12 percent above that of 1969. For the past 8 years, the total value of mineral output has remained in the range of \$50 to \$62 million per year. For 1970 metal production represented 37.5 percent of total value and nonmetals 61.9 percent. Fuels provided the remaining 0.6 percent. Compared with those of 1969, output value of metals declined and values of nonmetals and fuels rose.

Gold represented 91 percent of the metals production. Sand and gravel, stone, cement, and lime comprised 97 percent of the nonmetals total. These five commodi-

ties combined represented 94 percent of the total South Dakota mineral production.

In 1970 South Dakota retained its position as the Nation's leading gold producer, total output was 578,716 ounces, valued at \$21.1 million. As in the past, the Homestake Mining Co.'s large underground mine at Lead produced almost all of the output.

**Employment and Injuries.**—The extent of employment and injuries in the mineral industry, exclusive of the petroleum industry, is presented in table 4.

<sup>1</sup> Physical scientist, Division of Nonferrous Metals.

Table 1.—Mineral production in South Dakota <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate..... short tons..	46	\$23	W	W
Cement:				
Masonry..... thousand 280-pound barrels..	49	181	W	W
Portland..... thousand 376-pound barrels..	1,556	5,715	W	W
Clays..... thousand short tons..	187	1,171	165	\$946
Feldspar..... long tons..	29,494	194	17,211	114
Gem stones.....	NA	36	NA	35
Gold (recoverable content of ores, etc.)..... troy ounces..	598,146	24,621	578,716	21,059
Gypsum..... thousand short tons..	11	46	15	61
Lead (recoverable content of ores, etc.)..... short tons..	1	( <sup>2</sup> )	3	1
Mica (scrap)..... do..	423	20	( <sup>2</sup> )	34
Petroleum (crude)..... thousand 42-gallon barrels..	158	362	160	374
Sand and gravel..... thousand short tons..	11,158	10,807	16,556	16,656
Silver (recoverable content of ores, etc.)..... thousand troy ounces..	124	223	120	212
Stone..... thousand short tons..	2,092	10,839	1,979	13,375
Zinc..... short tons..	--	--	1	( <sup>2</sup> )
Value of items that cannot be disclosed: Columbium-tantalum concentrate (1969), lime, lithium minerals (1969), uranium, <sup>3</sup> tin (1969), vanadium (1970), and values indicated by symbol W.....	XX	683	XX	8,709
Total.....	XX	54,921	XX	61,576
Total 1967 constant dollars.....	XX	51,862	XX	<sup>p</sup> 55,726

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

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

<sup>2</sup> Less than ½ unit.

<sup>3</sup> Based on estimated recoverable content, average AEC price and estimated average price for private sales.

Table 2.—Value of mineral production in South Dakota, by counties <sup>1</sup>

		(Thousands)		
County	1969	1970	Minerals produced in 1970, in order of value	
Aurora	\$67	W	Sand and gravel.	
Beadle	249	\$317	Do.	
Bennett	--	W	Do.	
Bon Homme	45	85	Do.	
Brookings	259	321	Sand and gravel, stone.	
Brown	265	302	Sand and gravel.	
Brule	196	105	Do.	
Buffalo	6	W	Do.	
Butte	W	W	Clays, sand and gravel.	
Campbell	154	188	Sand and gravel, stone.	
Charles Mix	194	125	Sand and gravel.	
Clark	72	W	Do.	
Clay	27	W	Do.	
Codington	501	681	Do.	
Corson	50	W	Do.	
Custer	967	200	Feldspar, sand and gravel, lime, petroleum, stone.	
Davison	266	130	Sand and gravel.	
Day	325	223	Do.	
Deuel	106	123	Do.	
Dewey	13	W	Do.	
Douglas	196	95	Do.	
Edmunds	89	W	Do.	
Fall River	W	W	Uranium, vanadium, sand and gravel.	
Faulk	148	W	Sand and gravel.	
Grant	7,845	W	Stone, sand and gravel.	
Gregory	204	W	Sand and gravel.	
Hamlin	139	107	Do.	
Hand	122	385	Do.	
Hanson	536	W	Stone, sand and gravel.	
Harding	402	W	Petroleum, sand and gravel.	
Hughes	83	94	Sand and gravel.	
Hutchinson	96	W	Do.	
Hyde	389	W	Do.	
Jackson	291	--	--	
Jerauld	114	29	Sand and gravel.	
Jones	14	W	Do.	
Kingsbury	114	108	Do.	
Lake	203	120	Do.	
Lawrence	24,939	21,499	Gold, silver, sand and gravel, stone, lead, zinc.	
Lincoln	146	237	Sand and gravel.	
Lyman	322	W	Do.	
McCook	75	W	Do.	
McPherson	44	234	Do.	
Marshall	166	189	Do.	
Meade	176	W	Sand and gravel, gypsum.	
Mellette	23	154	Sand and gravel.	
Miner	54	W	Do.	
Minnehaha	W	W	Stone, sand and gravel.	
Moody	184	166	Sand and gravel.	
Pennington	8,329	8,503	Cement, stone, lime, sand and gravel, clays, mica (scrap), beryllium concentrates, feldspar.	
Perkins	248	155	Sand and gravel.	
Potter	88	W	Do.	
Roberts	88	91	Do.	
Sanborn	70	4	Do.	
Shannon	94	34	Do.	
Spink	418	W	Do.	
Stanley	150	W	Do.	
Sully	135	60	Do.	
Todd	8	14	Do.	
Tripp	W	W	Stone, sand and gravel.	
Turner	424	W	Sand and gravel.	
Union	79	W	Do.	
Walworth	70	145	Do.	
Washabaugh	70	W	Do.	
Yankton	86	176	Do.	
Ziebach	285	--	--	
Undistributed <sup>2</sup>	3,408	26,173		
Total	54,921	\$61,576		

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

<sup>1</sup> Haakon County not listed because no production was reported.

<sup>2</sup> Includes sand and gravel, and stone that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

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

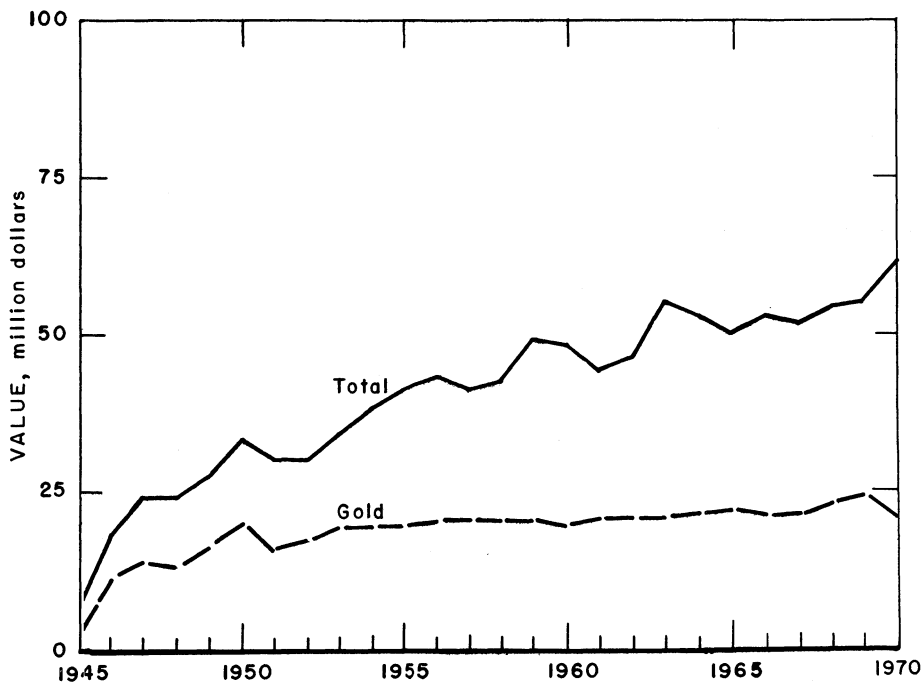


Figure 1.—Value of mine production of gold, and total value of mineral production in South Dakota.

Table 3.—Indicators of South Dakota business activity

	1969	1970	Change, percent	
<b>Employment and labor force, annual average:</b>				
Total labor force.....	thousands..	272.4	275.0	+1.0
Employment.....	do.....	264.8	266.2	+1.5
Unemployment.....	do.....	7.6	8.8	+15.8
<b>Nonagricultural employment:</b>				
Mining.....	do.....	2.3	2.2	-4.3
Construction.....	do.....	7.6	7.0	-7.9
Manufacturing.....	do.....	15.9	15.6	-1.9
Government.....	do.....	53.5	55.6	+3.9
Other nonagricultural employment.....	do.....	93.4	95.7	+2.5
<b>Personal income:</b>				
Total.....	millions..	\$1,995	\$2,119	+6.2
Per capita.....	do.....	\$2,986	\$3,182	+6.6
<b>Construction activity:</b>				
Highway construction contracts awarded.....	millions..	\$48.3	\$54.2	+12.2
Cement shipments to and within the State.....	do.....	1,375.0	1,289.0	-6.3
Number of authorized residential units.....	thousand 376-pound barrels..	1,507	2,513	+66.8
Value of nonresidential construction.....	millions..	\$22.6	\$26.4	+16.8
Farm marketing receipts.....	do.....	\$986.0	\$1,015.9	+3.0
Mineral production.....	do.....	\$54.9	\$64.2	+16.9

Sources: Construction Review, Streets and Roads, Farm Income Situation, Area Trends in Employment and Unemployment, Survey of Current Business, Employment and Earnings, U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Metal.....	1,677	311	522	4,176	2	87	21.31	4,505
Nonmetal.....	174	211	37	315	1	10	34.90	19,860
Sand and gravel.....	758	172	130	1,190	--	26	21.86	581
Stone.....	495	234	116	984	1	19	20.32	8,140
Total.....	3,104	259	805	6,665	4	142	21.91	5,068
<b>1970: <sup>p</sup></b>								
Metal.....	1,600	313	500	4,002	3	96	24.74	5,885
Nonmetal.....	175	246	43	345	--	14	40.57	1,516
Sand and gravel.....	725	183	133	1,198	--	25	20.87	1,623
Stone.....	535	240	129	1,093	1	31	29.28	6,020
Total <sup>1</sup> .....	3,035	265	804	6,638	4	166	25.61	4,911

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

## NONMETALS

**Cement.**—Shipments of cement in 1970 dropped slightly, compared with those of 1969. Sales were reported at 1.54 million barrels (376-pound) of portland cement and 44.35 thousand barrels (280-pound) of masonry cement during 1970.<sup>2</sup> All of the production came from the State-owned Rapid City plant operated by the South Dakota Cement Commission. Slightly over three-fourths of the cement was used in the building industry and nearly all of the remainder was used for highway construction. Almost 82 percent of the total shipments were within the State and 11 percent went to North Dakota and Wyoming.

Raw materials consumed in 1970 cement production were as follows in thousand tons: Limestone, 315; shale, 69; sand, 25; gypsum, 12; and iron ore, 5.

**Clays.**—Total output of clays in 1970 declined to 165,058 tons almost 12 percent below that of 1969. About one-third of this was bentonite and the remainder was clays used for cement, lightweight aggregate, and bricks. The American Colloid Co., which operates the only bentonite processing plant in South Dakota, obtains its raw material from South Dakota and Wyoming.

**Feldspar.**—Output of feldspar decreased from 29,434 tons in 1969, to 17,211 long tons in 1970 valued at almost \$114,000. Nearly all of this came from Custer County. Most of the production was sold to and processed by the International Minerals & Chemical Corp., which operates a grinding plant at Custer.

**Gypsum.**—The State's entire output of gypsum (15,189 tons in 1970) was used for cement production. The South Dakota Cement Commission was the operator of a small surface mine in Meade County that provided the entire output.

**Lime.**—Total output of lime in the State continued to increase. The two producers were Pete Lien & Sons at Rapid City, and the Black Hills Lime Co. at Pringle, which produced a lime for metallurgical uses.

**Sand and Gravel.**—Sand and gravel was produced in all but two counties. Of the total output of 16.6 million tons, 9.5 million (58 percent) was produced for governmental agencies. A total of 177 commercial firms operated at 180 locations; also, 78 Government-and-contractor crews oper-

ated at 132 locations. Of the total sand and gravel produced, 1.2 million tons was sand and 15.4 million tons was gravel. Minnehaha, Codington, Hand, Pennington, and Brookings Counties supplied 2.8 million tons, 17 percent of the State total.

**Stone.**—Stone production of nearly 2 million tons was obtained from granite, quartzite, limestone, quartz, traprock, and miscellaneous stone. The value of granite, mostly prepared for monumental and architectural purposes, amounted to \$10.4 million or 78 percent of the \$13.4 million total value of stone production. Limestone and quartzite production was valued at \$2.8 million.

Output of monumental and architectural granite came from five companies operating in Grant County, in the northeast corner of the State.

## METALS

**Gold and Silver.**—Gold output at the Homestake Mining Co.'s Lead operation declined slightly, to 578,716 ounces. Also 117,000 ounces of byproduct silver was produced. Nearly 2 million tons of ore was mined, and processed. Measured and indicated ore reserves at the end of 1970 were 10.4 million tons.

Homestake announced plans for a 5-year, \$8 million, deep-level development program, which will require sinking of a six-compartment shaft from the 4,850-foot level to the 7,400-foot level.

In late 1970, Homestake was ordered by the Federal Government to discontinue discharges of mercury into Whitewood Creek. To meet this requirement, plans were underway at yearend to completely eliminate the use of mercury (for amalgamation) in Homestake's milling process and use an all-cyanide method of extracting gold from ore. This changeover was expected to be implemented in early 1971.

**Lead.**—A very small amount of lead was recovered as a byproduct of silver ore produced by the Silver Queen Mine Co., operating in Lawrence County.

**Uranium.**—Output of uranium expanded in 1970, and sales were valued at an estimated \$9 to \$9.5 million.<sup>3</sup> All production came from the 650-ton-per-day mill at Edgemont, which is operated by Mines Development, Inc., a totally owned subsidiary of

<sup>2</sup> Rapid City Journal. Cement Shipments Decline. No. 28172, 92nd year, Jan. 14, 1971, p. 15.

<sup>3</sup> Susquehanna Corp. 1970 Annual Report, p. 14.



Table 5.—South Dakota: Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Aurora	2	72	\$67	3	W	W
Beadle	8	245	249	5	337	\$317
Bennett	--	--	--	1	15	W
Bon Homme	1	81	45	3	W	85
Brookings	15	232	251	9	385	313
Brown	13	315	265	8	343	302
Brule	7	191	196	3	118	105
Buffalo	1	4	6	6	W	W
Butte	4	157	81	4	122	96
Campbell	5	138	154	4	118	138
Charles Mix	8	193	194	9	143	125
Clark	2	72	72	1	W	W
Clay	2	58	27	2	W	W
Codington	13	545	501	12	723	681
Corson	3	81	50	3	W	W
Custer	4	693	672	2	W	W
Davison	13	296	266	5	161	130
Day	8	312	325	8	328	223
Deuel	5	131	106	5	181	123
Dewey	3	14	13	3	W	W
Douglas	7	179	186	4	104	95
Edmunds	3	90	39	2	W	W
Fall River	2	47	48	2	W	W
Faulk	5	164	148	3	W	W
Grant	5	224	225	2	W	W
Gregory	10	210	204	6	W	W
Hamlin	6	113	139	5	174	107
Hand	6	109	122	14	446	385
Harding	2	59	59	3	W	W
Hughes	1	83	83	4	120	94
Hutchinson	6	130	96	4	W	W
Hyde	3	387	389	2	W	W
Jackson	4	291	291	--	--	--
Jerauld	8	111	114	2	80	29
Jones	1	14	14	2	75	W
Kingsbury	7	114	114	7	112	108
Lake	12	274	203	7	177	120
Lawrence	4	41	42	4	271	194
Lincoln	6	134	146	8	279	237
Lyman	12	340	322	7	W	W
McCook	2	125	75	2	W	W
McPherson	2	41	44	4	291	234
Marshall	14	152	166	7	162	189
Meade	9	140	130	1	65	79
Mellette	3	23	23	4	178	154
Miner	2	52	54	1	W	W
Minnehaha	18	713	686	14	892	803
Moody	8	171	184	6	215	166
Pennington	9	446	553	8	389	437
Perkins	12	207	248	8	116	155
Potter	2	88	88	2	W	W
Roberts	5	95	88	3	75	91
Sanborn	3	86	70	1	28	4
Shannon	2	92	94	2	45	34
Spink	7	438	418	4	W	W
Stanley	4	131	150	1	W	W
Sully	4	175	135	3	W	60
Todd	1	7	3	1	25	14
Tripp	--	--	--	1	15	W
Turner	7	385	424	3	W	W
Union	5	95	79	1	W	W
Walworth	6	101	70	5	223	145
Washabaugh	2	70	70	2	W	W
Yankton	5	88	86	5	272	176
Ziebach	5	295	285	--	--	--
Undistributed <sup>1</sup>	--	--	--	39	8,754	9,905
Total <sup>2</sup>	364	11,158	10,807	312	16,556	16,656

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

<sup>1</sup> Includes Hanson County (1970) and some sand and gravel not assigned to any specific counties.<sup>2</sup> Data may not add to totals shown because of independent rounding.

**Table 6.—South Dakota: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building.....	485	\$529	496	\$567
Fill.....	68	54	110	60
Paving.....	148	207	254	287
Other uses <sup>1</sup> .....	--	--	56	69
Total <sup>2</sup> .....	701	790	917	983
Gravel:				
Building.....	217	313	152	245
Fill.....	43	38	117	91
Paving.....	2,282	2,188	4,762	4,062
Miscellaneous.....	9	8	889	691
Other uses <sup>3</sup> .....	--	--	179	165
Total <sup>2</sup> .....	2,551	2,548	6,098	5,254
<b>Government-and-contractor operations:</b>				
Sand:				
Building.....	5	4	--	--
Fill.....	1	1	1	1
Paving.....	1,015	982	248	205
Other uses.....	21	12	25	13
Total <sup>2</sup> .....	1,041	999	274	218
Gravel:				
Building.....	624	629	2	2
Fill.....	19	18	2	2
Paving.....	6,222	5,822	9,144	10,079
Other uses.....	--	--	118	118
Total <sup>2</sup> .....	6,864	6,470	9,266	10,201
Total sand and gravel <sup>2</sup> .....	11,158	10,807	16,556	16,656

<sup>1</sup> Includes unground sands.<sup>2</sup> Data may not add to totals shown because of independent rounding.<sup>3</sup> Includes railroad ballast (1970), and other gravel.**Table 7.—South Dakota: Stone sold or used by producers, by kinds**

(Thousand short tons and thousand dollars)

Kind of stone	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Limestone.....	--	--	W	W
Granite.....	44	\$7,620	63	\$10,409
Quartz.....	( <sup>1</sup> )	W	( <sup>1</sup> )	2
<b>Crushed and broken:</b>				
Limestone.....	989	1,207	1,043	1,052
Quartz.....	W	29	W	40
Quartzite.....	1,035	1,930	833	1,764
Sandstone.....	W	W	--	--
Traprock.....	3	8	3	8
Other stone.....	20	44	36	100
Total <sup>2</sup> .....	2,092	10,839	1,979	13,375

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

<sup>1</sup> Less than ½ unit; included with "Other stone."<sup>2</sup> Data may not add to totals shown because of independent rounding.

Table 8.—South Dakota: Stone sold or used by producers, by uses

(Thousand short tons and thousand dollars, unless otherwise specified)

Use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension stone:</b>				
Rough construction and rubble.....	3	W	W	W
Dressed architectural..... thousand cubic feet..	145	W	1 557	W
Rough monumental..... do.....				
Dressed monumental..... do.....	349	\$4,969	118	\$2,818
Flagging..... do.....	--	--	W	W
Total (approximate)..... short tons..	44	7,622	68	10,462
<b>Crushed and broken stone:</b>				
Concrete aggregates.....	524	1,004	453	847
Other road aggregates.....	714	1,108	777	1,276
Cement.....	304	222	310	218
Railroad ballast.....	321	511	207	( <sup>2</sup> )
Refractory stone.....	35	96	( <sup>2</sup> )	( <sup>2</sup> )
Riprap and jetty stone.....	62	90	37	54
Other <sup>3</sup> .....	88	185	125	518
Total <sup>4</sup> .....	2,048	3,217	1,911	2,913
Grand total.....	2,092	10,839	1,979	13,375

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

<sup>1</sup> Data includes a small amount of stone used in structural and sanitary purposes.<sup>2</sup> Withheld to avoid disclosing individual company confidential data; included with "Other."<sup>3</sup> Includes stone used for lime manufacture, roofing aggregates, stone sand, agricultural lime (1970), terrazzo (1970), refractory (1970), abrasives (1969), and small amounts of crushed and broken stone not listed.<sup>4</sup> Data may not add to totals shown because of independent rounding.

Table 9.—South Dakota: Mine production (recoverable) of gold and silver

	1968	1969	1970
<b>Mines producing—</b>			
Lode.....	1	2	2
Placer.....	2	1	--
<b>Material sold or treated:</b>			
Gold ore..... thousand short tons..	11,922	11,935	1,954
<b>Production (recoverable):</b>			
<b>Quantity:</b>			
Gold..... troy ounces..	593,052	593,146	578,716
Silver..... do.....	137,668	124,497	119,766
<b>Value:</b>			
Gold..... thousands..	\$23,283	\$24,621	\$21,059
Silver..... do.....	\$295	\$223	\$212
Total..... do.....	\$23,578	\$24,844	\$21,271

<sup>1</sup> Excludes placer gravel.

Table 10.—South Dakota: Homestake mine ore milled and receipts for bullion

Year	Ore milled (thousand short tons)	Receipts for bullion products	
		Total (thousands)	Per ton
1966.....	2,002	\$21,309	\$10.64
1967.....	1,896	21,200	11.18
1968.....	1,922	22,064	11.48
1969.....	1,935	24,570	12.70
1970.....	1,954	21,059	10.78

Source: Homestake Mining Co. Annual Report 1970.

the Susquehanna Corp. The Edgemont mill, following a brief shutdown in 1969, resumed operation in late 1969 processing ore from surface mines in newly discovered ore bodies in the Edgemont area. A small underground mine near Edgemont also provided about 60 to 75 tons per day of ore to the Edgemont mill. In 1970 a contractor was stripping 1.8 million cubic yards of overburden to prepare a second open pit for mining. During 1970, the Susquehanna Corp. received orders for 5 million pounds of uranium oxide, a portion of which will be delivered from the Edgemont mill.

**Vanadium.**—Output of vanadium products in 1970 expanded to 1.75 million pounds, compared with 1.6 million in 1969. The Susquehanna Corp's uranium mill at Edgemont recovers some vanadium as a byproduct of uranium ore; but, the larger amount of vanadium production comes from processing foreign ores, primarily from Europe. Both vanadium pentoxide and ferrovanadium are produced at the Edgemont mill.

#### MINERAL FUELS

**Coal (Lignite).**—Three power companies announced in early 1970 plans to construct a \$100 million generating plant in the Big Stone Lake area, Roberts County. Site preparation and transportation construction was underway in 1970 on the 400,000-kilowatt Big Stone plant, which will be fueled by 2 million tons of North Dakota lignite per year. The companies involved in this venture are Otter Tail Power Co. Northwestern Public Service Co., and the Montana-Dakota Utilities Co. Plant construction was expected to begin in the spring of 1972, and the plant is to go on

stream in 1974-75. It is reportedly the largest single capital investment ever made in South Dakota.

**Lignite Gasification Pilot Plant.**—In January 1970, construction began at Rapid City on a \$9 million pilot plant, designed to convert 30 tons of lignite per day into a methane-rich, sulfur-free synthetic gas. The plant will use the CO<sub>2</sub> Acceptor Process in which gasification is accomplished in a mixture of ground dolomite and coal. Developed by the Consolidation Coal Co., under contracts with the Department of the Interior's Office of Coal Research, the process is unique in that it eliminates the need for oxygen or hydrogen. Various types of lignites and western coals will be tested with dolomites and limestones. Completion of the plant is scheduled for June 1971.<sup>4</sup>

**Petroleum.**—In 1970, production of oil from 26 producing wells increased slightly over that of 1969. Petroleum output was nearly 160,000 barrels. Out of 83 wildcat wells drilled in 1970, none were commercial at yearend although 10 wells were cased and reportedly waiting to be put on production. About 49 miles of hole was drilled. The deepest well was 9,400 feet deep.

Exploration activity has centered on a sandstone formation known alternately as the Muddy or Newcastle, a prolific producer in southeastern Montana and north-eastern Wyoming. The formation occurs over much of western South Dakota at shallow depths. Because of large potential payoffs in the Muddy Formation, continued intensive exploration efforts were expected for 1971.

<sup>4</sup> Office of Coal Research, Department of the Interior. Annual Report 1971, pp. 20-22.

Table 11.—South Dakota: Oil and gas well drilling completions, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Butte.....	--	--	--	--	--	5	5	19,438
Campbell.....	--	--	--	--	--	7	7	12,585
Corson.....	--	--	--	--	--	6	6	29,091
Custer.....	--	--	--	--	--	1	1	1,340
Dewey.....	--	--	--	--	--	2	2	9,808
Fall River.....	--	--	--	--	--	9	9	22,981
Haakon.....	--	--	--	--	--	16	16	43,424
Harding.....	--	--	--	--	--	15	15	73,229
Jones.....	--	--	--	--	--	1	1	3,181
Lyman.....	--	--	--	--	--	1	1	2,411
Meade.....	--	--	--	--	--	10	10	24,099
Pennington.....	--	--	--	--	--	4	4	12,896
Shannon.....	--	--	--	--	--	1	1	3,400
Tripp.....	--	--	--	--	--	1	1	3,010
Walworth.....	--	--	--	--	--	3	3	5,200
Washabaugh.....	--	--	--	--	--	1	1	4,441
Total.....	--	--	--	--	--	83	83	270,534

Source: American Petroleum Institute.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Beryllium:</b>			
L. W. Judson .....	Hermosa, S. Dak. 57744 .....	See Mica .....	Pennington.
Northwest Beryllium Corp. ....	218-219 American National Bank Bldg. Rapid City, S. Dak. 57701	Stockpile .....	Do.
<b>Cement:</b>			
South Dakota Cement Commission.	Drawer 351 Rapid City, S. Dak. 57701	Wet-process plant, 3 rotary kilns.	Do.
<b>Clays:</b>			
American Colloid Co. ....	5100 Suffield Court Skokie, Ill. 60076	Open pit mine and plant.	Butte.
Light Aggregates, Inc. ....	Box 1922 Rapid City, S. Dak. 57701	.....	Pennington.
South Dakota Cement Commission.	Drawer 351 Rapid City, S. Dak. 57701	Open pit mine. ....	Do.
<b>Feldspar:</b>			
International Minerals & Chemical Corp., Industrial Minerals Division.	Administration Center Old Orchard Road Skokie, Ill. 60079	Open pit mine and dry-grinding plant.	Custer.
<b>Gold:</b>			
Homestake Mining Co. ....	Lead, S. Dak. 57754 .....	Underground mine, amalgamation-cyanidation mill, and refinery.	Lawrence.
<b>Gypsum:</b>			
South Dakota Cement Commission.	Drawer 351 Rapid City, S. Dak. 57701	Open pit mine. ....	Meade.
<b>Lime:</b>			
Pete Lien & Sons. ....	Box 3124, P.O. Annex Rapid City, S. Dak. 57703	Continuous-hydrator plant; 1 rotary kiln, 1 vertical kiln.	Pennington.
<b>Mica (scrap):</b>			
L. W. Judson .....	Hermosa, S. Dak. 57744 .....	Open pit mine .....	Do.
Northwest Beryllium Corp. ....	218-219 American National Bank Bldg. Rapid City, S. Dak. 57701	Stockpile .....	Do.
<b>Petroleum:</b>			
Ozark Corp. ....	Box 2491 Casper, Wyo. 82601	Crude oil wells .....	Custer (Barker Dome field).
Pennzoil United, Inc. ....	900 Southwest Tower Houston, Tex. 77002	.....do.....	Harding (Buffalo field).
Phillips Petroleum Co. ....	Frank Phillips Bldg. Bartlesville, Okla. 74003	.....do.....	Do.
<b>Sand and gravel (commercial):</b>			
Concrete Materials Co. ....	3000 West Madison Street Sioux Falls, S. Dak. 57104	Pit and 2 plants. ....	Minnehaha.
F. J. McLaughlin Co. ....	Watertown, S. Dak. 57201	.....do.....	Codington.
Hallett Construction Co. ....	Crosby, Minn. 56441	2 pits and plants .....	Do.
J. L. Healy Construction Co. ....	Box 512 Sioux Falls, S. Dak. 57102	9 pits and 1 plant. ....	Brule, Codington, Hand, Minnehaha, Moody.
L. G. Everist, Inc. ....	302 Paulton Bldg. Sioux Falls, S. Dak. 57102	2 pits and 2 plants. ....	Brookings and Pennington.
Mannerud, Inc. ....	612 13th Avenue Brookings, S. Dak. 57006	2 pits .....	Brookings and Edmunds.
Pickus Construction Co. ....	Box 1414 Aberdeen, S. Dak. 57401	Pit and plant. ....	Brown.
Sweetman Construction Co. ....	100 South Dakota Avenue Sioux Falls, S. Dak. 57102	4 pits .....	Beadle, Lake, Minnehaha, Yankton.
Weelborg Bros., Inc. ....	Dell Rapids, S. Dak. 57022	20 pits .....	Various.
Silver: Homestake Mining Co. ....	Lead, S. Dak. 57754 .....	See Gold .....	Lawrence.
<b>Stone:</b>			
Cold Spring Granite Co. ....	Cold Spring, Minn. 56320	2 quarries .....	Grant.
Concrete Materials Co. ....	3000 West Madison Street Sioux Falls, S. Dak. 57104	Quarry and plant. ....	Minnehaha.
Dakota Granite Co. ....	Box 269 Milbank, S. Dak. 57252	2 quarries .....	Grant.
Delano Granite Works, Inc. ....	Delano, Minn. 55328	Quarry .....	Do.
Hills Materials Co. ....	Box 1392 Rapid City, S. Dak. 57701	Quarry and plant. ....	Pennington.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
L. G. Everist, Inc.-----	302 Paulton Bldg. Sioux Falls, S. Dak. 57102	2 quarries and 2 plants.	Minnehaha and Pennington.
Pete Lien & Sons.-----	Box 3124, P.O. Annex Rapid City, S. Dak. 57703	Quarry and plant.-----	Pennington.
Robert Hunter Granite Co., Inc.---	Milbank, S. Dak. 57252-----	Quarry-----	Grant.
South Dakota Cement Commis- sion.	Drawer 351 Rapid City, S. Dak. 57701	Quarry and plant.-----	Pennington.
Spencer Quarries, Inc.-----	Spencer, S. Dak. 57374-----	Quarry-----	Hanson.
Steiner-Rausch Granite Co., Inc.---	Ortonville, Minn. 56278-----	do-----	Grant.
Uranium:			
Susquehanna-Western, Inc.-----	Edgemont, S. Dak. 57735---	Underground mine.---	Fall River.
Mines Development, Inc.-----	do-----	Acid-leach mill.-----	Do.



# The Mineral Industry of Tennessee

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Tennessee Division of Geology, for collecting information on all minerals.

By Herbert R. Babitzke,<sup>1</sup> William D. Hardeman<sup>2</sup> and Robert E. Hershey<sup>3</sup>

The 1970 production value of the mining and petroleum industries was \$220 million, an increase of 7 percent over that of 1969. Tennessee continues to be the leading U.S. producing State for ball clay, pyrite, and zinc.

Development work on a large zinc ore body in middle Tennessee, continued widespread exploration drilling for zinc ore, and the development of the Oneida West oilfield and gasfield were the highlights of the year and should play a significant

role in Tennessee's mineral industry. Expansion is also underway in the aluminum and copper industry. Exploration and leasing in west Tennessee for heavy-mineral sands (ilmenite, rutile, zircon, monazite, etc.) indicated that a new mineral industry may develop in this region in the near future.

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<sup>3</sup> State geologist, Department of Conservation, Division of Geology, Nashville, Tenn.

Table 1.—Mineral production in Tennessee<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite..... thousand short tons..	16	\$295	19	\$286
Cement:				
Portland..... thousand 376-pound barrels..	9,159	29,403	8,878	29,832
Masonry..... thousand 280-pound barrels..	1,331	3,587	969	2,749
Clays <sup>2</sup> ..... thousand short tons..	1,719	7,064	1,401	7,123
Coal (bituminous)..... do..	8,082	30,682	8,237	40,372
Copper (recoverable content of ores, etc.)..... short tons..	15,353	14,596	15,535	17,928
Gold (recoverable content ores, etc.)..... troy ounces..	126	5	124	5
Natural gas..... million cubic feet..	57	11	64	13
Petroleum (crude)..... thousand 42-gallon barrels..	32	W	309	W
Phosphate rock..... thousand short tons..	W	W	3,073	15,005
Sand and gravel..... do..	6,175	9,709	6,715	10,639
Silver (recoverable content of ores, etc.)..... thousand troy ounces..	79	141	95	168
Stone..... thousand short tons..	33,265	46,192	35,374	50,013
Zinc (recoverable content of ores, etc.)..... short tons..	124,532	36,363	118,260	36,233
Value of items that cannot be disclosed:				
Clay (fuller's earth), lime, pyrite, and values indicated by symbol W.....	XX	27,402	XX	10,099
Total <sup>3</sup> .....	XX	205,451	XX	220,465
Total 1967 constant dollars.....	XX	194,007	XX	199,521

<sup>p</sup> Preliminary. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." 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; included with "Value of items that cannot be disclosed."

<sup>3</sup> Data may not add to totals shown because of independent rounding.



Table 2.—Value of mineral production in Tennessee, by counties<sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Anderson	\$8,530	W	Coal, limestone.
Bedford	W	W	Limestone.
Benton	2,456	W	Sand and gravel, limestone.
Bledsoe	W	W	Coal.
Blount	W	W	Limestone, marble.
Bradley	W	\$1,697	Limestone.
Campbell	6,826	8,981	Coal, limestone, sandstone.
Cannon	W	W	Limestone.
Carter	W	W	Do.
Claiborne	6,588	W	Coal, limestone.
Clay	W	W	Limestone.
Cocke	W	W	Do.
Coffee	W	W	Do.
Cumberland	1,610	1,716	Limestone, sand and gravel, sandstone, coal.
Davidson	11,103	9,580	Limestone, cement, miscellaneous clay, phosphate rock.
Decatur	W	W	Limestone, sand and gravel.
DeKalb	W	135	Limestone.
Dickson	W	451	Do.
Fayette	W	55	Sand and gravel.
Fentress	369	418	Coal, limestone.
Franklin	6,247	4,720	Cement, limestone, sand and gravel, miscellaneous clay.
Gibson	W	W	Sand and gravel.
Giles	1,573	1,519	Phosphate rock, limestone, sand and gravel.
Grainger	W	146	Limestone, marble.
Greene	W	W	Limestone.
Grundy	599	W	Coal, sand and gravel, limestone.
Hamblen	W	W	Limestone.
Hamilton	11,590	13,745	Cement, limestone, sand and gravel, coal, miscellaneous clay.
Hancock	W	W	Zinc, limestone.
Hardeman	W	W	Sand and gravel.
Hardin	W	W	Sand and gravel, limestone.
Hawkins	W	W	Sandstone, limestone.
Haywood	46	-----	-----
Henderson	W	W	Sand and gravel.
Henry	4,095	3,564	Ball clay, fuller's earth.
Hickman	W	W	Phosphate rock.
Humphreys	W	W	Limestone, sand and gravel.
Jefferson	26,394	25,040	Zinc, limestone.
Johnson	W	W	Limestone.
Knox	20,310	23,966	Zinc, cement, limestone, lime, miscellaneous clay, sand and gravel, marble.
Lauderdale	97	W	Sand and gravel.
Lincoln	W	W	Limestone.
Loudon	447	421	Limestone, barite, marble, miscellaneous clay, sand and gravel.
McMinn	782	726	Limestone, sand and gravel, barite.
McNairy	W	W	Sand and gravel.
Macon	W	W	Limestone.
Marion	8,433	W	Cement, coal, limestone.
Marshall	W	W	Limestone.
Maury	13,557	6,679	Phosphate rock, limestone.
Meigs	W	W	Limestone.
Monroe	W	W	Limestone, barite, sand and gravel.
Montgomery	W	W	Limestone.
Moore	W	W	Do.
Morgan	1,200	2,312	Coal.
Obion	257	W	Sand and gravel.
Overton	W	78	Limestone.
Perry	144	W	Sand and gravel.
Pickett	34	24	Limestone.
Polk	W	W	Copper, pyrites, zinc, silver, sand and gravel, gold.
Putnam	693	1,720	Limestone, coal, sand and gravel.
Rhea	W	W	Limestone.
Roane	W	W	Limestone, coal.
Robertson	W	W	Limestone.
Rutherford	1,024	1,097	Do.
Scott	W	3,473	Coal.
Sequitche	1,011	W	Coal, limestone.
Sevier	587	606	Limestone, sand and gravel.
Shelby	825	810	Sand and gravel.
Smith	61	W	Limestone.
Stewart	W	W	Limestone, sand and gravel.
Sullivan	W	W	Cement, limestone, miscellaneous clay.
Sumner	1,090	W	Limestone.
Tipton	W	W	Sand and gravel.
Unicoi	W	W	Sand and gravel, limestone.

See footnotes at end of table.

**Table 2.—Value of mineral production in Tennessee, by counties<sup>1</sup>—Continued**  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Union.....	W	\$135	Limestone.
Van Buren.....	W	1,858	Coal.
Warren.....	W	W	Limestone.
Washington.....	W	W	Limestone, sand and gravel, miscellaneous clay.
Wayne.....	W	W	Sand and gravel, limestone.
Weakley.....	\$2,454	W	Ball clay, miscellaneous clay.
White.....	W	W	Limestone.
Williamson.....	W	W	Phosphate rock, limestone.
Wilson.....	W	W	Limestone.
Undistributed <sup>2</sup> .....	64,431	104,793	
Total <sup>3</sup> .....	205,451	220,465	

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

<sup>1</sup> The following counties are not listed because no production was reported: Carroll, Cheatham, Chester, Crockett, Dyer, Houston, Jackson, Lake, Lawrence, Lewis, Madison, and Trousdale.

<sup>2</sup> Includes value of petroleum, natural gas, and values indicated by symbol W.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

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

	1969	1970	Change, percent	
<b>Employment and labor force, annual average:</b>				
Total nonagricultural employment.....	thousands..	1,306.1	1,327.7	+1.7
Unemployment.....	do..	58.5	75.9	+29.7
<b>Employment:</b>				
Mining.....	do..	6.8	7.1	+4.4
Manufacturing.....	do..	470.0	466.5	-.7
Construction.....	do..	66.5	62.5	-6.0
Transportation and public utilities.....	do..	65.7	66.6	+1.4
Wholesale and retail trade.....	do..	254.8	258.1	+1.3
Finance, insurance, and real estate.....	do..	55.7	57.5	+3.2
Services.....	do..	172.4	182.7	+6.0
Government.....	do..	214.2	226.7	+5.8
<b>Personal income:</b>				
Total.....	millions..	\$11,189	\$12,002	+7.3
Per capita.....	do..	\$2,871	\$3,051	+6.3
<b>Construction activity:</b>				
Number of new housing units authorized.....	do..	22,912	23,611	+3.0
Valuation of nonresidential construction.....	millions..	\$214.1	\$250.1	+16.8
Cement shipments to and within Tennessee.....	thousand 376-pound barrels..	7,231	7,320	+1.2
Farm marketing receipts.....	millions..	\$673.4	\$705.3	+4.7
Mineral production.....	do..	\$204.5	\$220.5	+7.3

Sources: Employment and Earnings, Area Trends in Employment and Unemployment, Construction Review, Farm Income Situation, Survey of Current Business, U.S. Bureau of Mines.

**Government Programs.**—The Tennessee Division of Geology continued its quadrangle mapping of geology and mineral resources and published 20 new maps. This is a cooperative project with the Tennessee Valley Authority (TVA). Approximately 230 maps have been published since the project was begun in 1962. Several technical publications also were released including a very detailed report on barite.<sup>4</sup>

The Bureau of Mines, in cooperation with the Division of Geology, completed a detailed study of the strippable coal reserves of a five-county area in the north-eastern part of the coal region. This report is on open file and in process of publication by the State.

Beneficiation studies on Tennessee phosphate ores continued at the Bureau of

Mines, Tuscaloosa Metallurgy Research Center, Tuscaloosa, Ala.

A Bureau of Mines Liaison Office was established in Nashville, Tenn. The purpose of this office is to serve as the Bureau's primary public contact in Tennessee.

The U.S. Geological Survey continued its geological and water resource investigations. It is also engaged in geologic quadrangle mapping both independently and in cooperation with the Tennessee Division of Geology.

TVA Geologic Branch published a detailed color map, "Mineral Resources of the Tennessee Valley Region," which cov-

<sup>4</sup> Maher, Stuart W., Barite Resources of Tennessee, Tennessee Div. of Geology Rept. of Inv. 28, 1970, 40 pp.

ers parts of 11 States. The Geologic Branch is also engaged in geophysical studies, especially magnetic investigations, which will be published by the Tennessee Division of Geology.

Construction continued on schedule at TVA's three major power projects—the Sequoyah nuclear plant in southeastern Tennessee, the Raccoon Mountain pumped storage project near Chattanooga, and the Cumberland steam plant in northwest Tennessee. At Sequoyah, about 50 percent of the major construction (excluding equipment) has been completed, about 1,300 men are employed there, and the first generating unit is scheduled to begin operating in April 1974. At Raccoon Mountain, preliminary work on under-

ground excavation and construction of the dam is underway. About 650 men are employed at this project. Operations are scheduled to begin in October 1974. At Cumberland, all major construction is nearing completion and equipment is being installed. About 2,800 men are employed, and operation of the plant is scheduled for July 1972. The number of employees at both Sequoyah and Raccoon Mountain will be increased, but the number will be decreased at the Cumberland steam plant.

**Taxes.**—There is a privilege tax on oil of 4.2 cents per barrel, and there is a privilege tax of 5 percent gross value on gas as well. There are no severance taxes on minerals.

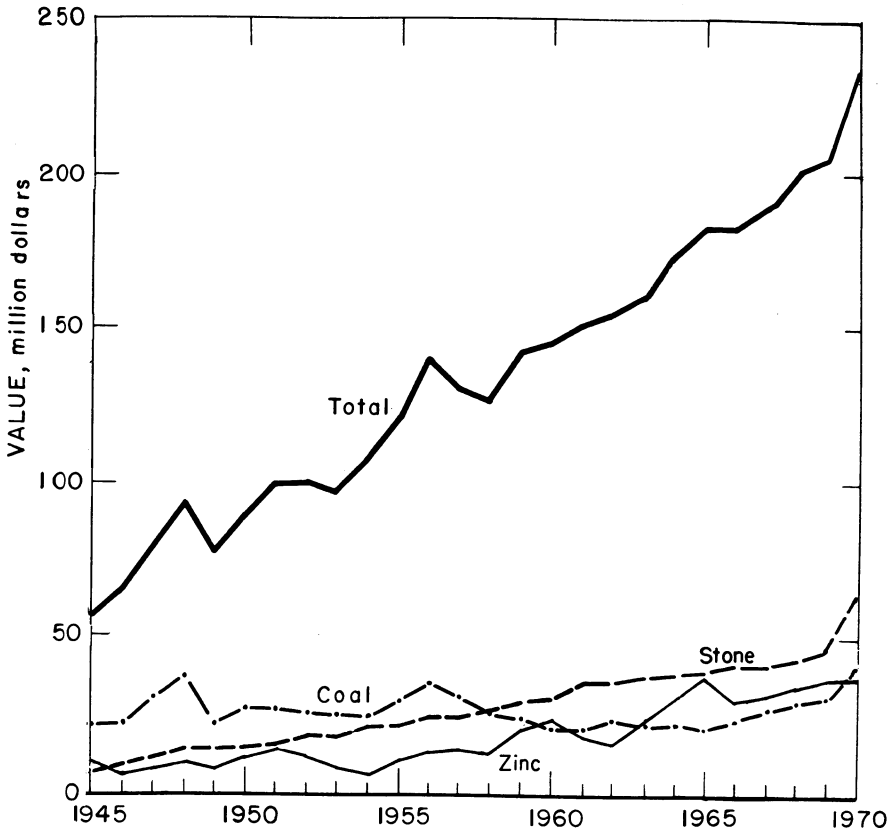


Figure 1.—Value of stone, coal, zinc, and total value of mineral production in Tennessee.

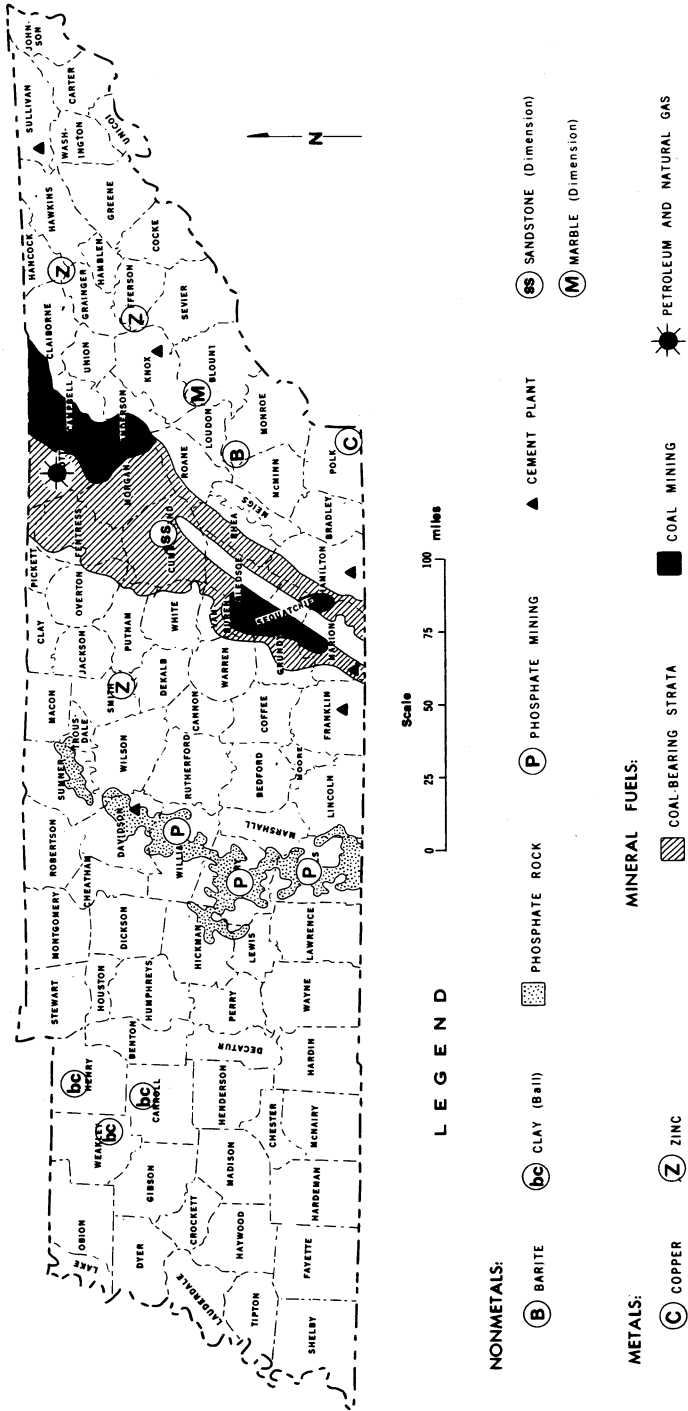


Figure 2.—Generalized map of selected mining areas and industries in Tennessee.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1969:								
Coal.....	2,099	192	404	3,276	3	69	21.98	9,012
Metal.....	1,697	267	453	3,624	1	95	26.49	3,593
Nonmetal.....	644	264	170	1,443	-----	37	25.65	446
Sand and gravel.....	548	266	146	1,280	-----	30	23.44	3,341
Stone.....	2,832	265	751	6,727	2	112	16.95	2,351
Total <sup>1</sup> .....	7,820	246	1,924	16,349	6	343	21.35	3,870
1970: <sup>p</sup>								
Coal.....	2,180	198	430	3,496	1	68	19.73	2,630
Metal.....	1,720	272	467	3,740	2	103	28.08	5,717
Nonmetal.....	640	251	161	1,349	-----	35	25.95	735
Sand and gravel.....	535	265	142	1,196	1	27	23.42	6,065
Stone.....	2,695	256	690	5,921	4	130	22.63	6,138
Total <sup>1</sup> .....	7,770	243	1,890	15,701	8	363	23.63	4,787

<sup>p</sup> Preliminary.<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW OF MINERAL COMMODITIES

### NONMETALS

Nonmetals accounted for 56 percent of the total value of mineral production. Non-metal production increased over that of 1969 along with the increase of the total mineral production. The three principal nonmetallic commodities, in order of value, were stone, cement, and phosphate rock.

**Barite.**—Four companies operated five open pit mines in the Sweetwater District of eastern Tennessee. Permits were issued allowing 9 acres of land to be disturbed in 1970. National Lead Co. shipped all its crushed ore to New Orleans to be ground for use as drilling mud, and B. C. Wood shipped all its ore out-of-State for manufacture of barium chemicals. Production increased but the total value declined because of the slow domestic market for primary barite.

**Cement.**—Portland cement was produced by four companies in six plants, and masonry cement was produced in five plants. Total value of portland cement produced was nearly \$30 million, a 1-percent increase in value but a decrease of 3 percent in quantity. Masonry cement production was \$2.7 million, a significant decrease of 23 percent in production value compared with that of 1969.

Raw materials used, in order of decreasing amounts, were limestone, shale, clay, sand, gypsum, iron ore, and fluorspar. The mode of transportation for most of the ce-

ment produced was by rail or truck. Most of the cement (89 percent) was purchased by building materials dealers, concrete products manufacturers, and ready-mix concrete manufacturers. Highway contractors and Federal, State, and other local government agencies consumed nearly 10 percent. The remaining went for miscellaneous uses. Out-of-State shipment data are not available.

Fuel and energy used to produce the cement were 1.8 billion cubic feet of natural gas, 225-million kilowatt-hours of electrical energy, and 407,000 short tons of coal (bituminous).

**Clays.**—The clay industry produced ball clay, fuller's earth, and miscellaneous clays. Tennessee ranked first in the Nation in the production of ball clay and fifth in the production of fuller's earth. Production of clay products decreased while value increased slightly from that of 1969. Permits were issued allowing 273 acres of land to be disturbed in 1970.

Ball clay production was 410,078 short tons valued at \$5.7 million, a significant decrease from the previous year. This clay was mined at open pits in Henry and Weakley Counties. Major end products were pottery, whiteware, brick, fillers, floor and wall tile, insecticides, and catalysts.

Fuller's earth production and value increased over that of 1969. This clay product was mined in Henry County by open pit methods. The end use was for absorbent material.

**Table 5.—Tennessee: Ball clay sold or used by producers, by uses**

Use	Short tons	
	1969	1970
Whiteware, etc.....	270,061	242,342
Floor and wall tile.....	W	64,600
Other uses <sup>1</sup> .....	183,433	103,136
Total.....	453,494	410,078

W Withheld to avoid disclosing individual company confidential data.

<sup>1</sup> Includes art pottery (1969), firebrick and block, kiln furniture, other refractories (1970), heavy clay products, filler (1970), and other uses (1970), and uses indicated by symbol W.

Miscellaneous clay production decreased from that of 1969. Major uses for this clay were for making building brick, light-weight aggregate, and cement.

**Graphite.**—Union Carbide Corp. continued production of artificial graphite from petroleum coke at its plant near Columbia, Tenn. All the graphite was used for the manufacture of electrodes.

**Lime.**—Foote Mineral Co. and Williams Lime Mfg. Co. operated limekilns in Knox County and were the only producers of quicklime and hydrated lime. Production decreased 6 percent from that of 1969. All the lime produced was used for construction, agricultural, and chemical purposes. Of the total, 31 percent was used within the State, 61 percent was shipped to North Carolina, 2 percent was shipped to Kentucky, and the remaining 6 percent was shipped to other States.

**Perlite.**—Chemrock Corp. expanded crude perlite at its Nashville plant for use as filter aids and concrete aggregate. The total amount of raw material came from New Mexico.

**Phosphate Rock.**—Tennessee ranked third in the Nation in phosphate rock production. This industry is in a five-county area in Central Tennessee extending from Nashville south into Alabama.

Marketable production showed only a small decrease from last year, but value declined 19 percent. The reduction in price is in concurrence with the national price decline. Most of the rock mined (99 percent) was used as a furnace charge in the manufacture of elemental phosphorus with the remaining being used as fertilizer filler.

Production was by six companies operating 22 mines. The rock was mined by open-pit methods and shipped to plants

near the mine sites. Permits were issued by the State allowing 796 acres of land to be disturbed in 1970 for phosphate rock mining.

**Pyrite.**—Tennessee led the Nation in pyrite output. The only producer was Cities Service Co., Copperhill Operations. Pyrite concentrates were recovered by flotation from sulfide ore mined in Polk County. The concentrates were used to produce sulfuric acid, sulfur dioxide, ferric sulfate, and iron sinter. The iron sinter was shipped to Alabama for processing.

**Sand and Gravel.**—Sand and gravel production increased 9 percent over that of 1969. Unit value increased slightly, and total production value increased 10 percent over the 1969 production value. Forty-four companies and Government operators were mining sand and gravel from 50 mines in 30 counties. Production came from 39 stationary plants, 11 portable plants, and 12 dredges. County government plants used about 10 percent of the total sand and gravel produced in the State for their own paving operations. Permits were issued allowing 209 acres of land to be disturbed for mining sand and gravel in 1970.

Benton County led the State in production of sand and gravel. Most of the sand and gravel produced in the State was construction grade. Commercial sand and gravel production comprised 88 percent of the total. The remaining 12 percent was noncommercial.

Benton County also led the State in the production of industrial unground sand used primarily for glass and molding. A significant amount of this high-grade glass sand was used at the Ford Motor Co. glass plant in Nashville. This sand was produced by Hardy Sand Co. in Benton County.

**Stone.**—Stone was the major mineral commodity produced in Tennessee in 1970. Production increased 6 percent over that of last year. The value was \$50 million, an increase of 8 percent over that of last year, thus establishing a new record in amount and value. One company produced crushed dolomite, three companies produced dimension quartzite, 75 companies produced crushed limestone, four produced crushed sandstone, four produced dimension marble, and one produced crushed marble. There were 117 quarries in 64 counties. Limestone was of greatest importance in

**Table 6.—Tennessee: Sand and gravel sold or used by producers, by counties**  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Benton.....	6	1,010	\$1,695	8	1,078	\$1,811
Fayette.....	3	49	47	2	61	55
Giles.....	1	200	200	1	W	W
Haywood.....	1	51	46	-----	-----	-----
Lauderdale.....	1	108	97	1	W	W
Monroe.....	1	W	15	1	W	W
Obion.....	2	W	257	2	W	W
Perry.....	1	144	144	1	W	W
Polk.....	1	30	68	1	28	62
Shelby.....	4	704	825	4	688	810
Undistributed <sup>1</sup> .....	28	3,880	6,318	29	4,859	7,902
<b>Total<sup>2</sup>.....</b>	<b>49</b>	<b>6,175</b>	<b>9,709</b>	<b>50</b>	<b>6,715</b>	<b>10,639</b>

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."  
<sup>1</sup> Includes Cumberland, Decatur, Franklin, Gibson, Grundy, Hamilton, Hardeman, Hardin, Henderson, Humphreys, Knox, Loudon, McMinn, McNairy, Putnam, Sevier, Stewart, Tipton, Unicoi, Washington and Wayne Counties, and some sand and gravel not assigned to specific counties.  
<sup>2</sup> Data may not add to totals shown because of independent rounding.

**Table 7.—Tennessee: Sand and gravel sold or used by producers, by classes of operations and uses**  
(Thousand short tons and thousand dollars)

Class of operations and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	1,703	\$2,527	1,822	\$2,660
Paving.....	787	1,381	935	1,678
Other uses <sup>1</sup> .....	786	2,531	790	2,537
<b>Total<sup>2</sup>.....</b>	<b>3,276</b>	<b>6,439</b>	<b>3,547</b>	<b>6,876</b>
<b>Gravel:</b>				
Building.....	692	956	872	1,137
Paving.....	1,405	1,503	1,198	1,470
Other uses <sup>3</sup> .....	183	296	314	462
<b>Total<sup>2</sup>.....</b>	<b>2,279</b>	<b>2,755</b>	<b>2,384</b>	<b>3,069</b>
<b>Government and contractor operations:</b>				
<b>Sand: Paving.....</b>			2	2
<b>Gravel:</b>				
Fill.....	40	40	40	40
Paving.....	579	475	744	653
<b>Total<sup>2</sup>.....</b>	<b>619</b>	<b>515</b>	<b>784</b>	<b>693</b>
<b>Total sand and gravel<sup>2</sup>.....</b>	<b>6,175</b>	<b>9,709</b>	<b>6,715</b>	<b>10,639</b>

<sup>1</sup> Includes glass, abrasives, blast, chemical, engine, fire or furnace, fill, molding, and other sands.

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

<sup>3</sup> Includes railroad ballast, fill, miscellaneous and other gravel.

terms of tonnage (99 percent) and value (97 percent). The five counties in east Tennessee where marble was quarried were Blount, Grainger, Knox, Loudon, and Union. Knox and Davidson Counties were the leading stone producers in the State by value.

End uses for crushed limestone were roadbase stone (29 percent); concrete ag-

gregate (15 percent), bituminous aggregate (12 percent), and agricultural lime (8 percent). Numerous miscellaneous uses (36 percent) consumed the remainder.

Marble produced in eastern Tennessee was 40 percent dimension and 60 percent crushed and broken. Products were cut and sawed stone, rough blocks, terrazzo, and agricultural lime.

**Table 8.—Crushed limestone sold or used by producers, by counties**  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Bradley.....	2	W	W	2	1,150	\$1,697
Campbell.....	3	650	W	3	691	W
Davidson.....	7	4,946	\$5,591	7	4,296	5,289
DeKalb.....	1	W	W	1	103	135
Dickson.....	1	W	W	1	301	451
Fentress.....	1	159	202	1	149	199
Franklin.....	4	888	1,348	4	965	W
Grainger.....	1	80	108	1	80	108
Greene.....	5	W	W	4	283	393
Jefferson.....	5	1,825	2,251	5	1,738	2,223
Knox.....	8	2,647	4,019	9	4,444	6,211
Marion.....	4	1,264	1,815	4	1,266	1,800
Overton.....	1	W	W	1	53	78
Pickett.....	1	15	24	1	15	24
Rutherford.....	3	771	1,024	3	836	1,097
Smith.....	1	61	61	1	W	W
Sumner.....	3	1,070	1,090	2	W	W
Unicoi.....	1	31	39	1	W	W
Union.....	1	101	135	1	101	135
Washington.....	5	294	371	5	W	W
Undistributed <sup>1</sup> .....	61	18,310	26,438	60	18,706	28,677
Total <sup>2</sup> .....	119	33,109	44,512	117	35,177	48,512

<sup>1</sup> Withheld to avoid disclosing individual company confidential data; included with "Undistributed."  
<sup>2</sup> Includes Anderson, Bedford, Benton, Blount, Cannon, Carter, Claiborne, Clay, Cocke, Coffee, Cumberland, Decatur, Fayette (1969), Giles, Grundy, Hamblen, Hamilton, Hancock, Hardin, Hawkins, Humphreys, Johnson, Lincoln, Loudon, McMinn, Macon, Marshall, Maury, Meigs, Monroe, Montgomery, Moore, Putnam, Rhea, Roane, Robertson, Sequatchie, Sevier, Stewart, Sullivan, Warren, Wayne, White, Williamson, and Wilson Counties.

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

**Table 9.—Tennessee: Crushed limestone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Bituminous aggregate.....	3,796	\$5,193	4,206	\$6,230
Concrete aggregate.....	5,066	6,986	5,157	7,024
Dense graded roadbase stone.....	15,078	19,354	10,412	13,864
Macadam aggregate.....	W	W	572	1,792
Surface treatment aggregate.....	W	W	1,531	1,976
Unspecified aggregate and roadstone.....	W	W	2,831	3,784
Agricultural limestone <sup>1</sup> .....	2,418	3,253	2,716	3,805
Asphalt filler.....	6	W	6	27
Cement <sup>2</sup> .....	2,501	3,572	2,462	3,231
Riprap and jetty stone.....	38	W	88	107
Stone sand.....	38	58	453	722
Other uses <sup>3</sup> .....	4,207	6,097	4,743	6,952
Total <sup>4</sup> .....	33,109	44,512	35,177	48,512

<sup>1</sup> Withheld to avoid disclosing individual company confidential data; included with "Other uses."

<sup>2</sup> Data includes poultry grit.

<sup>3</sup> Data includes lime.

<sup>4</sup> Includes fluxing stone, railroad ballast, filter stone, drain fields, mine dusting, other uses not specified, and uses indicated by symbol W; also magnesia (1969), glass, roofing aggregates, and other uses not listed (1970).

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

Quartzite was used as cut and irregular-shaped stone. House stone veneer was the major end use (61 percent) for dimension sandstone. A variety of end products were produced from crushed and broken sandstone. Some uses were glass, ferrosilicon, and asphalt fill.

**Vermiculite.**—W. R. Grace & Co., at Nashville, expanded crude vermiculite from South Carolina. It was used for con-

crete and plaster aggregates, fire-proof loose-fill insulation, agriculture, and fire base.

#### METALS

Metals accounted for 25 percent of the total value of mineral production in 1970. Zinc production accounted for nearly 67 percent of metal value, and copper accounted for most of the remainder.



**Aluminum.**—The Aluminum Co. of America (Alcoa) in Blount County and Consolidated Aluminum Corp. (Conalco) in Madison County produced aluminum metal from imported raw material.

Aluminum production increased over that of last year, even though Alcoa suspended operation of one potline with an annual capacity of 25,000 tons and at the same time stretched out the production schedule of its new 100,000-ton line. It is a duplicate of the potline placed in operation August 1969. The action was taken to bring primary metal production into closer balance with market demand. Tennessee ranked third in the Nation in quantity and value of aluminum produced in 1970.

**Copper.**—Cities Service Co., Copperhill Operations, in Polk County, was the only producer of copper in the State. The company, formerly Tennessee Copper Co., recovered copper concentrate from sulfide ore mined at its five underground mines in Polk County. Mining operations were at capacity throughout the year.

Work on modernization and expansion of the complex at Copperhill progressed on schedule. When completed in 1972, the project will increase output approximately 40 percent. Not only will the expansion increase the copper production but also by-product production. The major byproduct is sulfuric acid produced from smelter gases.

**Ferroalloys.**—Six companies produced ferroalloys in Maury, Roane, and Shelby Counties. The plants in Maury County produced only ferrophosphorous as a by-

product in making elemental phosphorus; the plants in Roane and Shelby Counties produced ferromanganese and silicomanganese. The Shelby County plant also produced ferrosilicon and ferrophosphorous.

Production of ferroalloys in 1970 amounted to 446,890 short tons valued at \$81.7 million.

**Gold.**—Gold was recovered as a byproduct of refining copper from Cities Service Co., Copperhill Operations. No significant change in production or value was noted from that of 1969.

**Manganese.**—Foote Mineral Co. produced electrolytic manganese at two plants in Knoxville and New Johnsonville.

**Silver.**—Silver was recovered as a byproduct of copper at the Cities Service Co., Copperhill Operations. Production increased from that of 1969, to 95,000 troy ounces valued at \$168,000.

**Titanium.**—E. I. duPont de Nemours and Co., Inc. produced pigments (titanium dioxide) from concentrates imported from Florida and Georgia. The plant at New Johnsonville has a capacity of 95,000 tons per year. An expansion scheduled for completion in late 1971 will raise the capacity to 120,000 tons per year.

Kerr-McGee Corp. operated a pilot plant in Camden to beneficiate titanium-bearing sands from west Tennessee. The company has large holdings in Henry, Carroll, and Henderson Counties.

**Zinc.**—For the 13th consecutive year Tennessee has led the United States in zinc production. In 1970, the State produced 22

Table 10.—Tennessee: Mine production (recoverable) of gold, silver, copper, and zinc

	1968	1969	1970
Mines producing:			
Lode.....	14	13	13
Material sold or treated:			
Ore..... thousand short tons..	5,969	5,863	5,837
Copper-zinc..... do.....	1,624	1,574	1,680
Zinc..... do.....	4,345	4,289	4,157
Production (recoverable):			
Quantity:			
Gold..... troy ounces..	140	126	124
Silver..... do.....	89,525	78,614	94,770
Copper..... short tons..	14,196	15,353	15,535
Zinc..... do.....	124,039	124,532	118,260
Value:			
Gold..... thousands..	\$5	\$5	\$5
Silver..... do.....	192	141	168
Copper..... do.....	11,881	14,596	17,928
Zinc..... do.....	33,491	36,363	36,233
Total <sup>1</sup> ..... do.....	45,569	51,105	54,333

<sup>1</sup> Data may not add to totals shown because of independent rounding.

percent of the national total. Production, which was nearly equal to that of last year, amounted to 118,260 short tons valued at \$36.2 million, thus ranking third in value of all commodities produced in the State.

Four companies mined zinc ore from eight mines in eastern Tennessee (Hancock, Jefferson, and Knox Counties). Zinc was also recovered from smelting zinc concentrates produced by Cities Service Co., Copperhill Operations in Polk County.

The New Jersey Zinc Co. (a subsidiary of Gulf & Western Industries) made a major zinc discovery in Middle Tennessee in which one deposit may have as much as 2.5 to 5 million tons of zinc metal, according to the company announcement. Additional areas explored in Middle Tennessee reveal that this could be the largest area of zinc deposits in the United States. The potential value of zinc ore in the ground may amount to billions of dollars.

Occidental Minerals Corp. has under lease 10,000 acres in middle Tennessee; an additional area has been optioned. Drilling on these holdings indicated that the mineralized zinc zone is flat-lying at a depth of 1,200 to 1,400 feet. The test holes have shown that the significant mineralization has an average thickness of 14.7 feet and an average grade of 5.59 percent zinc, according to the annual report of the company.

Other large companies are also active in the area. Among the most active are The

New Jersey Zinc Co., Cominco American, Inc., Humble Oil & Refining Co., and St. Joe Minerals Corp. Numerous exploration holes were drilled from a depth of 900 to 3,000 feet.

#### MINERAL FUELS

Mineral fuels accounted for 19 percent of the total value of mineral production in 1970, compared with 15 percent in 1969.

**Coal (Bituminous).**—The quantity and value of coal produced increased over that of 1969. The value of coal produced was \$40 million for 8,236,893 short tons, an increase of 155,000 tons. Production was from 203 mines in 15 counties in the Cumberland Plateau region of east-central Tennessee. Of the total, 53 percent was from underground mining, 45 percent from strip mining, and 2 percent by auger.

The nine northern counties (District 8) had 155 mines, and accounted for 79 percent of the total. The six southern counties (District 13) and 48 mines and produced the remaining 21 percent.

Most of the coal produced in Tennessee was used for heating and power production. TVA was the major consumer.

Numerous conservation groups are actively seeking more restrictive surface mining laws. This is especially significant in the northeast coal region, where much of the coal is produced by contour strip mining. Permits were issued by the State of Tennessee in 1970 allowing 2,772 acres of land to be disturbed for coal strip mining.

Table 11.—Tennessee: Bituminous coal production, by type of mine and counties  
(Excludes mines producing less than 1,000 short tons per year)

County	Number of mines in operation				Production (thousand short tons)				Value (thousand dollars)
	Under-ground	Strip	Auger	Total	Under-ground	Strip	Auger	Total <sup>1</sup>	
Anderson	29	15	2	46	1,121	665	27	1,813	\$9,628
Bledsoe		2		2		W		W	W
Campbell	20	20	2	42	329	1,167	95	1,591	7,879
Claiborne	5	10		15	1,483	450		1,933	9,435
Cumberland	2	1		3	W	W		W	W
Fentress	5			5	43			43	219
Grundy		1		1		134		134	401
Hamilton		2	1	3		W	W	W	W
Marion	27			27	745			745	2,976
Morgan	7	11		18	121	313		434	2,312
Putnam	1			1	80			80	W
Roane		1		1		W		W	W
Scott	12	10	2	24	W	348	W	605	3,473
Sequatchie	8	2		10	196	103		299	1,126
Van Buren		5		5		400		400	1,858
Undistributed <sup>2</sup>					232	149	35	159	1,065
Total <sup>1,3</sup>	116	80	7	203	4,350	3,729	157	8,237	40,372

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

<sup>1</sup> Data may not add to totals shown because of independent rounding.

<sup>2</sup> Includes mines and value indicated by symbol W.

<sup>3</sup> These figures are on a calendar year basis and do not agree with State publications, which are reported on a fiscal year basis.

**Coke.**—Chattanooga Coke and Chemicals produced all of the coke and breeze in Tennessee. Additional coke commodities produced were ammonium sulfate, crude coal tar, benzene, toluene, and xylene. The coal used for production of coke and by-products was imported from Pennsylvania, Virginia, and West Virginia.

**Natural Gas.**—Standard Explorations Co. and Pemberton Oil and Lumber Co., Inc., both of Oneida, Tenn. were the leading producers of natural gas in 1970. Production was 64 million cubic feet compared with 57 million cubic feet in 1969. Production was from five wells in Scott County and 16 wells in Morgan County.

**Petroleum.**—Total oil production for the State was 309,305 barrels, a tenfold increase over that of 1969. The most significant development was in Scott County with the

extension of the Oneida West field. By the end of 1970, there were 20 flowing oil wells with a daily production estimated to be 2,000 barrels. A law was passed in 1970 to give the State Oil and Gas Board more power to deal with pollution.

Another small shallow oilfield was discovered in Overton County in the same producing formation (Ft. Payne). This indicates that the Ft. Payne may be a widespread producing formation in this general area. By yearend 1970, there were eight pumping wells averaging 10 to 15 barrels per day.

A total of 40 exploratory wells and 34 development wells were drilled in Tennessee during 1970. Scott County led in both production and exploration. Five companies produced 89 percent of all the oil in the State.

Table 12.—Tennessee: Oil and gas well drilling completions, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
Claiborne.....	1	-----	-----	-----	-----	-----	1	3,030
Clay.....	-----	-----	-----	-----	-----	1	1	615
Coffee.....	-----	-----	-----	-----	-----	1	1	840
Humphreys.....	-----	-----	-----	-----	-----	1	1	1,405
Overton.....	8	-----	2	1	-----	6	17	8,066
Putnam.....	-----	-----	-----	1	-----	4	5	3,720
Robertson.....	-----	-----	-----	1	-----	-----	1	1,516
Scott.....	17	3	3	2	3	14	42	69,241
Sequatchie.....	-----	-----	-----	-----	-----	1	1	7,402
Smith.....	-----	-----	-----	-----	2	1	3	953
Sumner.....	-----	-----	-----	-----	-----	1	1	200
Total.....	26	3	5	5	5	30	74	96,988
API totals <sup>1</sup> .....	19	3	6	5	1	16	50	68,917

<sup>1</sup> American Petroleum Institute data do not agree because the cutoff date was earlier in the year; consequently data submitted to API were not complete.

Source: Tennessee Division of Geology.

Table 13.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Aluminum smelters:</b>			
Consolidated Aluminum Corp.	1102 Richmond St. Jackson, Tenn. 38301	Plant	Humphreys.
Aluminum Co. of America	P.O. Box 158 Alcoa, Tenn. 37701	do	Blount.
<b>Barite:</b>			
W. L. Ball	Rt. 3 Sweetwater, Tenn. 37874	Open pit mine and plant.	McMinn.
Godsey Mines, Inc.	Box 227 Sweetwater, Tenn. 37874	do	Do.
National Lead Co.	Box 187 Sweetwater, Tenn. 37874	do	Monroe.
B. C. Wood	Box 284 Sweetwater, Tenn. 37874	do	Loudon.
<b>Cement:</b>			
General Portland Cement Co.	1300 American National Bank Bldg. Chattanooga, Tenn. 37402	Plant	Hamilton.
Ideal Cement Co.	P.O. Box 6238 Knoxville, Tenn. 37914	do	Knox.
Marquette Cement Mfg. Co.	P.O. Box 1242 Nashville, Tenn. 37202	do	Davidson.
Penn-Dixie Cement Corp.	P.O. Box 157 Cowan, Tenn. 37318	Open pit mine and plant.	Franklin.
	Richard City, Tenn. 37371	Plant	Marion.
	Kingsport, Tenn. 37662	do	Sullivan.
<b>Clay:</b>			
<b>Ball:</b>			
Bell Clay Co.	Gleason, Tenn. 38229	4 open pit mines and plant.	Weakley.
United Sierra, Div. Cyprus Mines Corp.	Gleason, Tenn. 38229	8 open pit mines and plant.	Do.
Kentucky-Tennessee Clay Co.	Box 449 Mayfield, Ky. 42066	5 open pit mines and plant.	Henry.
Laird Brick Co., Inc.	P.O. Box 98 Puryear, Tenn. 38251	Open pit mine and plant.	Do.
H. C. Spinks Clay Co., Inc.	Box 829 Paris, Tenn. 38242	7 open pit mines and plants.	Henry and Weakley.
<b>Fuller's earth:</b>			
Southern Clay, Inc. (Sub- sidiary of Lowe's, Inc.).	Box 819 Paris, Tenn. 38242	Open pit mine and plant.	Henry.
<b>Miscellaneous:</b>			
W. G. Bush and Co., Inc.	1136 2d Ave. North Nashville, Tenn. 37208	do	Davidson.
General Portland Cement Co.	1300 American National Bank Bldg. Chattanooga, Tenn. 37402	do	Hamilton.
General Shale Products Corp.	Box 3547 Johnson City, Tenn. 37601	4 open pit mines and plants.	Hamilton, Knox, Sullivan, and Washington.
Shalite Corp.	Box 441 Knoxville, Tenn. 37901	Open pit mine and plant.	Knox.
Tennlite, Inc.	Box 340 Greenbrier, Tenn. 37073	do	Davidson.
<b>Coal:</b>			
Consolidation Coal Co.	Box 460 Middlesboro, Ky. 40965	2 underground mines and plant.	Anderson and Claiborne.
Howard Ensley Coal Co., Inc.	Rt. 1, Box 49B Newcomb, Tenn. 37819	2 strip mines	Campbell.
Farrell Mining Co.	414 Cotton Exchange Bldg. Memphis, Tenn. 38103	1 auger and 2 strip mines.	Do.
Grundy Mining Co.	Box 878 Jasper, Tenn. 37347	2 underground mines.	Marion.
Oliver Springs Mining Co., Inc.	Box 350 Oliver Springs, Tenn. 37840	do	Anderson.
Volunteer Coal Co.	Cody, Ky. 41808	Underground mine.	Do.
<b>Coke:</b>			
Chattanooga Coke and Chemi- cals, Woodward Co., Div. The Mead Corp.	4800 Central Ave. Chattanooga, Tenn. 37410	Plant	Hamilton.
<b>Copper:</b>			
Cities Service Co., Copperhill Operations.	Copperhill, Tenn. 37371	5 underground mines, mill, smelter, chemical plant.	Polk.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Ferrous alloys:</b>			
Chromium Mining and Smelting Co.	P.O. Box 28538 Memphis, Tenn. 38128	Plant.....	Shelby.
Hooker Chemical Corp.....	P.O. Box 591 Columbia, Tenn. 38401	---do-----	Maury.
Mobil Chemical Co.....	Box 432 Mt. Pleasant, Tenn. 38474	---do-----	Do.
Monsanto Co.....	Columbia, Tenn. 38401	---do-----	Do.
Roane Electric Furnace, Woodward Co., Div. The Mead Corp.	Box 298 Rockwood, Tenn. 37854	---do-----	Roane.
Stauffer Chemical Co.....	P.O. Box 472 (Furnace Plant) Mt. Pleasant, Tenn. 38474	---do-----	Maury.
<b>Gold:</b>			
Cities Service Co., Copperhill Operations.	Copperhill, Tenn. 37317.....	See Copper---	Polk.
<b>Graphite, artificial:</b>			
Union Carbide Corp.....	P.O. Box 513 Columbia, Tenn. 38401	Plant.....	Maury.
<b>Lime, primary:</b>			
Foote Mineral Co.....	Rt. 8, Asbury Rd. Knoxville, Tenn. 37914	Limekiln.....	Knox.
Williams Lime Mfg. Co.....	Box 2286 Knoxville, Tenn. 37901	---do-----	Do.
<b>Natural gas:</b>			
Standard Explorations Co.....	P.O. Box 420 Oneida, Tenn. 37841	2 wells.....	Scott.
Pemberton Oil and Lumber Co., Inc.	P.O. Box P Oneida, Tenn. 37841	9 wells.....	Morgan.
<b>Perlite, expanded:</b>			
Chemrock Corp.....	Osage St. Nashville, Tenn. 37208	Plant.....	Davidson.
<b>Petroleum:</b>			
E. J. Clowes & William Ray....	P.O. Box 199 Oneida, Tenn. 37841	2 wells.....	Scott.
C. G. Collins.....	P.O. Box 370 Greensburg, Ky. 42743	3 wells.....	Do.
Green River Gas Co.....	P.O. Box 420 Oneida, Tenn. 37841	4 wells.....	Do.
Tenexco Co.....	P.O. Box 290 Oneida, Tenn. 37841	3 wells.....	Do.
Irvin Vawter.....	Box 223 Albany, Ky. 42602	5 wells.....	Do.
<b>Petroleum refinery:</b>			
Delta Refinery Co.....	543 W. Mallory Ave. Memphis, Tenn. 38106	Refinery.....	Shelby.
<b>Phosphate rock:</b>			
Hooker Chemical Corp.....	Box 588 Columbia, Tenn. 38401	7 open pit mines and 1 plant.	Hickman and Maury.
Monsanto Co.....	Columbia, Tenn. 38401.....	5 open pit mines and 1 plant.	Davidson, Giles, Hickman, Maury, and Williamson.
Stauffer Chemical Co.....	P.O. Box 472 (Furnace Plant) Mt. Pleasant, Tenn. 38474	3 open pit mines and 1 plant.	Maury.
Tennessee Valley Authority....	Muscle Shoals Ala. 35660	2 open pit mines and 1 plant.	Maury and Williamson.
M. C. West, Inc.....	Box 381 Columbia, Tenn. 38401	Open pit mine and plant.	Hickman.
<b>Pyrite:</b>			
Cities Service Co., Copperhill Operations.	Copperhill, Tenn. 37317.....	See Copper---	Polk.
<b>Sand and gravel:</b>			
Camden Gravel Co.....	Camden, Tenn. 38320.....	Open pit mine.	Benton.
Dixie Sand & Gravel Co.....	515 River St. Chattanooga, Tenn. 37402	Open pit and dredge.	Hamilton.
Hardy Sand Co.....	P.O. Box 507 Camden, Tenn. 38320	2 open pit mines.	Benton.
Memphis Sand & Gravel Co....	Box 6247 Memphis, Tenn. 38106	---do-----	Benton and Shelby.
Wedron Silica Co.....	Sewanee Silica Co. Sewanee, Tenn. 37375	Silica sand, open pit.	Franklin.
Tenn. Valley Sand and Gravel Co.	Box 520 Sheffield, Ala. 35661	Dredge.....	Hardin.
<b>Silver:</b>			
Cities Service Co., Copperhill Operations.	Copperhill, Tenn. 37317.....	See Copper---	Polk.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone:			
Dolomite:			
Agricultural Lime Co., Inc.	R.F.D. 9 Greeneville, Tenn. 37743	Open quarry...	Greene.
New Jersey Zinc Co.	Jefferson City, Tenn. 37760...	Underground mine.	Jefferson.
Limestone, crushed:			
American Zinc Co.	20 S. 4th St. St. Louis, Mo. 63102	See Zinc.....	Jefferson and Knox.
Ralph Rogers & Co.	720 Argyle Ave. Nashville, Tenn. 37203	2 open quarries and 1 under- ground mine.	Anderson, Coffee, and Sumner.
The Stone Man, Inc.	3908 B Tennessee Ave. Chattanooga, Tenn. 37409	5 open quar- ries.	Bedford, Hamilton, and Warren.
Vulcan Materials Co.	Box 7 Knoxville, Tenn. 37901	20 open quar- ries.	Benton, Blount, Claiborne, Davidson, Decatur, Hamilton, Hardin, Hawkins, Hum- phreys, Knox, Loudon, Marion, Sevier, Sullivan, Wayne, and Williamson.
Watauga Stone Co.	Mascot, Tenn. 37806.....	Open quarry...	Carter.
Marble, crushed:			
John J. Craig Co.	P.O. Box 9300 Knoxville, Tenn. 37920	3 open quar- ries.	Blount and Loudon.
Marble, dimension:			
Appalachian Marble Co.	2607 Middlebrook Pike Knoxville, Tenn. 37921	2 open quar- ries.	Knox.
John J. Craig Co.	P.O. Box 9300 Knoxville, Tenn. 37920	4 open quar- ries.	Blount and Loudon.
Georgia Marble Co.	Box 1550 Knoxville, Tenn. 37901	2 open quar- ries.	Knox.
Imperial Black Marble Co.	801 Bluff Dr. Knoxville, Tenn. 37919	Open quarry...	Grainger.
Quartzite, dimension:			
Ross L. Brown Cut Stone Co., Inc.	Crab Orchard, Tenn. 37723...	...do.....	Cumberland.
Crab Orchard Stone Co., Inc.	P.O. Drawer J. Crossville, Tenn. 38555	...do.....	Do.
Crossville Stone Co.	Box 426 Crossville, Tenn. 38555	...do.....	Fentress.
Sandstone, crushed:			
Hunt's Gap Sand and Clay Corp.	Box 929 Kingsport, Tenn. 37600	...do.....	Hawkins.
Turner Bros. Stone Co., Inc.	P.O. Box 297 Crossville, Tenn. 38555	...do.....	Cumberland.
White Silica Sand Co., Inc.	Rt. 2 Caryville, Tenn. 37714	...do.....	Campbell.
Sandstone, dimension:			
Cumberland Mountain Stone Co.	Crab Orchard, Tenn. 37723...	...do.....	Do.
Turner Bros. Stone Co., Inc.	P.O. Box 297 Crossville, Tenn. 38555	...do.....	Cumberland.
Vermiculite, exfoliated:			
W. R. Grace & Co.	4061 Powell Ave. Nashville, Tenn. 37204	Plant.....	Davidson.
Zinc:			
American Zinc Co.	Mascot, Tenn. 37806.....	4 underground mines and mill.	Jefferson and Knox.
Cities Service Co., Copperhill Operations.	Copperhill, Tenn. 37317.....	See Copper....	Polk.
New Jersey Zinc Co., (Gulf & Western Industries, Inc.).	Jefferson City, Tenn. 37760...	2 underground mines and mill.	Hancock and Jefferson.
New Market Zinc Co.	Box 66 New Market, Tenn. 37820	Underground mine and mill.	Jefferson.
U.S. Steel Corp.	Box 599 Fairfield, Ala. 35064	...do.....	Do.



# The Mineral Industry of Texas

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Bureau of Economic Geology, the University of Texas at Austin, for collecting information on all minerals except fuels.

By Richard F. Zaffarano,<sup>1</sup> Roselle Girard,<sup>2</sup> and Eugene R. Slatick<sup>3</sup>

Texas recorded a \$6.4 billion mineral output in 1970, and led the Nation for the 36th consecutive year, by providing approximately one-fifth of the total U.S. mineral value. Fuels again was the State leader in value of minerals produced, \$5,952 million; nonmetals second, \$396 million; and metals third \$54 million. Gain in fuel value was attributed to increases of \$408 million in petroleum (crude) production, \$128 million in natural gas, and \$93 million in natural gas liquids. Unit price for these fuels was higher than in 1969. Increased output of lime, salt, sand and gravel, sulfur (Frasch process), and talc and higher unit prices (except salt and

sulfur) were responsible for the rise in mineral value of nonmetals. Magnesium chloride showed the greatest metal value gain, reflecting increases in output.

Seventeen of the State's 254 counties reported mineral value in excess of \$100 million, representing about 47 percent of total mineral value. In four of these counties, Andrews, Ector, Brazoria, and Scurry, value of mineral production exceeded \$200 million, with petroleum the major revenue-producing mineral.

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<sup>3</sup> Mineral specialist, Division of Fossil Fuels.

Table 1.—Mineral production in Texas<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland.....thousand 376-pound barrels..	36,037	\$117,989	33,967	\$122,960
Masonry.....thousand 280-pound barrels..	1,110	3,873	1,007	3,769
Clays.....thousand short tons..	4,407	8,664	4,148	9,587
Gem stones.....	NA	150	NA	150
Gypsum.....thousand short tons..	1,314	4,398	1,220	4,252
Helium:				
High-purity.....million cubic feet..	141	4,917	82	2,862
Crude.....do.....	1,190	13,053	1,175	13,262
Lime.....thousand short tons..	1,633	22,107	1,673	24,427
Natural gas.....million cubic feet..	7,853,199	1,075,880	8,357,716	1,203,511
Natural gas liquids:				
Natural gasoline and cycle products				
thousand 42-gallon barrels..	96,628	289,042	97,511	284,871
LP gases.....do.....	194,599	237,411	204,177	334,850
Petroleum (crude).....do.....	1,151,775	3,696,328	1,249,697	4,104,005
Salt.....thousand short tons..	9,261	43,012	10,184	45,000
Sand and gravel.....do.....	29,972	39,756	31,438	46,362
Stone.....do.....	46,638	64,986	45,557	64,422
Sulfur (Frasch process).....thousand long tons..	2,552	68,360	2,801	62,290
Talc.....short tons..	163,812	668	171,420	878
Value of items that cannot be disclosed: Asphalt (native), bromine (1969), coal, (lignite), graphite, iron ore (usable), magnesium chloride (for metal), magnesium compounds (except for metal), mercury, pumicite, sodium sulfate, uranium (recoverable content U <sub>3</sub> O <sub>8</sub> ), and crude vermiculite (1969).....	XX	79,368	XX	75,004
Total.....	XX	5,769,970	XX	6,402,462
Total 1967 constant dollars.....	XX	5,448,583	XX	5,794,228

<sup>2</sup> Preliminary. 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.—Value of mineral production in Texas, by counties <sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Anderson	\$33,514	\$44,998	Petroleum, natural gas, natural gas liquids, stone.
Andrews	262,096	330,096	Petroleum, natural gas liquids, natural gas.
Angelina	247	201	Clays, natural gas, sand and gravel, petroleum.
Aransas	12,223	13,340	Petroleum, natural gas, natural gas liquids.
Archer	21,689	17,545	Petroleum, natural gas, sand and gravel.
Armstrong	--	W	Sand and gravel.
Atascosa	23,709	22,973	Petroleum, natural gas, natural gas liquids.
Austin	7,499	8,868	Petroleum, natural gas, sand and gravel, natural gas liquids.
Bastrop	826	895	Clays, petroleum, natural gas, sand and gravel.
Baylor	4,107	3,700	Petroleum, natural gas.
Bee	19,001	17,378	Natural gas, petroleum, natural gas liquids, stone.
Bell	W	W	Sand and gravel, stone.
Bexar	30,310	30,794	Cement, stone, sand and gravel, petroleum, natural gas liquids, lime, clays.
Blanco	3	1	Sand and gravel.
Borden	33,247	31,998	Petroleum, natural gas, sand and gravel.
Bosque	155	W	Stone, sand and gravel.
Bowie	82	339	Petroleum, natural gas.
Brazoria	242,105	254,356	Petroleum, natural gas liquids, natural gas, magnesium chloride, salt, magnesium compounds, lime.
Brazos	305	1,189	Sand and gravel, petroleum, natural gas, stone.
Brewster	W	W	Mercury.
Brooks	45,117	58,944	Natural gas, petroleum, natural gas liquids.
Brown	2,233	3,090	Stone, petroleum, natural gas, clays.
Burleson	522	485	Stone, petroleum, natural gas.
Burnet	4,731	4,365	Stone, graphite, sand and gravel.
Caldwell	12,816	10,807	Petroleum, natural gas, sand and gravel.
Calhoun	27,501	29,641	Natural gas, petroleum, stone, natural gas liquids, lime, sand and gravel.
Callahan	5,555	5,242	Petroleum, natural gas, natural gas liquids, stone.
Cameron	2,555	2,911	Natural gas, petroleum.
Camp	2,748	3,115	Petroleum, natural gas.
Carson	28,554	31,334	Natural gas, petroleum, natural gas liquids.
Cass	22,786	15,208	Natural gas liquids, petroleum, natural gas, iron ore.
Chambers	93,543	113,420	Petroleum, natural gas, natural gas liquids, salt, clays.
Cherokee	7,099	4,182	Petroleum, clays, natural gas liquids, natural gas.
Childress	385	658	Sand and gravel, petroleum, natural gas.
Clay	12,076	11,833	Petroleum, natural gas, stone.
Cochran	45,680	39,100	Petroleum, natural gas, natural gas liquids.
Coke	23,597	26,247	Petroleum, natural gas liquids, natural gas, sand and gravel.
Coleman	4,673	3,485	Petroleum, natural gas, stone, clays.
Collin	163	W	Stone.
Collingsworth	1,039	1,027	Natural gas, petroleum.
Colorado	52,497	45,538	Natural gas, natural gas liquids, sand and gravel, petroleum.
Comal	W	W	Lime, stone, sand and gravel.
Comanche	139	147	Natural gas, petroleum, clays, stone.
Concho	1,279	1,592	Petroleum, natural gas, natural gas liquids.
Cooke	30,184	29,986	Petroleum, natural gas liquids, natural gas.
Coryell	505	W	Stone, sand and gravel.
Cottle	84	81	Petroleum, natural gas, sand and gravel.
Crane	186,517	187,436	Petroleum, natural gas, natural gas liquids.
Crockett	33,976	48,603	Do.
Crosby	1,168	1,107	Sand and gravel, petroleum, natural gas.
Culberson	377	W	Sulfur, petroleum, natural gas, gypsum.
Dallam	29	27	Natural gas.
Dallas	11,965	13,927	Sand and gravel, cement, stone, clays.
Dawson	33,700	34,550	Petroleum, natural gas, natural gas liquids, stone.
Denton	1,294	1,781	Sand and gravel, clays, petroleum, natural gas.
DeWitt	11,556	13,248	Natural gas, petroleum, natural gas liquids, sand and gravel, stone.
Dickens	616	1,339	Petroleum, sand and gravel, natural gas.
Dimmit	1,358	3,232	Petroleum, natural gas.
Donley	262	W	Sand and gravel, natural gas.
Duval	33,502	36,753	Petroleum, natural gas, natural gas liquids, salt.
Eastland	3,148	2,447	Petroleum, natural gas, natural gas liquids, clays, stone.
Ector	270,940	305,842	Petroleum, natural gas liquids, natural gas, cement, stone, sand and gravel.
Edwards	67	68	Petroleum, natural gas.
Ellis	W	W	Cement, stone, clays, petroleum, natural gas.
El Paso	7,142	6,300	Cement, stone, sand and gravel.
Erath	1,062	1,063	Natural gas, natural gas liquids, petroleum, sand and gravel.
Falls	100	32	Petroleum, natural gas.
Fayette	2,060	1,833	Petroleum, clays, sand and gravel, stone, natural gas.
Fisher	24,510	24,863	Petroleum, natural gas, gypsum, natural gas liquids, clays.

See footnotes at end of table.

Table 2.—Value of mineral production in Texas, by counties <sup>1</sup>—Continued  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Floyd	W	\$10	Petroleum, natural gas.
Foard	\$1,820	1,311	Petroleum, natural gas, sand and gravel.
Fort Bend	60,998	65,152	Petroleum, sulfur, natural gas, salt, natural gas liquids, clays.
Franklin	11,353	17,647	Petroleum, natural gas liquids, natural gas.
Freestone	3,273	3,753	Natural gas, stone, petroleum, clays.
Frio	4,532	4,416	Petroleum, natural gas, natural gas liquids.
Gaines	139,483	153,501	Petroleum, natural gas, sodium sulfate, natural gas liquids, stone.
Galveston	50,870	48,449	Petroleum, natural gas, sulfur, natural gas liquids, clays, sand and gravel.
Garza	14,505	14,941	Petroleum, natural gas.
Gillespie	W	W	Gypsum, sand and gravel, talc, stone.
Glasscock	17,797	7,472	Petroleum, natural gas.
Goliad	10,837	10,448	Do.
Gonzales	1,415	1,795	Natural gas, petroleum, clays, sand and gravel.
Gray	48,055	39,952	Natural gas, natural gas liquids, petroleum.
Grayson	32,083	34,816	Natural gas, petroleum, natural gas liquids, stone, sand and gravel.
Gregg	153,186	174,552	Petroleum, natural gas liquids, natural gas.
Grimes	189	141	Petroleum, stone, natural gas.
Guadalupe	10,270	9,603	Petroleum, sand and gravel, stone, clays, natural gas.
Hale	8,607	15,020	Petroleum, natural gas, natural gas liquids.
Hall	42	W	Sand and gravel.
Hamilton	82	118	Natural gas, petroleum, sand and gravel.
Hansford	25,995	21,161	Natural gas, helium, petroleum.
Hardeman	5,580	5,337	Petroleum, gypsum, natural gas liquids, natural gas, sand and gravel.
Hardin	30,480	29,835	Petroleum, natural gas, natural gas liquids, sand and gravel.
Harris	138,986	147,706	Petroleum, natural gas, natural gas liquids, cement, lime, salt, sand and gravel, clays.
Harrison	13,582	21,244	Petroleum, natural gas, natural gas liquids, coal, clays.
Hartley	1,975	2,232	Natural gas, petroleum.
Haskell	12,288	11,577	Petroleum, natural gas, stone.
Hays	400	W	Sand and gravel.
Hemphill	7,029	16,455	Petroleum, natural gas.
Henderson	30,679	40,507	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Hidalgo	33,814	33,662	Natural gas liquids, petroleum, natural gas, sand and gravel, clays.
Hill	W	W	Lime, stone.
Hockley	81,370	124,143	Petroleum, natural gas liquids, natural gas.
Hood	635	569	Stone, sand and gravel, natural gas.
Hopkins	6,988	9,071	Petroleum, natural gas liquids, natural gas.
Houston	6,879	9,826	Petroleum, natural gas, natural gas liquids.
Howard	51,368	60,956	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Hudspeth	1,230	1,154	Talc, stone, gypsum.
Hunt	133	194	Natural gas, petroleum.
Hutchinson	34,000	64,535	Natural gas liquids, petroleum, natural gas, salt, stone.
Irion	4,837	5,059	Petroleum, natural gas liquids, natural gas.
Jack	18,914	16,246	Petroleum, natural gas, natural gas liquids, stone, sand and gravel.
Jackson	102,117	107,459	Petroleum, natural gas, natural gas liquids.
Jasper	2,443	1,898	Petroleum, natural gas, lime, sand and gravel.
Jefferson	66,107	69,835	Petroleum, natural gas, sulfur, natural gas liquids, salt, sand and gravel, clays.
Jim Hogg	23,225	14,533	Petroleum, natural gas, natural gas liquids.
Jim Wells	74,587	84,904	Do.
Johnson	W	W	Lime, stone, sand and gravel.
Jones	9,538	9,379	Petroleum, natural gas liquids, natural gas, stone.
Karnes	24,458	24,223	Petroleum, natural gas, uranium, natural gas liquids.
Kaufman	3,007	2,946	Petroleum, stone, natural gas.
Kenedy	21,643	22,430	Natural gas, petroleum.
Kent	63,282	83,271	Petroleum, natural gas.
Kerr	W	W	Sand and gravel.
Kimble	138	118	Sand and gravel, natural gas, petroleum.
King	3,735	3,909	Petroleum, natural gas.
Kleberg	180,990	171,302	Natural gas, petroleum, natural gas liquids, stone.
Knox	6,615	5,452	Petroleum, sand and gravel, natural gas.
Lamb	2,872	998	Petroleum, natural gas, stone.
Lampasas	26	W	Sand and gravel.
La Salle	1,768	2,298	Natural gas, petroleum.
Lavaca	7,794	7,818	Natural gas, natural gas liquids, petroleum, stone, sand and gravel.
Lee	31	28	Petroleum, natural gas.
Leon	4,199	3,149	Natural gas, petroleum, natural gas liquids, stone.
Liberty	44,963	39,815	Petroleum, sulfur, natural gas, natural gas liquids, sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Texas, by counties 1—Continued

(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Limestone	\$3,099	\$4,689	Sand and gravel, clays, natural gas, petroleum, stone.
Lipscomb	14,386	15,146	Natural gas, petroleum, stone.
Live Oak	21,966	20,982	Natural gas, petroleum, natural gas liquids, uranium.
Llano	624	W	Stone, talc.
Loving	7,346	5,858	Petroleum, natural gas.
Lubbock	1,256	1,699	Do.
Lynn	1,328	1,235	Petroleum, natural gas, sand and gravel.
McCulloch	W	W	Sand and gravel, natural gas, stone.
McLennan	W	8,502	Cement, sand and gravel, natural gas liquids, stone, clays, petroleum, natural gas.
McMullen	9,904	11,123	Natural gas, petroleum.
Madison	3,273	3,035	Do.
Marion	5,933	7,138	Petroleum, natural gas, natural gas liquids.
Martin	8,483	27,630	Petroleum, natural gas.
Mason	17	W	Sand and gravel.
Matagorda	71,913	62,100	Natural gas, petroleum, natural gas liquids, salt, sulfur.
Maverick	4,522	4,126	Petroleum, natural gas liquids, natural gas.
Medina	709	880	Petroleum, clays, natural gas.
Menard	1,092	1,015	Petroleum, natural gas.
Midland	45,937	56,024	Petroleum, natural gas, natural gas liquids, sand and gravel.
Milam	W	W	Coal, petroleum, natural gas, sand and gravel.
Mills	153	W	Stone.
Mitchell	13,323	14,957	Petroleum, stone, natural gas, sand and gravel.
Montague	14,704	18,374	Petroleum, natural gas liquids, natural gas, sand and gravel.
Montgomery	41,364	58,354	Do.
Moore	62,292	62,485	Natural gas, natural gas liquids, helium, petroleum.
Morris	W	W	Iron ore.
Motley	1,319	1,425	Petroleum, sand and gravel, natural gas.
Nacogdoches	7,192	5,764	Natural gas, iron ore, petroleum, clays.
Navarro	4,653	4,522	Petroleum, natural gas, clays, sand and gravel.
Newton	5,288	4,952	Petroleum, natural gas, natural gas liquids.
Nolan	30,819	32,021	Petroleum, cement, natural gas, natural gas liquids, gypsum, stone, sand and gravel.
Nueces	96,786	94,717	Natural gas, petroleum, natural gas liquids, cement, lime, sand and gravel, stone.
Ochiltree	26,980	33,238	Petroleum, natural gas, natural gas liquids.
Oldham	1,805	1,803	Petroleum, sand and gravel, natural gas, clays.
Orange	11,020	10,282	Petroleum, cement, natural gas, clays.
Palo Pinto	10,545	12,279	Stone, natural gas liquids, natural gas, petroleum, clays, sand and gravel.
Panola	39,940	26,750	Natural gas, natural gas liquids, petroleum.
Parker	4,535	5,183	Natural gas liquids, natural gas, stone, petroleum, clays, sand and gravel.
Pecos	148,099	176,663	Natural gas, petroleum, natural gas liquids, sulfur, sand and gravel.
Polk	6,224	5,958	Petroleum, natural gas.
Potter	16,486	18,448	Natural gas, natural gas liquids, cement, stone, helium, petroleum, sand and gravel.
Presidio	W	W	Mercury.
Rains	315	1,304	Natural gas, petroleum.
Randall	700	1,069	Stone.
Reagan	30,223	41,817	Petroleum, natural gas liquids, natural gas.
Red River	89	80	Petroleum, natural gas.
Reeves	23,801	32,267	Natural gas, petroleum, natural gas liquids, sand and gravel.
Refugio	116,992	137,470	Petroleum, natural gas, natural gas liquids.
Roberts	8,718	10,335	Natural gas, petroleum.
Robertson	251	49	Natural gas, stone, petroleum.
Runnels	9,797	6,556	Petroleum, natural gas, natural gas liquids.
Rusk	51,233	86,358	Petroleum, natural gas liquids, natural gas.
Sabine	3	W	Do.
San Jacinto	1,223	1,490	Petroleum, natural gas, sand and gravel.
San Patricio	43,340	45,692	Petroleum, natural gas liquids, natural gas, stone, sand and gravel, clays.
San Saba	13	W	Stone.
Schleicher	11,493	11,921	Petroleum, natural gas, natural gas liquids.
Scurry	173,221	219,447	Petroleum, natural gas liquids, natural gas, stone, magnesium chloride, clays.
Shackelford	12,696	13,232	Petroleum, natural gas, natural gas liquids, stone.
Shelby	901	856	Natural gas, petroleum.
Sherman	11,520	11,343	Do.
Smith	14,816	16,303	Petroleum, natural gas, clays, natural gas liquids.
Somervell	W	W	Sand and gravel.
Starr	37,017	44,746	Petroleum, natural gas, natural gas liquids, pumicite, clays.
Stephens	8,603	7,172	Petroleum, natural gas, natural gas liquids.
Sterling	8,644	7,323	Petroleum, natural gas.

See footnotes at end of table.

Table 2.—Value of mineral production in Texas, by counties <sup>1</sup>—Continued

(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Stonewall.....	\$22,058	\$22,368	Petroleum, natural gas liquids, natural gas, sand and gravel.
Sutton.....	2,740	2,604	Petroleum, natural gas, sand and gravel.
Tarrant.....	9,625	9,414	Cement, sand and gravel, stone, natural gas.
Taylor.....	13,130	12,754	Petroleum, stone, natural gas, sand and gravel, natural gas liquids, clays.
Terrell.....	4,376	4,783	Natural gas, petroleum.
Terry.....	35,637	34,656	Petroleum, sodium sulfate, natural gas liquids, natural gas.
Throckmorton.....	6,703	6,567	Petroleum, natural gas.
Titus.....	13,869	9,135	Do.
Tom Green.....	7,033	7,566	Petroleum, natural gas, natural gas liquids, sand and gravel.
Travis.....	W	5,802	Lime, stone, sand and gravel, petroleum, natural gas.
Trinity.....	27	—	—
Tyler.....	4,609	4,774	Petroleum, natural gas.
Upshur.....	12,582	11,214	Petroleum, natural gas, sand and gravel.
Upton.....	86,080	73,254	Petroleum, natural gas, natural gas liquids, sand and gravel.
Uvalde.....	W	W	Asphalt, stone, sand and gravel, natural gas.
Val Verde.....	463	510	Natural gas, petroleum.
Van Zandt.....	46,197	52,918	Petroleum, salt, natural gas liquids, natural gas, clays.
Victoria.....	24,060	23,849	Petroleum, natural gas, sand and gravel, natural gas liquids.
Walker.....	214	282	Clays, natural gas, petroleum, stone.
Waller.....	54,248	66,144	Natural gas, natural gas liquids, petroleum, sand and gravel.
Ward.....	66,087	75,285	Petroleum, natural gas, sodium sulfate, salt, sand and gravel.
Washington.....	861	758	Petroleum, stone, sand and gravel, natural gas.
Webb.....	9,715	11,445	Natural gas, petroleum, natural gas liquids, clays, sand and gravel.
Wharton.....	60,151	64,000	Petroleum, sulfur, natural gas, sand and gravel, natural gas liquids, clays.
Wheeler.....	9,943	8,832	Petroleum, natural gas, natural gas liquids, sand and gravel.
Wichita.....	29,085	28,719	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Wilbarger.....	13,480	12,785	Petroleum, natural gas, sand and gravel.
Willacy.....	12,736	14,869	Petroleum, natural gas.
Williamson.....	W	W	Stone, lime, petroleum, sand and gravel, natural gas.
Wilson.....	2,968	2,642	Petroleum, natural gas.
Winkler.....	106,523	105,169	Petroleum, natural gas, natural gas liquids.
Wise.....	35,178	43,052	Natural gas, natural gas liquids, stone, petroleum, clays.
Wood.....	91,662	127,800	Petroleum, natural gas liquids, natural gas, clays, sand and gravel.
Yoakum.....	114,616	161,230	Petroleum, natural gas liquids, natural gas, salt.
Young.....	12,810	13,163	Petroleum, natural gas, natural gas liquids, stone, sand and gravel.
Zapata.....	4,141	4,177	Natural gas, petroleum.
Zavala.....	1,526	2,062	Petroleum, natural gas.
Undistributed <sup>2</sup> .....	74,228	81,852	—
Total.....	5,769,970	6,402,462	—

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

<sup>1</sup> The following counties were not listed because no production was reported: Bailey, Bandera, Briscoe, Castro, Deaf Smith, Delta, Fannin, Jeff Davis, Kendall, Kinney, Lamar, Parmer, Real, Rockwall, San Augustine, and Swisher.<sup>2</sup> Includes some petroleum, natural gas liquids, sand and gravel, stone and gem stones that cannot be assigned to specific counties and values indicated by symbol W.

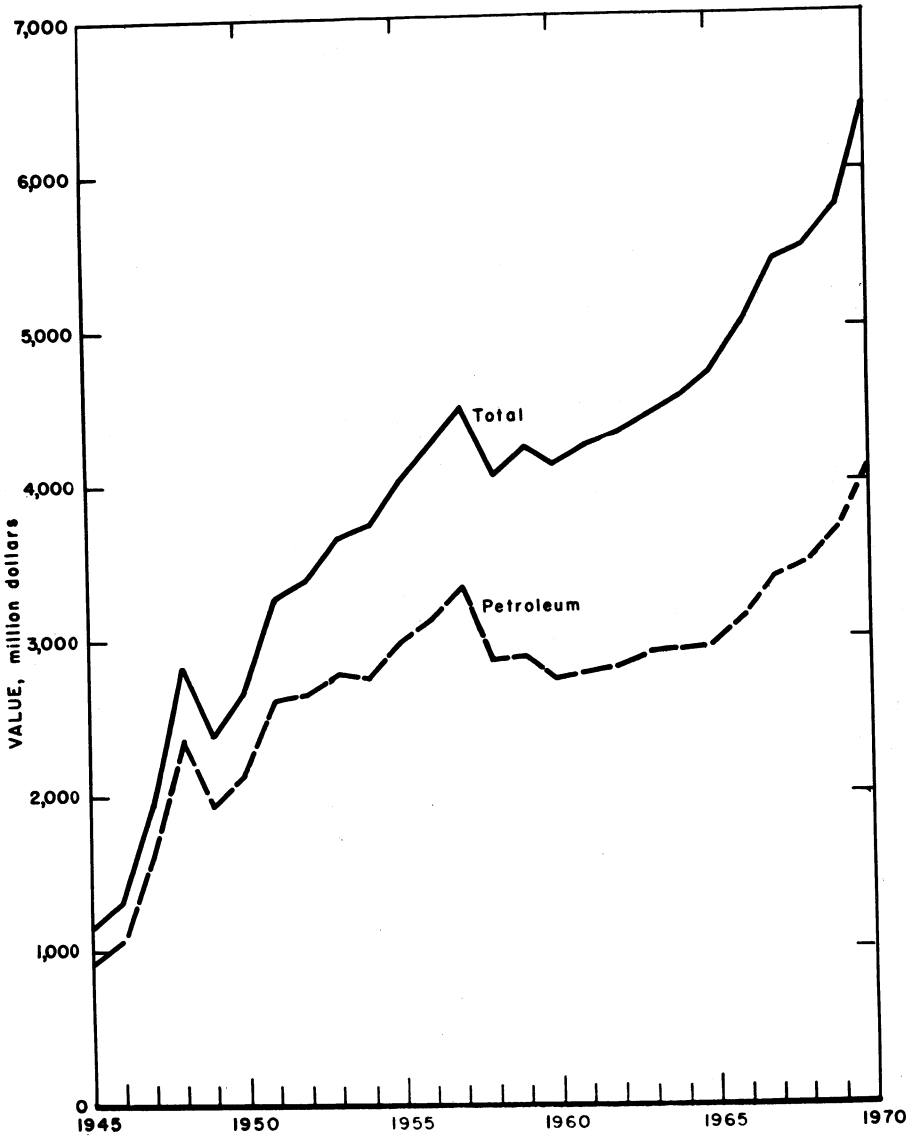


Figure 1.—Value of petroleum and total value of mineral production in Texas.

Table 3.—Indicators of Texas business activity

	1969	1970	Change, percent
Annual average labor force and employment:			
Total labor force.....thousands..	4,610.9	4,693.6	+1.8
Unemployment.....do.....	122.8	167.8	+36.6
Employment:			
Construction.....do.....	228.4	223.3	-2.2
Mining.....do.....	104.6	104.7	+1
Manufacturing.....do.....	753.0	742.2	-1.4
Transportation and public utilities.....do.....	250.4	255.0	+1.8
Wholesale and retail trade.....do.....	850.2	875.1	+2.9
Finance, insurance, and real estate.....do.....	183.7	191.4	+4.2
Services.....do.....	577.5	586.6	+1.6
Government.....do.....	651.4	661.6	+1.6
Personal income:			
Total.....millions..	\$36,401	\$39,525	+8.6
Per capita.....do.....	\$3,301	\$3,515	+6.5
Construction activity:			
Value of authorized nonresidential construction.....millions..	\$740.2	\$898.8	+21.4
Number of new building permits issued.....do.....	94,185	94,543	+4
Highway construction contracts awarded.....millions..	\$484.0	\$377.8	-21.9
Cement shipments to and within Texas thousand 376-pound barrels..	30,051	28,792	-4.2
Farm marketing receipts.....millions..	\$2,905.3	\$3,100.1	+6.7
Mineral production.....do.....	\$5,770.0	\$6,402.5	+11.0

Sources: Survey of Current Business; Area Trends in Employment and Unemployment; Employment and Earnings and Annual Report on the Labor Force; Construction Review; Roads and Streets Magazine; The Farm Income Situation; and U.S. Bureau of Mines.

**Legislation and Government Programs.**—The Texas Railroad Commission (RRC) has broadened and toughened rules dealing with prevention and reporting oil spills. Two new rules were adopted. The first, effective October 1, 1970, requires all flowing wells in bays, estuaries, lakes, rivers, or streams to be equipped with down-hole flow-control devices to prevent pollution in case of accidents. Subsurface chokes are to be set in tubing at least 100 feet below the surface. The other rule requires companies to notify the Commission immediately after any spill of more than 5 bar-

rels of oil, gas liquids, or associated products.

Texas and Louisiana attorneys and a U.S. Supreme Court Special Master have established ground rules for a hearing to resolve the dispute over the exact location of the Sabine River boundary. Texas claims the boundary should be the middle of the river, and Louisiana claims the west bank of the Sabine. The dispute is not expected to be settled until 1971 or 1972.

**Employment and Injuries.**—Employment and injury statistics of the mineral industry as compiled by the U.S. Bureau of Mines are shown in table 4.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non-fatal	Frequency	Severity
1969:								
Coal.....	116	321	37	298	--	--	15.76	4.036
Metal.....	1,448	342	495	3,998	2	61	26.46	1,797
Nonmetal and native asphalt.....	3,305	285	942	7,634	1	201	26.33	2,241
Sand and gravel.....	1,879	260	488	4,482	1	234	21.37	1,272
Stone.....	4,487	293	1,316	10,999	1	234	21.37	1,272
Total <sup>1</sup> .....	11,235	292	3,278	27,412	5	613	22.54	1,966
1970: <sup>p</sup>								
Coal.....	140	315	44	357	--	45	10.59	3.737
Metal.....	1,665	332	553	4,439	2	146	22.28	4,429
Nonmetal.....	2,850	294	837	6,732	4	129	28.69	1,879
Sand and gravel.....	1,870	257	481	4,497	--	261	23.13	2,215
Stone <sup>2</sup> .....	4,390	303	1,329	11,373	2	261	23.13	2,215
Total <sup>1</sup> .....	10,910	297	3,244	27,397	8	581	21.50	2,922

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

<sup>2</sup> Beginning in 1970, data on asphaltic stone operations, which formerly were included in "Native Asphalt" have been included in "Stone."

## REVIEW BY MINERAL COMMODITIES

## MINERAL FUELS

Fossil fuels remained the dominant mineral commodities produced, accounting for approximately 93 percent of the total 1970 mineral value. Crude oil, the most valuable mineral commodity, contributed approximately 64 percent of the total value; natural gas, 19 percent; and natural gas liquids, 10 percent.

During the year, a total of 7,710 wells

were drilled, according to the American Petroleum Institute (API). The industry completed 4,891 of these as producers, and abandoned 2,819 as dry holes. Exploratory drilling totaled 2,099 holes and resulted in 256 oil producers and 179 gas producers; 1,664 holes were dry and abandoned. Developmental drilling totaled 5,611 holes and resulted in 3,858 oil producers and 598 gas producers; 1,155 wells were dry and abandoned.

Table 5.—Texas: Production and value of mineral fuels

Year	Crude petroleum		Natural gas <sup>1</sup>	
	Thousand 42-gallon barrels	Value (thousands)	Million cubic feet	Value (thousands)
1966-----	1,057,706	\$3,141,387	6,953,790	\$903,993
1967-----	1,119,962	3,375,565	7,188,900	948,935
1968-----	1,133,380	3,450,707	7,495,414	1,011,881
1969-----	1,151,775	3,696,328	7,853,199	1,075,888
1970-----	1,249,697	4,104,005	8,357,716	1,203,511

Year	Natural gas liquids					
	Natural gasoline and cycle products		LP gas		Total	
	Thousand 42-gallon barrels	Value (thousands)	Thousand 42-gallon barrels	Value (thousands)	Thousand 42-gallon barrels	Value (thousands)
1966-----	92,625	\$269,332	151,425	\$260,755	244,050	\$530,087
1967-----	95,991	277,105	177,367	320,326	273,358	597,431
1968-----	97,075	269,182	189,162	278,068	286,237	547,250
1969-----	96,628	289,042	194,599	237,411	291,227	526,453
1970-----	97,511	284,871	204,177	334,850	301,688	619,721

<sup>1</sup> Marketed production, gas either sold or consumed by producers including losses in transmission, amounts added to storage, and increases in gas pipelines.

Table 6.—Texas: Production trends of crude oil, natural gas, and natural gas liquids (Million barrels of oil equivalent)

Year	Production <sup>1</sup>				Percentage of—							
					Annual total			Change of reported year				
	Oil	Gas	Liquids	Total	Oil	Gas	Liquids	Oil	Gas	Liquids	Total	
1966----	1,058	1,242	179	2,479	42.7	50.1	7.2	5.7	4.8	6.5	5.3	
1967----	1,120	1,284	199	2,603	43.0	49.3	7.7	5.9	3.4	11.2	5.0	
1968----	1,133	1,338	208	2,679	42.3	49.9	7.8	1.2	4.2	4.5	2.9	
1969----	1,152	1,402	211	2,765	41.7	50.7	7.6	1.7	4.8	1.4	3.2	
1970----	1,250	1,492	219	2,961	42.2	50.4	7.4	8.5	6.4	3.8	7.1	

<sup>1</sup> 1 barrel of crude oil equivalent to 5,600 cubic feet of natural gas or 57.6 gallons of natural gas liquids, a composite of 52.7 gallons of natural gasoline and 60.8 gallons of LP gases.

**Table 7.—Texas: Comparison of mineral fuels production in Texas and the United States**

Fuel	Production <sup>1</sup> as oil equivalent				Change from 1969 (percent)				Percent of fuels				Texas as percent of United States	
	Texas		United States		Texas		United States		Texas		United States		1969	1970
	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970
Crude oil.....	1,152	1,250	3,372	3,517	+8.5	+4.3	41.7	42.2	45.0	44.7	34.2	35.5	37.9	38.1
Natural gas.....	1,402	1,492	3,696	3,914	+6.4	+5.9	50.7	50.4	49.4	49.7	37.9	38.1	37.9	38.1
Natural gas liquids.....	211	219	422	440	+3.8	+4.3	7.6	7.4	5.6	5.6	50.0	49.8	50.0	49.8
Total oil equivalent.....	2,765	2,961	7,490	7,871	+7.1	+5.1	100.0	100.0	100.0	100.0	36.9	37.6	36.9	37.6

<sup>1</sup> Million barrels of oil equivalent, derived by gas and liquids factors reported in table 6.

**Table 8.—Texas: Fuels reserves ratio to production in Texas and the United States**

Fuel	Reserves <sup>1</sup>				Texas as percent of United States				Percent change from 1969				Reserve ratio	
	Texas		United States		Texas		United States		Texas		United States		1969	1970
	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970	1969	1970
Crude oil.....	13,063	13,195	29,682	39,001	44.1	33.8	+1.0	+31.6	11.3	10.6	8.8	11.1	8.8	11.1
Natural gas.....	20,070	18,982	49,127	51,919	40.9	36.6	-5.4	+5.7	14.3	12.7	13.3	13.3	13.3	13.3
Natural gas liquids.....	2,668	2,428	5,988	5,617	44.8	43.2	-8.8	-5.4	12.6	11.1	14.1	12.8	14.1	12.8
Total oil equivalent.....	35,796	34,615	84,697	96,537	42.3	35.9	-3.3	+14.0	12.9	11.7	11.3	12.3	11.3	12.3

<sup>1</sup> Million barrels of oil equivalent, derived by gas and liquids factors reported in table 6.



Table 9.—Texas: Estimated proved recoverable reserves of natural gas, natural gas liquids, and crude oil in 1970, by railroad districts

Railroad district	Proved reserves, Jan. 1, 1970	Extensions and revisions	New fields and new pools	Proved reserves, Jan. 1, 1971 <sup>1</sup>	Change from Jan. 1, 1970
NATURAL GAS <sup>2</sup> (MILLION CUBIC FEET)					
1.....	2,127,201	-54,597	17,860	1,954,567	-172,634
2 <sup>3</sup> .....	10,445,403	+134,069	115,793	10,060,030	-385,373
3 <sup>3</sup> .....	23,751,937	+136,206	571,244	22,813,727	-938,260
4 <sup>3</sup> .....	31,215,625	-73,655	486,836	29,237,231	-1,928,394
5.....	1,423,567	+23,901	48,033	1,393,434	-35,033
6.....	5,997,201	+221,036	16,150	5,830,740	-166,461
7B.....	786,257	+44,666	3,085	752,131	-34,126
7C.....	3,766,150	+41,126	42,771	3,602,966	-163,184
8.....	17,217,339	+314,982	200,067	16,104,203	-1,113,136
8A.....	3,001,185	-172,154	946	2,596,621	-404,564
9.....	1,925,141	+123,837	4,151	1,864,447	-60,694
10.....	10,730,566	+551,783	89,434	10,092,846	-637,720
Total.....	112,392,622	+580,189	1,601,375	106,352,993	-6,039,629
NATURAL GAS LIQUIDS <sup>4</sup> (THOUSAND BARRELS)					
1.....	31,923	-105	196	28,980	-2,943
2 <sup>3</sup> .....	147,625	-2,910	1,385	132,961	-14,664
3 <sup>3</sup> .....	742,313	3,213	2,609	685,846	-56,972
4 <sup>3</sup> .....	678,451	-26,255	9,597	597,683	-80,768
5.....	87,813	656	945	83,915	-3,898
6.....	453,951	-3,387	450	423,879	-30,072
7B.....	52,181	13,829	414	58,790	+6,609
7C.....	154,537	34,925	795	173,494	+18,957
8.....	565,936	-5,965	1,416	499,965	-65,971
8A.....	322,707	-26,504	-	272,197	-50,510
9.....	69,700	7,666	309	68,304	-1,396
10.....	344,292	-2,691	2,630	304,145	-40,147
Total.....	3,651,939	-7,528	20,746	3,330,159	-321,780
CRUDE OIL <sup>5</sup> (THOUSAND BARRELS)					
1.....	157,166	+2,990	10,064	153,325	-3,841
2 <sup>3</sup> .....	886,483	+32,032	3,688	844,961	-41,522
3 <sup>3</sup> .....	1,834,428	+4,101	9,146	1,686,995	-147,433
4 <sup>3</sup> .....	563,865	+37,374	4,353	523,403	-35,462
5.....	134,866	+7,933	1,808	123,102	-6,764
6.....	2,590,282	+61,826	232	2,497,771	-92,511
7B.....	242,444	+30,948	3,054	233,803	-3,641
7C.....	348,353	-11,003	2,037	298,519	-49,834
8.....	3,168,582	+219,049	9,392	3,106,879	-61,703
8A.....	2,566,178	+808,818	5,217	3,130,328	+564,150
9.....	335,567	+77,203	4,587	363,458	+27,891
10.....	234,968	+9,853	251	217,932	-17,036
Total.....	13,063,182	1,281,174	53,829	13,195,476	-132,294

<sup>1</sup> Change reflects production and net additions and withdrawals in storage.

<sup>2</sup> Committee on Natural Gas Reserves of American Gas Association.

<sup>3</sup> Includes offshore reserves.

<sup>4</sup> Committees on Natural Gas Liquid Reserves of American Petroleum Institute and American Gas Association.

<sup>5</sup> Committees on Crude Oil Reserves of American Petroleum Institute and American Gas Association.

**Pipelines.**—Product and natural gas pipelines accounted for the major pipeline construction in 1970. Chaparral Pipeline System completed a 520-mile 12-inch products line from west Texas to Mont Belvieu. Seadrift Pipeline Corp. installed a 34-mile 10-inch line from Texas City to Mont Belvieu.

Pennzoil Pipeline Co completed a 10.2-mile 12-inch gas line from the High Island area, Gulf of Mexico to the existing 20-inch DuPont Chemical Co. main line in Jefferson County. Houston Natural Gas Co. added 15 miles of 36-inch and 42 miles of

30-inch gas lines from Katy to Pearland. Lone Star Gas Co. completed a 181-mile 30-inch gas line from Sweetwater to the Delaware Basin in Pecos County.

**Asphalt (Native).**—Uvalde County supplied the native asphalt rock. The major market for this product was highway maintenance. Production was slightly above the 1969 level.

**Carbon Black.**—Texas was the leading producer of carbon black. Production was 1,396 million pounds, a decrease of 46 million pounds, or 3.2 percent less than in 1969. This State provided 47.6 percent of

the U.S. production. During the year, 12 furnace plants and three channel plants operated in 13 counties. Furnace black totaled 1,294 million pounds, or 44 percent of the U.S. furnace black production. Channel black recorded a 102 million pound output, or 89 percent of total U.S. channel black production.

**Coal (Lignite).**—Texas Utilities Co. continued constructing a 1.1-megawatt generating plant in Freestone County to be fueled with lignite. Freestone and Limestone County lignites will provide the 5-million-ton-per-year fuel requirements.

Two producers mined lignite in Milam and Harrison Counties. Milam County lignite was used as fuel for electric power generation, while Harrison County lignite was processed into activated carbon.

**Helium.**—Four extraction plants were operated in Texas: two Bureau of Mines and two Phillips Petroleum Co. plants. Total production from the two Bureau of Mines plants was 266.5 MMcf (million cubic feet), compared with 313.5 MMcf in 1969. These plants sold a combined total of 81.8 MMcf for \$2.9 million. The 184.7 MMcf produced but not sold was placed in underground storage. The Bureau's Amarillo plant shut down April 15, 1970.

Phillips Petroleum Co. plants in Moore and Hansford Counties produced and sold 995.4 MMcf of crude helium, a decrease of 194.9 MMcf from 1969. This helium was purchased by the Bureau of Mines for \$11.2 million and stored in the Cliffside field in Potter County for conservation purposes.

Modernization program at the Exell plant continued through 1970, with a completion date of June 1972.

**Natural Gas.**—Texas led the nation in natural gas production, supplying 38 percent of domestic output. Marketed natural gas production was 8.4 trillion cubic feet, an increase of 6.4 percent above the previous year. The average wellhead value was 14.4 cents per thousand cubic feet (Mcf), compared with 13.7 cents per Mcf in 1969.

According to RRC, at yearend there were 23,417 producing gas wells. Average production from these wells was 842,900 cubic feet per day in 1970. The 184,418 wells that produced casinghead and associated gas averaged 33,356 cubic feet per

day, a 1.7-percent increase above the 1969 figure.

Deep gas discoveries in west Texas from the Devonian and Ellenburger reservoirs continued to be of prime importance. A highly significant deep gas discovery was Evetts field in Winkler County. The discovery well was a dual gas completion with an initial daily production rate of 28.5 MMcf from the Silurian formation at 17,808 feet and 35.5 MMcf from an Ellenburger reservoir at 20,330 feet.

In the upper gulf coast of Texas, Frio Formation gas production was established at the Buffalo Camp field in Brazoria County. Initial open flow was calculated to be 142 MMcf per day from a depth of 10,716 feet.

In the offshore area, a gas field was discovered in Block 30-L, High Island area. The discovery well was completed to produce gas condensate from the Lower Miocene. Initial gas production was 42 MMcf per day from 8,752 feet. Another significant offshore discovery in the area was Block 14-L. The discovery well, approximately 12 miles south of Sabine Pass, was completed to produce gas from the Lower Miocene. Initial daily production was 27.5 MMcf from a depth of 9,430 feet.

Vicksburg gas production was discovered in the Jeffress field in Hidalgo County in south Texas. The discovery well flowed 17.2 MMcf per day from a depth of 11,476 feet.

According to the American Gas Association, Inc., proved natural gas reserves as of December 31, 1970, were 106,353 billion cubic feet (MMMcf), a decline of 5.4 percent from the previous year. Texas reserve represented 37 percent of the U.S. total.

**Natural Gas Liquids.**—Texas produced 50 percent of the Nation's natural gas liquids. Output increased 3.6 percent above the previous year, an increase of 10.5 million barrels. Value of these liquids increased 18 percent from \$526 to \$620 million.

According to The Oil and Gas Journal, there were 386 natural gas processing plants at yearend. Installed capacity was 29.4 MMMcfd, a 2.4-MMMcfd increase over the previous year. As reported by API, proved natural gas liquids reserves at yearend comprised 3.33 billion barrels, compared with 3.65 billion barrels the pre-

vicious year; a decrease of 9 percent. Texas contained 43 percent of the U.S. proved gas liquids reserves at the end of 1970, a decrease of 1.8 percent from 1969.

Gas processing plant construction registered a steady gain following the national trend. At yearend Cities Service Oil Co. was adding a 60,000-b/d (barrel per day) fractionation plant at Mont Belvieu to produce ethane, propane, iso and normal butanes, and natural gasoline. They also were constructing a 13.5-MMcfd ethane unit at Longview. El Paso Natural Gas Co. completed a 350-MMcfd plant in Reeves County. Gulf Refining Co. at Mont Belvieu was expanding fractionation capacity by 20,000 b/d. HNG Petrochemicals completed a 300 MMcfd plant at Barstow. Mobil Oil Corp. completed at 30,000-b/d ethane plant at Beaumont. Natural Gas

Pipeline Co. of America completed a 200-MMcfd plant in Hemphill County. Skelly Oil Co. expanded ethane recovery facilities by 21 million gallons per day in Howard County. Sun Oil Co. installed a 30-MMcfd plant in the Midfield field, Matagorda County.

**Petroleum.**—Crude oil production totaled 1,249,697,000 barrels, an increase of 8.5 percent over 1969. Average price of crude oil in Texas was \$3.28 per barrel, compared with \$3.21 in 1969.

Crude oil production was reported from 203 counties. The seven leading oil producing counties were Gaines, Gregg, Andrews, Ector, Scurry, Crane, and Cochran. There were 177,221 producing oil wells, a decrease of 5,920 wells from 1969. Average production per well per day was 19.0 barrels.

Table 10.—Texas: Oil and gas well drilling completions, by Texas Railroad Commission districts and counties

County	Proved field wells			Exploratory wells			Total number of wells	Footage
	Oil	Gas	Dry	Oil	Gas	Dry		
<b>District 1:</b>								
Atascosa.....	36	1	6	4	--	16	63	265,144
Bastrop.....	--	--	--	--	--	16	16	63,012
Bexar.....	49	--	1	--	--	3	53	58,765
Caldwell.....	39	--	1	--	--	8	48	119,206
Dimmit.....	51	1	1	5	1	11	70	383,302
Edwards.....	--	--	--	--	--	3	3	17,122
Frio.....	4	2	1	--	--	10	17	86,847
Gonzales.....	--	--	1	--	--	14	15	59,969
Guadalupe.....	30	--	--	1	--	2	33	81,878
Hays.....	--	--	--	--	--	3	3	7,015
Kerr.....	--	--	--	--	--	1	1	4,012
La Salle.....	5	1	6	5	4	22	43	235,439
McMullen.....	5	3	9	--	1	22	40	226,942
Maverick.....	10	--	3	2	--	13	28	83,297
Medina.....	2	--	1	--	--	--	3	3,281
Milam.....	6	--	4	6	--	6	22	70,361
Travis.....	--	--	--	--	--	4	4	2,623
Williamson.....	--	--	--	--	--	5	5	8,732
Wilson.....	8	--	7	1	--	15	31	81,330
Zavala.....	10	2	3	2	2	8	27	118,025
<b>Total.....</b>	<b>255</b>	<b>10</b>	<b>44</b>	<b>26</b>	<b>8</b>	<b>182</b>	<b>525</b>	<b>1,976,352</b>
<b>District 2:</b>								
Bee.....	15	4	5	2	4	15	45	216,771
Calhoun.....	2	8	1	2	2	24	39	317,835
DeWitt.....	--	--	2	--	4	15	21	220,792
Goliad.....	3	4	4	--	5	7	23	116,200
Jackson.....	18	4	14	1	3	20	60	404,839
Karnes.....	2	2	2	1	1	13	21	155,348
Lavaca.....	--	7	6	1	4	15	33	263,324
Live Oak.....	3	4	11	1	4	19	42	226,455
Refugio.....	26	1	4	2	--	9	42	239,636
Victoria.....	4	4	7	--	5	18	38	246,531
<b>Total.....</b>	<b>73</b>	<b>38</b>	<b>56</b>	<b>10</b>	<b>32</b>	<b>155</b>	<b>364</b>	<b>2,407,731</b>
<b>District 3 and offshore:</b>								
Austin.....	18	--	1	1	--	8	28	55,920
Brazoria.....	37	3	17	11	4	18	90	504,235
Brazos.....	7	3	--	--	--	1	11	30,839
Brazos-LB.....	--	--	--	--	--	14	14	131,865
Brazos-South.....	--	--	--	--	--	1	1	11,616
Burleson.....	4	--	--	--	1	1	6	20,457
Chambers.....	14	1	1	4	3	14	37	298,614
Colorado.....	3	7	6	3	7	11	37	246,261

Table 10.—Texas: Oil and gas well drilling completions, by Texas Railroad Commission districts and counties—Continued

County	Proved field wells			Exploratory wells			Total number of wells	Footage
	Oil	Gas	Dry	Oil	Gas	Dry		
District 3 and offshore—								
Continued								
Fayette	4	--	3	--	--	2	9	23,042
Fort Bend	12	--	5	--	1	7	25	139,554
Galveston	3	1	1	1	--	7	13	138,445
Galveston-LB	1	--	--	2	--	9	12	127,668
Galveston-SB	--	--	--	--	1	1	2	16,296
Grimes	--	--	--	--	--	5	6	51,340
Hardin	84	2	20	5	3	8	122	423,613
Harris	10	8	7	4	3	6	38	206,981
High IS-East	--	1	--	1	1	2	4	42,659
High IS-LB	--	5	--	1	7	9	22	212,356
Jasper	--	--	--	4	--	13	17	148,159
Jefferson	19	8	11	7	3	12	60	457,886
Lee	--	--	--	--	--	3	3	15,285
Liberty	37	--	19	1	--	10	66	353,610
Madison	1	1	--	1	--	4	7	66,828
Matagorda	6	5	7	7	15	31	71	565,432
Matagorda IS-LB	--	1	--	--	--	1	2	17,956
Montgomery	2	3	3	--	--	8	16	132,444
Mustang IS-LB	--	1	--	--	--	--	1	8,149
Mustang IS-SB	--	--	--	--	1	--	1	11,265
Newton	2	--	1	3	--	13	19	168,514
North Padre IS-SB	--	--	--	--	--	1	1	10,650
Orange	4	--	2	--	--	2	8	44,093
Polk	6	1	3	--	1	6	17	93,040
San Jacinto	--	--	--	--	1	4	5	52,150
Tyler	2	--	2	--	2	5	11	106,643
Walker	--	--	--	--	--	5	5	33,512
Waller	--	3	2	--	--	2	7	67,442
Washington	--	--	1	--	--	2	3	25,270
Wharton	10	21	20	1	13	33	98	533,136
Total	286	75	132	56	67	279	895	5,588,175
District 4:								
Aransas	2	7	6	--	--	6	21	200,580
Brooks	7	9	5	--	3	6	30	225,273
Cameron	--	3	--	--	--	10	13	125,690
Duval	80	14	36	4	--	30	164	581,985
Hidalgo	--	32	8	1	1	9	51	446,022
Jim Hogg	2	1	6	2	--	14	25	143,825
Jim Wells	13	11	8	--	--	14	46	286,240
Kenedy	5	8	4	--	--	3	20	199,161
Kleberg	54	3	8	1	--	6	72	538,120
Nueces	15	28	21	1	5	20	90	724,487
San Patricio	28	14	18	--	1	21	82	590,310
Starr	21	24	20	1	1	12	79	431,509
Webb	3	14	16	--	2	26	61	254,887
Willacy	6	9	3	--	2	4	24	152,820
Zapata	4	5	6	--	--	9	24	122,490
Total	240	182	165	10	15	190	802	5,023,404
District 5 and 6:								
Anderson	48	4	11	--	--	12	75	199,462
Angelina	--	1	--	--	--	2	3	18,934
Bowie	--	1	1	--	--	--	2	19,125
Camp	1	--	2	--	--	2	5	33,671
Cass	1	--	2	--	--	4	7	52,883
Cherokee	--	2	2	1	--	16	21	105,514
Delta	--	--	--	--	--	3	3	21,660
Ellis	--	--	--	--	--	1	1	3,350
Falls	9	--	5	--	--	1	15	19,974
Franklin	4	1	2	--	--	1	8	54,105
Freestone	--	1	1	1	2	5	10	81,767
Gregg	5	1	--	--	--	1	7	36,913
Harrison	8	5	2	--	1	6	22	126,244
Henderson	--	1	1	1	--	6	9	71,320
Hill	--	--	--	--	--	6	6	17,976
Hopkins	2	--	2	2	--	4	10	81,327
Houston	14	3	3	--	2	3	25	196,626
Hunt	--	--	--	--	--	1	1	9,222
Kaufman	--	--	--	--	--	3	3	25,044
Lamar	--	--	--	--	--	1	1	2,560
Leon	4	2	1	--	--	8	15	96,669
Limestone	--	3	3	--	--	12	18	131,888
Marion	49	1	1	--	--	4	55	169,116

Table 10.—Texas: Oil and gas well drilling completions, by Texas Railroad Commission districts and counties—Continued

County	Proved field wells			Exploratory wells			Total number of wells	Footage
	Oil	Gas	Dry	Oil	Gas	Dry		
District 5 and 6—Continued								
Morris	--	--	--	--	--	1	1	5,250
Nacogdoches	--	1	--	--	1	4	6	60,528
Navarro	1	1	1	--	--	9	12	96,319
Panola	--	7	1	--	1	4	13	72,440
Rains	--	--	--	--	--	3	3	29,557
Red River	--	--	--	--	--	4	4	12,491
Robertson	--	1	3	--	1	4	9	53,349
Rusk	10	--	2	1	1	7	21	102,435
Sabine	--	--	--	--	--	1	1	6,465
San Augustine	--	--	--	--	--	1	1	9,050
Shelby	--	1	1	--	1	--	3	27,059
Smith	2	--	1	--	--	6	9	66,063
Titus	3	--	1	--	--	2	6	32,896
Upshur	3	2	3	--	--	4	12	80,793
Van Zandt	2	2	1	1	1	7	14	139,116
Wood	16	1	6	3	--	8	34	196,999
Total	182	42	59	10	11	167	471	2,566,160
District 7 B:								
Brown	30	5	12	2	1	3	53	99,237
Callahan	67	2	30	4	--	16	119	196,527
Coleman	17	2	5	--	--	14	38	62,694
Comanche	--	1	2	--	--	1	4	3,585
Eastland	7	2	5	2	--	3	19	43,481
Erath	8	1	--	--	2	2	13	48,107
Fisher	10	--	3	6	--	9	28	117,666
Hamilton	--	--	--	1	--	4	5	16,450
Haskell	6	--	5	2	--	16	29	124,977
Hood	--	--	--	--	--	2	2	877
Jones	14	--	11	4	--	23	52	136,613
Nolan	36	1	7	2	--	15	61	349,805
Palo Pinto	1	9	8	1	2	5	26	91,955
Parker	--	4	1	--	--	--	5	13,667
Shackelford	83	1	54	14	--	26	178	413,421
Stephens	28	2	2	--	--	7	39	130,831
Stonewall	9	--	5	1	--	12	27	125,021
Taylor	48	2	28	4	1	27	110	353,951
Throckmorton	58	--	44	6	1	25	134	285,873
Total	422	32	222	49	7	210	942	2,614,738
District 7 C, 8, and 8 A:								
Andrews	64	--	7	3	--	7	81	648,837
Borden	1	--	8	1	--	10	20	148,367
Brewster	--	--	--	--	--	2	2	3,217
Cochran	41	2	2	--	--	1	46	197,236
Coke	12	--	5	2	--	9	28	159,520
Concho	--	--	--	--	--	8	8	22,798
Cottle	--	--	2	--	--	5	7	35,797
Crane	108	2	18	3	--	10	141	634,351
Crockett	27	62	12	5	4	9	119	721,236
Crosby	--	--	--	--	--	1	1	6,158
Culberson	2	1	1	1	--	2	7	14,555
Dawson	24	--	9	1	--	7	41	302,978
Dickens	5	--	11	--	--	5	21	99,711
Ector	239	1	8	2	--	5	255	1,455,843
El Paso	--	--	--	--	--	1	1	7,910
Floyd	--	--	--	--	--	6	6	51,371
Gaines	32	--	6	1	--	8	47	324,749
Garza	9	--	--	1	--	7	17	93,490
Glasscock	3	--	1	--	--	8	12	56,454
Hale	7	--	1	--	--	1	9	46,141
Hockley	429	--	3	--	--	2	434	2,047,749
Howard	54	--	16	3	--	13	86	440,788
Hudspeth	--	--	--	--	--	2	2	13,952
Irion	4	--	8	2	--	10	24	102,202
Jeff Davis	--	--	--	--	--	1	1	12,500
Kent	19	--	1	1	--	13	34	185,942
Kimble	--	--	1	--	--	3	4	9,475
King	9	--	3	2	--	7	21	106,313
Lamb	3	--	--	--	--	3	6	27,546
Loving	--	--	3	--	--	2	5	21,809
Lubbock	7	--	1	1	--	3	12	91,759
Lynn	1	--	1	--	--	3	5	29,130
McCulloch	--	--	--	--	--	3	3	1,804
Martin	119	--	1	7	--	1	128	1,169,388
Menard	2	1	1	--	--	5	9	24,760

Table 10.—Texas: Oil and gas well drilling completions, by Texas Railroad Commission districts and counties—Continued

County	Proved field wells			Exploratory wells			Total number of wells	Footage
	Oil	Gas	Dry	Oil	Gas	Dry		
District 7 C, 8, and 8 A								
Continued								
Midland	33	1	2	2	--	2	40	282,231
Mitchell	10	--	2	--	--	7	19	83,486
Mortley	1	--	1	--	--	1	3	11,928
Pecos	56	36	22	6	4	25	149	1,183,290
Reagan	64	--	1	1	--	2	68	276,057
Reeves	11	11	2	--	6	9	39	481,925
Runnels	8	--	11	2	--	25	46	165,328
Schleicher	7	2	8	5	4	8	34	189,047
Scurry	25	--	7	2	--	8	42	247,211
Sterling	9	--	10	1	--	5	25	184,164
Sutton	1	3	4	--	2	10	20	86,449
Terrell	--	1	1	--	2	1	5	77,678
Terry	18	2	1	1	--	4	26	128,234
Tom Green	3	--	5	1	--	10	19	98,136
Upton	11	3	3	3	1	6	27	149,732
Ward	58	10	15	3	--	12	98	633,823
Winkler	66	2	11	2	1	5	87	448,048
Yoakum	235	--	6	1	--	6	248	1,192,385
Total	1,837	140	242	66	24	329	2,638	15,234,988
District 9:								
Archer	68	--	36	1	--	8	113	282,971
Baylor	2	--	2	--	--	11	15	38,842
Clay	30	--	9	4	--	4	47	205,990
Cooke	49	--	14	1	--	21	85	223,465
Denton	--	--	--	--	--	3	3	10,936
Foard	3	--	--	--	--	3	6	24,607
Hardeman	--	--	1	--	--	2	3	22,905
Jack	43	8	28	6	1	11	97	372,073
Knox	--	--	2	2	--	9	13	38,193
Montague	19	--	7	4	--	7	37	199,709
Wichita	167	--	28	1	--	4	200	423,222
Wilbarger	33	--	15	1	--	12	61	200,456
Wise	9	7	12	--	--	1	29	164,548
Young	70	1	35	6	--	23	135	399,239
Total	493	16	189	26	1	119	844	2,607,156
District 10:								
Briscoe	--	--	--	--	--	1	1	10,002
Carson	13	4	3	--	--	1	21	70,164
Castro	--	--	--	--	--	1	1	6,800
Childress	--	--	--	--	--	3	3	15,689
Dallam	--	--	--	--	--	1	1	7,071
Gray	24	2	4	--	--	2	32	111,810
Hansford	2	2	7	--	--	3	14	99,152
Hartley	--	1	--	--	--	2	3	20,588
Hemphill	2	26	1	--	7	4	40	585,949
Hutchinson	21	1	6	--	--	--	28	89,239
Lipscomb	6	5	7	--	1	2	21	187,589
Moore	7	4	2	--	--	1	14	46,748
Ochiltree	14	5	8	3	1	1	32	260,325
Oldham	1	--	1	--	--	2	4	36,091
Parmer	--	--	--	--	--	1	1	8,532
Potter	1	9	1	--	--	1	12	32,084
Roberts	1	--	1	--	3	2	7	72,222
Sherman	--	--	--	--	1	2	3	16,684
Wheeler	1	1	--	--	1	2	5	48,247
Total	93	60	41	3	14	32	243	1,724,986

Source: American Petroleum Institute.

**Table 11.—Texas: Crude petroleum production, indicated demand, and stocks in 1970, by months**

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	End of month stocks originating within State
January.....	105,532	101,690	102,345
February.....	96,005	93,262	105,088
March.....	105,965	105,112	105,941
April.....	102,178	102,041	106,078
May.....	103,310	102,994	106,394
June.....	96,560	97,585	105,369
July.....	97,124	101,870	100,623
August.....	104,439	109,388	95,674
September.....	106,393	100,272	101,795
October.....	112,352	105,364	108,783
November.....	108,886	106,182	111,487
December.....	110,953	112,064	110,376
Total:			
1970..	1,249,697	1,237,824	XX
1969..	1,151,775	1,153,655	XX

XX Not applicable.

The upper gulf coast (RRC District 3) includes 29 counties and three offshore areas, encompassing approximately 25,000 square miles in the southeastern part of the State. Developmental drilling declined to 493 wells, 83 percent of the 1969 total; successful completions also decreased slightly from 76 percent in 1969 to 73 percent in 1970. Decrease in developmental drilling at Esperson dome accounted for much of the overall decline. Wells drilled in areas of salt dome structures continued to dominate the field activity.

The number of exploratory wells drilled decreased from 441 to 402 in 1970, but overall successful completions increased to 30 percent, 7 percent above the 1969 level. The Oligocene was the most actively explored trend, displacing the Eocene, the previous 2-year leader. Three lease sales of State offshore tracts were held. Leases involving a total of 112,674 acres were sold at an average of \$40.21 per acre. The bidding for leases did not indicate widespread interest in the State tracts. Only 22 of the 103 offshore tracts received more than one bid, and only two received as many as three bids.

In east Texas (RRC Districts 5 and 6) drilling activity decreased 22.2 percent from that of 1969. Most exploration and developmental activity centered around the

discovery of deeper pay zones on the Van structure in Van Zandt County. Oil production from the east Texas oilfield increased 36.8 million barrels for a 1970 output of 166.6 million barrels. The increase was attributed to increased allowables. Acreage under lease declined from 3.4 million to 2.7 million acres in 1970 to continue the trend of recent years. One reason for the decline was the sharp drop in new acquisitions because the companies are now more inclined to test a lease and release it rather than maintain it for several years, as was a previous practice.

In south Texas (RRC Districts 1, 2, and 4) a total of 1,758 exploratory and developmental wells were drilled, a decrease of 293 wells (14.3 percent) from 1969. The producing trend associated with the Big Wells field in Dimmit and Zavala Counties was the most active. This new field includes an area more than 14 miles long and 6 miles wide with limits of the field still undefined.

In north-central Texas (RRC Districts 7B and 9), the total number of wells drilled was 1,786, compared with 2,090 in 1969. Exploratory drilling declined from 459 wells in 1969 to 412 in 1970, whereas developmental wells declined 13.9 percent from 1,595 to 1,374. Petroleum production declined 3 percent, a decrease of 2.9 million barrels from 1969. Leasing was confined primarily to the acreage in lease blocks assembled for drilling, and to acreage in the immediate areas of new discoveries.

In west Texas (RRC Districts 7C, 8, and 8A) the Permian basin followed the national pattern of decline in exploration. There was a decrease of 161 in exploratory wells and an increase of 228 in developmental wells compared with 1969. The Delaware basin continued to be active and appeared to have the greatest potential. Leasing was active. At a University of Texas oil and gas sale held on October 8, \$1,407,000 was received for 32,711 acres (average price \$43.01 per acre). The Texas State School Board held three lease sales (April 7, August 4, and December 1) that offered a total of 76 tracts comprising 33,747 acres for which the total bids amounted to \$1,345,168. The average of the top bids was \$39.87 per acre.

Table 12.—Texas: Runs to stills and output of refineries in 1970, by months  
(Thousand 42-gallon barrels)

Month	Runs				Output				Special naphtha	
	Crude	Products	Rerun	Gasoline	Kerosine	Fuel oil		Jet fuel		Miscellaneous
						Distillate	Residual			
January.....	90,271	12,218	-2,089	47,240	3,719	22,966	3,881	6,231	14,877	1,486
February.....	81,045	11,616	-3,864	40,668	3,029	20,720	3,052	6,607	13,410	1,311
March.....	91,506	12,189	-4,935	45,491	3,421	22,146	3,408	7,496	15,261	1,537
April.....	85,032	12,029	-3,481	44,964	2,458	20,217	3,087	7,120	14,170	1,564
May.....	86,870	12,433	-2,669	47,851	2,571	19,451	2,593	6,493	16,087	1,638
June.....	83,302	12,721	-1,804	46,475	2,221	20,602	2,221	6,554	14,138	1,455
July.....	83,358	13,389	-1,168	47,513	2,460	19,869	2,002	7,110	15,165	1,460
August.....	86,908	13,300	-4,873	46,529	2,087	20,401	3,898	7,078	13,846	1,496
September.....	82,883	12,840	-617	45,537	2,318	21,220	3,786	6,501	14,463	1,281
October.....	87,880	13,821	-1,419	48,903	2,799	21,843	3,679	6,912	14,569	1,587
November.....	89,008	13,462	-1,093	48,929	2,941	22,880	4,341	6,442	14,379	1,515
December.....	90,435	14,452	-1,519	52,022	3,021	22,358	5,285	6,469	14,685	1,566
Total: 1970.....	1,088,498	154,470	-27,493	562,122	33,598	254,623	41,233	81,013	174,980	17,896
1969.....	r 1,020,142	147,736	-31,413	534,286	43,138	237,925	40,357	86,681	r 177,500	16,578

r Revised.

Table 13.—Texas: Stocks of refined products held by refining and pipeline companies in 1970, by months  
(Thousand 42-gallon barrels)

Month	Naphthas	Gasoline	Kerosine	Fuel oil		Jet fuel	Miscellaneous products	Total products refined
				Distillate	Residual			
				January.....	2,872			
February.....	2,691	47,525	2,545	12,456	3,982	4,457	37,183	110,800
March.....	2,731	44,215	2,662	11,264	3,415	4,551	39,404	108,242
April.....	2,643	40,709	3,384	12,939	3,480	4,788	40,063	108,006
May.....	2,619	39,198	3,701	13,105	3,666	4,231	40,414	106,935
June.....	2,465	36,405	4,240	13,547	3,291	5,769	39,998	105,715
July.....	2,438	33,167	4,352	16,253	3,446	4,723	38,200	102,579
August.....	2,279	32,178	4,985	20,461	3,747	5,123	39,875	108,598
September.....	2,078	31,419	5,083	23,859	3,322	5,084	38,492	109,287
October.....	2,171	30,830	5,524	25,178	4,183	4,710	37,341	110,046
November.....	2,807	33,568	5,026	27,267	4,633	4,909	37,543	118,352
December.....	2,892	34,607	4,256	21,888	4,286	4,895	36,887	109,211



**Table 14.—Texas: Stocks of crude petroleum at refineries, tank farms, and gathering systems in 1970, as of last day of each month**

(Thousand 42-gallon barrels)

Month	Refineries	Tank farms and pipelines	Lease tanks	Total
January.....	15,638	66,196	5,596	87,430
February.....	16,430	67,844	5,596	89,870
March.....	15,829	67,406	5,452	88,687
April.....	16,705	68,116	5,289	90,110
May.....	18,079	68,495	5,518	92,092
June.....	17,167	68,727	5,340	91,234
July.....	17,103	64,821	5,163	87,087
August.....	15,958	60,588	5,359	81,905
September.....	17,727	65,605	5,378	88,710
October.....	17,857	69,886	5,497	92,740
November.....	19,158	70,744	5,609	95,511
December.....	17,510	71,966	5,310	94,786

In the Panhandle (RRC District 10), drilling occurred in 19 of the 26 counties. The number of exploratory tests decreased 19 percent from the previous year and footage drilled declined 12 percent. Relatively brisk leasing activity occurred in the deeper portions of the Anadarko basin, and local flurries of infill leasing occurred around isolated planned wildcat locations. In general, short-term lease bonus prices remained at 1969 levels.

The Texas RRC held hearings, September 9, 1970, concerning Mobil Oil Corp's plan for a 400,000-b/d maximum efficient rate (MER) for the east Texas field with the increase allocated among prorated wells on a basis "reasonable proportionate to present well allowables." New discoveries, confirmations, and developmental drilling continued throughout the Smackover Jurassic trend area in the east Texas district.

Slocum field in east Texas which, over the years, has not responded to large-scale recovery operations responded favorably to oil recovery techniques in a thermal-recovery project. Injection of steam and hot water into a water zone underlying and in contact with the oil zone proved successful after 3 years of full-scale operation. As the steam moves horizontally through the water layer, it rises vertically into the oil layer and displaces oil that has been heated and mobilized. The oil then falls in a countercurrent direction, saturates the underlying water sand, and is swept toward the producing wells.

A computer-controlled system was installed at the Mobil Oil Corp, Pegasus

field, 22 miles southwest of Midland. The system controls 351 wells, including 40 injection wells, gathers operating data, checks status of many functions, and then takes actions automatically and unattended.

Crude petroleum stocks at refineries, tank farms, and gathering systems at yearend totaled 94,786,000 barrels, up 10.4 percent from 1969. Refinery stocks were 17,510,000 barrels, 18.5 percent of the U.S. total. Stocks at tank farms and in pipelines were 71,966,000 barrels, and on-lease stocks were 5,310,000 barrels. Refinery stocks were 15.6 percent more than at the end of 1969. Tank farms and pipeline stocks increased 10.9 percent and on-lease stocks declined 8.3 percent.

Crude oil refinery receipts rose 2.2 percent to 1,041,094,000 barrels (29.8 percent of U.S. total). Intrastate receipts accounted for 76.3 percent of the Texas refinery receipts.

Capacity of the 43 active oil refineries was 3,469,750 b/sd (barrels per stream-day) an increase of 2.2 percent above the 1969 level, according to The Oil and Gas Journal. Texas refineries at yearend contained approximately 27 percent of the U.S. refinery capacity, identical to the previous year's level.

Expansion projects accounted for the increase in refining capacity. Coastal State Petrochemical Co. at Corpus Christi added a 20,000-b/sd platformer and a 20,000-b/sd catalytic hydrotreater. Diamond Shamrock Oil and Gas at Sunray added 7,500 b/sd crude distillation, 2,500 b/sd vacuum capacity, and 150 b/sd straightrun asphalt units. Shell Oil Co. at Deer Park opened a 160,000-b/sd crude distillation unit and a 46,500-b/sd naphtha-hydrotreating unit.

Texaco, Inc., at Port Arthur increased crude distillation capacity from 310,000 to 390,000 b/sd, including a 130,000-b/sd vacuum pipe still, a 15,000-b/sd hydrocracker, and a 25,000-b/sd hydrotreating unit. American Oil Co. was expanding its Texas City refinery to include a 500-t/d delayed coking unit, a 80,000-b/sd crude distillation unit, and a 45,000-b/sd ultraforming unit.

**Petrochemicals.**—Much of the U.S. petrochemical industry is concentrated along the Texas gulf coast. Amoco Chemical Corp. at Alvin added a 100-million-pound-per-year polyethylene plant and continued work on a 150-million-pound-per-year polypropylene

facility. Avisum Corp. at Houston completed a 150-million-pound-per-year polypropylene plant. Celanese Chemical Co. at Bishop placed on stream a 200-million-pound-per-year cumene expansion. Diamond Shamrock Oil and Gas Co. at Deer Park expanded polypropylene capacity to 90 million pounds per year. The Dow Chemical Co. at Freeport completed a 10-million-pound-per-year 2-hydroxyethyl acrylate and hydropropyl acrylate monomers unit. Gulf Oil Corp. at Port Arthur added a 300-million-pound-per-year cumene unit.

Monsanto Co. at Alvin increased the phenol plant capacity by 275 million pounds per year, raising the total capacity to 400 million pounds per year. Monsanto Co. was constructing a 1.3-billion-pounds per year styrene monomer plant at Texas City, incorporating improved technology in the alkylation, distillation, and dehydrogenation phases. The company plans to phase out an existing 800-million pound per-year operation at the site when the new installation begins operations.

Phillips Petroleum Co. at Houston built an 80-million-pound-per-year polypropylene plant. Rohn & Hass at Deer Park completed a 400-million-pound-per-year methyl methacrylate monomer plant.

Shell Chemical Co. at Deer Park continued construction on a 1-billion-pound-per-year ethylene unit. A butadiene unit and a 30-million-pound-per-year epoxy resins unit were completed. Two 150-ton-per-day sulfur recovery units and a 1,000-ton-per-day vinyl chloride monomer unit are scheduled for completion in 1971. Upon completion, this plant will be one of the largest olefin-producing units in the world. The plant will add approximately 10 percent to the total U.S. ethylene production capacity.

### NONMETALS

Value of nonmetals produced in Texas during 1970 was \$396 million, a decline of 1.3 percent from that of the previous year. Nonmetals constituted 6.2 percent of the total mineral production value in Texas.

Output of lime and of salt set new record highs. Production increases also were registered for sand and gravel, sulfur, and talc and soapstone. Declines were noted in production of portland cement, graphite, gypsum, magnesium compounds, natural sodium sulfate, and stone. Total clay out-

put also was down, resulting from lower production levels of bentonite, common clay, and fire clay. Tonnages of ball clay, fuller's earth, and kaolin, however, were higher for the year.

Reflecting the increased rise in prices that was experienced in many sectors of the Nation's economy, total values of several of the nonmetals produced or processed in Texas during 1970 showed sharp increases.

**Barite.**—No production of crude barite in the State was reported during 1970. Grinding plants located in Brownsville, Corpus Christi, and Houston processed barite that was mined outside of Texas, including imports from Mexico. Duty on imported barite was reduced during recent years—in 1970, tariff on crude barite was \$1.78 per long ton. Most of the barite processed in Texas was used as a weighting agent in drilling muds. Output of ground barite increased 14 percent.

**Bromine.**—With the closing of the Freeport bromine plant of Ethyl-Dow Chemical Co., during 1969, production of bromine ceased in Texas.

**Cement.**—Thirteen companies produced portland cement at 18 plants in Texas during 1970. Seventeen of the plants shipped masonry cement; one of these plants had facilities for producing both white and gray cement. Texas plants had a combined capacity of 47.4 million barrels of portland and masonry cement and operated at 73 percent of capacity. Following a national trend, shipments of gray and white portland cement decreased during the year. Shipments were down 6 percent; total value increased 4 percent. Average mill value per barrel was \$3.62, compared with \$3.27 in 1969. Shipments of masonry cement also were down, a drop of 9 percent for the year.

Cement production capacity in Texas was increased as Gifford-Hill & Co., Inc., completed a \$6.4 million expansion program. Capacity of the company's plant at Midlothian in Ellis County was doubled to 3 million barrels of portland cement per year. Added to the plant were a 12- by 450-foot kiln, a 1,250-horsepower wet raw-grinding mill, and a 2,250-horsepower finish mill. Dust-control facilities at the plant also were improved.

**Table 15.—Texas: Portland cement salient statistics**

(Thousand 376-pound barrels and thousand dollars)

	1969	1970
Number of active plants.....	18	18
Production.....	35,823	34,584
Shipments from mills:		
Quantity.....	36,037	33,967
Value.....	\$117,989	\$122,960
Stocks at mills, Dec. 31.....	2,740	2,827

Several acquisitions occurred during 1970. Centex Corp. of Dallas (parent company of Centex Cement Corp. of Corpus Christi) purchased Construction Chemicals, Inc., of Austin, a manufacturer of curing and acid-retardant admixtures that improve strength, quality, and hardening rate of concrete. Southdown, Inc., of Houston acquired Southwestern Portland Cement Co., which retained its name and continued, as a subsidiary, to operate cement plants in Amarillo, El Paso, and Odessa, and in cities of other States.

**Clays.**—Clays produced in Texas during 1970 included ball clay, bentonite, common clay and shale, fire clay, fuller's earth, and kaolin. Total clay production was down 6 percent, but total value was up 11 percent for the year. Increased output was registered for ball clay, fuller's earth, and kaolin; output of other clays declined.

Fifty-three clay producers reported production from 109 mines in 44 Texas counties during 1970. Common clay and shale constituted 86 percent of the total production and 52 percent of the total value. They were used to prepare products such as building brick, floor and wall tile, drain tile, pottery, sewer pipe, cement, and lightweight aggregate.

A number of Texas clay producers improved their facilities during the year. Ab-

ilene Brick Co. modernized its brick plant at Abilene with the installation of a \$250,000 kiln. Baroid Division of National Lead Co., a producer of bentonite in Fayette County, completed construction of a \$4 million mineral synthesis facility at its Wallisville Road plant in Houston. Dresser Industries, Inc., whose Dresser Minerals Division produces bentonite and kaolin in Texas, began construction of two new buildings at the Dresser Center in Houston; with completion scheduled for 1971, the \$2.9-million expansion program was designed to add 88,000 square feet to the facilities there. Teague Brick and Tile Co., Division of LRB Enterprises, continued a \$1.3 million program to improve and expand its facilities at Teague in Freestone County. Company plans called for modernization of the plant and for construction of an adjacent new plant for the manufacture of a unique kind of brick.

Several clay-producing companies changed ownership during the year. Georgia Kaolin Co., of Elizabeth, N.J., purchased Bennett-Clark Co., Inc., a producer of bentonite in Angelina County. In another change of ownership, Terra Firma Tile Co., Inc., of Houston purchased the plant and clay pit of Cisco Pottery, Inc., a manufacturer of flower pots at Cisco in Eastland County since the 1940's. Following the acquisition, Terra Firma Tile Co. moved its ceramic floor and wall tile manufacturing operation from Houston to Cisco.

**Fluorspar.**—No fluorspar was mined in the State, but several plants in Texas processed material brought in from Mexico. Framspar, Inc., prepared metallurgical and acid-grade fluorspar in Alpine; Delhi Foundry and Sand Co., Oglebay-Norton Corp., and Pennwalt Corp. made fluorspar

**Table 16.—Texas: Clays sold or used by producers, by kinds**

(Thousand short tons and thousand dollars)

Year	Bentonite		Fire clay		Miscellaneous clay		Total <sup>1</sup>	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1966.....	107	\$876	859	\$2,057	3,523	\$3,934	4,516	\$7,187
1967.....	97	660	748	1,862	3,598	4,882	4,497	8,081
1968.....	92	611	766	1,988	3,756	5,338	4,687	8,860
1969.....	100	655	635	1,669	3,593	5,402	4,407	8,664
1970.....	74	339	351	1,334	3,550	4,945	4,148	9,587

<sup>1</sup> Includes ball, kaolin, and fuller's earth.

pellets for the steel industry in Brownsville plants. In Eagle Pass, Reynolds Mining Co. (a subsidiary of Reynolds Metals Co.) operated a fluorspar processing and refining facility. Processors of fluorspar in Marathon included Bailey Fluorspar Co. and The Dow Chemical Co.

A worldwide shortage of fluorspar resulted in increased exploration for deposits of the mineral in western Texas and central Texas, but no significant discoveries were reported in 1970.

**Gem Stones.**—Although no actual gem stone mines operated in Texas during 1970, dealers and hobbyists collected specimens valued at an estimated \$150,000. The gem stones and rock and mineral specimens included agate, calcite, jasper, cinnabar, fluorite, fossiliferous limestone, opal, petrified wood, tektites, quartz, and topaz.

**Graphite.**—Production of small-flake crystalline graphite at the open pit mine of Southwestern Graphite Co. in western Burnet County was less than that of 1969. The company, which is a subsidiary of The Joseph Dixon Crucible Co., also operates a mill adjacent to the mine site. Graphite is used in foundry mold facings, in refractories such as crucibles, in steel-making to increase the carbon content, and in lead pencils. It is also used as a lubricant and for other purposes.

**Gypsum.**—Eight companies reported production of crude gypsum in Texas during 1970. The output was from open pit mines located in Gillespie County (central Texas), Fisher, Hardeman, and Nolan Counties (northern Texas); and Culberson and Hudspeth Counties (western Texas). Production was down 7 percent for the year, and total value was down 3 percent.

Seventy-one percent of the crude gypsum was calcined for uses that included the

manufacture of wallboard, lath, sheathing, formboard, and plasters. Seven gypsum-calcining plants operated in Dallas, Fisher (2 plants), Hardeman, Harris, and Nolan (2 plants) Counties. Uncalcined gypsum was used as brewers' fixe, portland cement retarder, and soil conditioner.

**Lime.**—Tonnage of lime that was sold or used by Texas lime producers increased only slightly during 1970, but the amount was an alltime high for the State. Tonnage was up 2 percent with an increase of 10 percent in total value.

As in previous years, principal use of the lime was for soil stabilization in the construction of airports, roads, parking lots, and building foundations. Lime also was used in water purification, paper and pulp manufacture, petrochemical feedstocks, preparation of alkalis, sugar and petroleum refining, treatment of sewage and industrial wastes, metallurgical processes, and for other purposes. Texas users consumed 97 percent of the State's lime output; the remaining 3 percent was sent to other States.

The lime was prepared by 11 companies at 14 plants in Texas. Seven of the plants operated on the Gulf Coast in Brazoria, Calhoun, Harris (3 plants), Jasper, and Nueces Counties. In other areas of the State, plants operated in Bexar, Comal, Hill, Johnson (2 plants), Travis, and Williamson Counties. Raw materials were shell, limestone, and dolomite.

Plans were made for the construction of a new lime plant in central Texas. Chemical Limestone Products, Inc., a producer of crushed limestone, announced that a 250-ton-per-day rotary kiln and also hydrating facilities would be installed at the company's quarry site near Clifton in Bosque

Table 17.—Texas: Lime sold or used by producers, by uses

(Short tons)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Construction.....	500,061	\$5,851,459	546,376	\$6,815,703
Water purification.....	74,575	1,069,000	113,677	1,392,018
Paper and pulp.....	95,585	1,609,000	92,205	1,678,248
Steel, open-hearth.....	72,371	800,000	59,975	659,264
Other uses <sup>1</sup> .....	890,721	12,777,263	861,085	13,882,068
Total.....	1,633,313	22,106,722	1,673,318	24,427,301

<sup>1</sup> Includes other chemicals, alkalis, aluminum petrochemicals, electric steel furnaces, petroleum refining, sewage, magnesium metal, sand-lime brick, oil well drilling, insecticides, magnesia from sea water, and sugar refining.

County. Completion of the plant was scheduled for early 1971.

A lime producer in Johnson County, Texas Lime Co., subsidiary of Rangaire Corp., increased the hydrated-lime capacity of its No. 2 plant by approximately 40 percent with the addition of two 10-ton-per-hour hydrators. The plant is located near the company quarry about 12 miles west of Cleburne, Tex.

**Magnesium Compounds.**—In addition to the magnesium chloride that was used to produce magnesium metal, The Dow Chemical Co. prepared magnesium compounds that included magnesium hydroxide and caustic-calcined magnesia. The compounds were extracted from raw sea water of the Gulf of Mexico at the company's Freeport plants in Brazoria County. Production was down for the year.

Two other companies with plants at Freeport, A. P. Green Refractories Co. and E. J. Lavino & Co., used magnesium hydroxide obtained from The Dow Chemical Co. to prepare magnesium oxide (refractory magnesia). In western Texas, American Magnesium Co. extracted magnesium chloride from well brines at a plant southwest of Snyder in Scurry County for use in producing magnesium metal.

Magnesium compounds were consumed by the chemical, sugar, paper, rayon, fertilizer, rubber, ceramic, and petroleum industries; they also were used in the preparation of oxychloride and oxysulfate cements and in refractories. The use for caustic-calcined or light-burned magnesia in air-pollution-control applications continued to grow. The compound is used as a fuel additive and also in removing sulfur dioxide from stack gases.

**Natural Sodium Sulfate.**—One producer, Ozark-Mahoning Co., obtained sodium sulfate brines from shallow wells in alkalilake beds in Gaines, Terry, and Ward Counties of western Texas. The company processed the brines at plants located near Brownfield, Monahans, and Seagraves to obtain salt cake, which is used in making kraft paper, detergents, glass, dyes, chemicals, and other products. Output and total value were down for the year.

**Perlite.**—No mined production of perlite in Texas was reported during 1970. Crude perlite mined outside the State was expanded by seven companies at seven plants

located in Dallas, Fort Worth, Irving, La-Porte, Midland, Tomball, and Sweetwater. Output from the plants was up 32 percent for the year; total value was up 61 percent. The expanded perlite was used as concrete aggregate, filter aid, horticultural aggregate, low-temperature insulation, masonry and cavity-fill insulation, and plaster aggregate and in preparing insulation board.

**Pumicite (Volcanic Ash).**—The only reported output of pumicite in Texas during 1970 was from the plant of Nordmeyer, Inc. The pumicite, obtained from an open pit mine located near Rio Grande City in Starr County, was prepared for use as an admixture in concrete and as an insecticide carrier. Production and total value during 1970 were virtually the same as in 1969.

**Salt (Sodium Chloride).**—The production of salt in Texas again set a record high. Total production, comprising brine, rock salt, and evaporated salt, was up 10 percent; total value was up 5 percent. Texas was the Nation's second leading salt-producing State, supplying approximately 22 percent of the total domestic output.

Nine companies reported production of salt in Texas during 1970. Most of the salt was produced as brine, which was obtained from wells drilled into underground salt domes in Brazoria, Chambers, Duvall, Harris, Jefferson, and Matagorda Counties on the Texas gulf coast and into Permian salt beds in Hutchinson, Ward, and Yoakum Counties on the Texas High Plains and in western Texas. Production and total value of brine increased in 1970. The brine was used for chemical purposes that included the manufacture of chlorine, caustic soda (sodium hydroxide), and soda ash (sodium carbonate).

Rock salt and evaporated salt were produced by two companies. In east Texas, Morton Salt Co. obtained rock salt and evaporated salt from Grand Saline salt dome in Van Zandt County. On the Texas gulf coast, United Salt Corp. mined rock salt at Hockley salt dome in Harris County and prepared evaporated salt in Fort Bend County. Production of rock salt declined, and production of evaporated salt increased during the year.

**Sand and Gravel.**—Total production of sand and gravel in Texas during 1970 was

up 5 percent from that of 1969, with total value up 17 percent. The output, however, was 11 percent less than the record high that was reached in 1959 when 35.3 million short tons was produced.

Production was reported in 100 Texas counties by 153 commercial and 101 non-commercial (Government-and-contractor) operations. Colorado County led in the total amount of sand and gravel produced in the State during 1970, followed in order of output by Dallas, Tarrant, Wharton, and McCulloch Counties.

Commercial operations accounted for 87 percent of the total production, most of which was used for building, paving, fill, and other construction purposes. Industrial sands were obtained from pits in Bexar, Colorado, Hardin, Liberty, Limestone, McCulloch, Somervell, and Wood Counties. They included abrasive, blast, enamel, engine, filtration, foundry, glass, hydraulic-fracturing, molding, and pottery sands. Commercial sand operations accounted for 44 percent of the total sand and gravel

output in the State during 1970 and 43 percent of the total value.

Two companies announced in 1970 that they would construct new sand and gravel plants in Colorado County. Superior Sand & Gravel Co. of Eagle Lake planned a \$1.2 million operation at which 25 persons would be employed. Thorstenberg Materials Co., Inc., of Houston planned to build a facility near Texas Highway 71, between Altair and Garwood, capable of producing 750 short tons of sand and gravel each hour. Completion of the new plant was to be followed by the phasing-out of production at the company's Jayray, Ramsey, and Skull Creek operations in Colorado County.

**Stone.**—Texas ranked fourth among the States in stone output. Producers quarried and processed basalt, caliche, dolomite, granite, graphitic schist, limestone, marble, quartz, quartzite, rhyolite, and sandstone during 1970. In addition, shell was dredged from shallow bays along the gulf coast. Texas stone production, including

**Table 18.—Texas: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building.....	6,102	\$6,151	8,886	\$10,894
Fill.....	927	624	314	234
Paving.....	4,141	4,742	2,080	2,426
Other uses <sup>1</sup> .....	1,121	4,765	2,409	6,269
Total <sup>2</sup> .....	12,292	16,283	13,689	19,824
Gravel:				
Building.....	5,488	7,981	8,840	15,391
Fill.....	280	162	252	180
Paving.....	5,728	8,056	3,196	4,507
Other uses <sup>3</sup> .....	439	640	1,489	2,350
Total <sup>2</sup> .....	11,935	16,839	13,776	22,428
<b>Government-and-contractor operations:</b>				
Sand:				
Building.....	8	9	20	2
Fill.....			3	( <sup>4</sup> )
Paving.....	1,205	1,435	605	704
Total <sup>2</sup> .....	1,214	1,444	628	707
Gravel:				
Building.....	3	4	52	42
Fill.....	12	6		
Paving.....	4,515	5,179	3,294	3,361
Total <sup>2</sup> .....	4,531	5,189	3,346	3,403
Total sand and gravel <sup>2</sup> .....	29,972	39,756	31,438	46,362

<sup>1</sup> Includes abrasives, blast, enamel (1970), chemical (1969), fire or furnace (1969), filtration, fill, foundry glass, oil (hydraulic), molding, pottery, and other sand.

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

<sup>3</sup> Includes miscellaneous and other gravel.

<sup>4</sup> Less than ½ unit.

shell, totaled 45.6 million short tons, a decrease of 2 percent for the year. Total value was down slightly—less than 1 percent. Over 77 percent of the stone produced in Texas during 1970 consisted of crushed and dimension limestone.

Several stone producers either added to their facilities or announced expansion plans in 1970. Heldenfels Brothers, Contractors, who quarry caliche in Bee, Hidalgo, and San Patricio Counties, were constructing a new asphalt plant at Mathis in San Patricio County. Gifford-Hill & Co., Inc., announced plans to double the capacity of the limestone-crushing plant at Bridgeport in Wise County by the construction of a new \$4 million unit equipped with devices to control air pollution. Texas Crushed Stone Co., producer of crushed limestone at a quarry south of Georgetown in Williamson County, put into operation a new automated rock-crushing plant with a capacity of 1,400 tons per hour.

**Sulfur.**—Texas was second among the States in amount of Frasch sulfur sold during 1970. Five producers, using the Frasch method of mining, obtained the native sulfur in molten form through wells drilled into the caprock of salt domes in Fort Bend, Galveston, Jefferson, Liberty, Matagorda, and Wharton Counties along the Texas gulf coast and into subsurface Permian strata in Culberson and Pecos Counties in western Texas. Eight of the operations were along the gulf coast; three were in west Texas.

Production from the Frasch mines increased 5 percent during 1970, but only 81

percent of the output was sold, resulting in increased producer inventories. Nevertheless, the sales, which totaled 2.8 million long tons, were up almost 10 percent for the year. They were the highest since 1967, when 3.45 million long tons was sold. Total value of 1970 sales (shipments, f.o.b. mine plant) from Texas operations, however, was down almost 9 percent compared with the 1969 value. Average value in 1970 was \$22.24 per long ton; actual price of domestic Frasch sulfur (f.o.b. vessel at Gulf ports) was an estimated \$18 per long ton.

Several producers closed their Frasch operations in Texas during 1970. Duval Corp., subsidiary of Pennzoil United, Inc., shut down two sulfur facilities. One, located north of Fort Stockton in Pecos County, was closed in July; the other, located west of Rosenberg at Orchard salt dome in Fort Bend County, was closed in October. (Production continued, however, at Duval's large Frasch sulfur operation in Culberson County.) At the end of the year, Texas Gulf Sulphur Co. ceased sulfur production at Gulf salt dome located north of Matagorda in Matagorda County, sulfur had been obtained intermittently at the facility since 1919, with the latest period of operation initiated in 1965. Also closed during 1970 was the Rock House plant of Elcor Chemical Corp., located in Culberson County, about 40 miles northeast of Van Horn. The Elcor facility had been planned for the extraction of elemental sulfur from gypsum, which is abundant in the area.

One of the State's sulfur producers, Pan-American Petroleum, subsidiary of Standard Oil Co. of Indiana, announced

Table 19.—Texas: Stone sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Kind of stone	1969		1970	
	Quantity	Value	Quantity	Value
Dimension stone—total.....	65	\$2,430	29	\$1,850
Crushed and broken:				
Limestone.....	35,259	48,452	35,229	49,673
Sandstone, quartz and quartzite.....	1,243	2,101	2,166	3,583
Shell.....	7,177	8,558	W	W
Other stone <sup>1</sup> .....	2,894	3,445	8,133	9,316
Total crushed.....	46,573	62,556	45,528	62,572
Grand total.....	46,638	64,986	45,557	64,422

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

<sup>1</sup> Includes dolomite, granite, marble, marl, quartzite (1969), and trap rock.

that the company name would be changed early in 1971 to Amoco Production Co. The company's Frasch sulfur facility is at High Island salt dome in Galveston County.

In addition to the native sulfur obtained by the Frasch process, sulfur also was extracted from sour gas and oil in Texas—the State led the Nation during 1970 in shipments of recovered sulfur. (Statistics of recovered sulfur are not included in table 1.) Shipments in 1970 from 46 sulfur-recovery plants located in 24 Texas counties totaled 769,689 long tons, an increase of 6 percent for the year. Total value of the shipments was \$13,633,141, down 31 percent for the year. The average price was \$17.71 per long ton, compared with \$27.18 in 1969 and \$39.47 in 1968.

The depressed price of all sulfur was due, in part, to the large amount of cheap sulfur, recovered from sour gas, that continued to enter the market from western Canada. Even so, sulfur consumption in the free world increased during 1970, and demand is expected to grow during the coming years. Most of the 1970 output was used to prepare sulfuric acid for fertilizer production.

Potential new sources of sulfur were developing as a result of the Nation's efforts to reduce air pollution. For example, American Smelting and Refining Co. (Asarco) announced plans to construct a facility for the recovery of sulfur from the SO<sub>2</sub> contained in smoke emissions at the company's copper-lead-zinc refinery at El Paso. Estimated cost of the plant, designed to produce 450 tons of sulfur acid per day, was \$15 million.

Table 20.—Texas: Sulfur produced and shipped from Frasch mines

(Thousand long tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value <sup>1</sup>
1966	2,916	3,703	\$96,820
1967	2,956	3,448	111,931
1968	3,203	2,571	105,482
1969	3,289	2,552	68,360
1970	3,446	2,801	62,290

<sup>1</sup> F.o.b. mine plant.

**Talc and Soapstone.**—Production of talc centered in west Texas, where five companies reported output from eight mines in the Allamoore district of Hudspeth County. One of the producers, Pioneer

Talc Co., operated a talc-grinding mill in the area. Another producer of talc in west Texas, United Sierra division of Cyprus Mines Corp., also reported production of soapstone from two mines in central Texas. One of the mines is located in Llano County; the other is in Gillespie County. The company's grinding mill at Llano was shut down during the year because of inadequate dust-control facilities.

In 1970, total mined production of talc and soapstone in Texas increased 5 percent. Total value was up 31 percent for the year. Average value of the crude mined material was \$5.54 per long ton; average value after grinding was \$20.18. The talc and soapstone were used in the preparation of ceramic wall tile, roofing material, insecticides, paint, rubber, and plastics.

**Vermiculite.**—No production of crude vermiculite in Texas was reported in 1970. The State's only vermiculite mine, located in Llano County, was closed during the year. The vermiculite exfoliating plant in Llano also ceased operation.

Vermiculite, mined outside Texas, was processed at exfoliating plants located in Dallas, Houston, and San Antonio. The expanded material was used for concrete and plaster aggregates, for insulation, and for other purposes.

## METALS

Metal mining continued to have a minor role in the State's mineral economy in 1970. Although the total value of the metals produced during the year rose to \$54 million, compared with \$43 million in 1969, it accounted for less than 1 percent of the State's total mineral value.

The metals mined during the year continued to be iron ore, mercury, and uranium; magnesium metal was recovered by chemical methods from sea water and underground brines. Developments pertaining to uranium highlighted the metal mining sector.

During the year, several plants increased or were increasing their capacities. The metal industries were among the many industries in the Corpus Christi area that suffered heavy losses in August from Hurricane Celia.

**Aluminum.**—In August, the Reynolds Metals Co.'s 1,185,000-ton-per-year alumina refinery at Sherwin and 111,000-ton-per-



year reduction plant at San Patricio were damaged by Hurricane Celia. Insured losses totaled about \$13 million; \$7 million was for plant damage and \$6 million was for business interruption. Part of the alumina refinery and one of the two potlines at the reduction plant were restarted in about a month. Both facilities were in full production by yearend. Production losses due to the hurricane were estimated at more than 100,000 tons of alumina and almost 30,000 tons of metal. The alumina refinery accounts for about 85 percent of the company's domestic alumina output, and the reduction plant for about 12 percent of its primary aluminum production capacity.

The alumina refinery of Aluminum Co. of America at Point Comfort was being expanded from 900,000 tons to 1,080,000 tons per year. The unit, which will be the refinery's fifth, is expected to begin operation in 1971.

**Copper.**—During the year, Phelps Dodge Refining Corp. began expanding its copper refinery at El Paso, the largest in the world. The expansion program includes building a new plant to replace the existing facilities for making copper sulfate from the electrolyte solutions used in the tankhouse, and for recovering copper from the slimes that accumulate in the bottom of the tanks. The plant is expected to be in operation by early 1972. The company's copper rodmill, which began operation in 1969, reached full production in 1970.

In a joint venture, Asarco and Phelps Dodge Refining Corp. are to test a new process for converting sulfur dioxide in smelter stack gases to elemental sulfur. Asarco began building a 20-ton-per-day pilot plant at its El Paso smelter. The plant, which will cost about \$2.5 million, is expected to be completed in mid-1971. In September, Asarco announced plans to build a 500-ton-per-day sulfuric acid plant at the smelter at a cost of about \$15 million. By recovering a large amount of the sulfur dioxide produced in the copper smelting operations, the plant will help reduce emissions of the gas into the atmosphere. Asarco has established a department of environmental services at its smelter to study meteorological conditions in order to reduce or prevent pollution by the smelter stack emissions. Asarco's smelter operations were curtailed during the year to

control atmospheric pollution by sulfur dioxide.

**Iron Ore.**—In December, Armco Steel Corp. began constructing a 1,000-ton-per-day direct reduction plant at its facilities in Houston. The plant will use natural gas to refine iron ore into material that can be charged into steelmaking furnaces. Scheduled to begin operation in 1972, the plant will make Armco the first major steelmaker to operate its own direct reduction plant. An operating staff of about 300 will be needed. The company's eight open hearth furnaces at the Houston facilities were shut down in May, a year ahead of schedule, to eliminate a source of air pollution. They were replaced by electric furnaces.

United States Steel Corp. was constructing a steel plant at Cedar Point, near Baytown. A 160-inch plate mill began operation during the year. Two 200-ton electric furnaces, vacuum degassing equipment, and a continuous single-strand slab caster are scheduled to be completed in 1971. When the plant is fully operational, the labor force is expected to rise from about 650 at the end of 1970 to as much as 1,300.

**Magnesium.**—The Dow Chemical Co.'s 30,000-ton-per-year addition to its primary magnesium plant at Freeport was completed in January. It raises the company's total capacity to 120,000 tons per year.

**Mercury.**—Early in 1970, the Study Butte mine of Diamond Shamrock Corp. was shut down. The company produced more than 1,000 flasks of mercury in 1969. Mineral Industries, Inc., purchased the Study Butte property from Diamond Shamrock Corp. and reopened the mine in July 1970.

Late in 1970, the Anchor Co. began developing a new mine, the Whit-Roy, in Presidio County. About 138 tons of ore were mined. A furnace and retort were under construction.

**Tin.**—Gulf chemical and Metallurgical Corp. Texas City, signed a contract with Corporación Minera de Bolivia (COMIBOL) to smelt and refine 15,000 tons of Bolivian tin concentrates and produce 7,000 tons of fine electrolytic tin.

**Uranium.**—According to the U.S. Atomic Energy Commission, uranium reserves in Texas totaled 6,622,323 tons of ore averaging 0.16 percent  $U_3O_8$  and based on an

Table 21.—Texas: Smelters, refineries, and reduction plants in 1970

Product, company, and plant	Location (county)	Material treated
<b>Aluminum:</b>		
Aluminum Company of America:		
Point Comfort (alumina).....	Calhoun.....	Bauxite.
Point Comfort (reduction).....	do.....	Alumina.
Rockdale (reduction).....	Milam.....	Do.
Reynolds Metals Co.:		
Sherwin Works (alumina).....	San Patricio.....	Bauxite.
San Patricio (reduction).....	do.....	Alumina.
Antimony: National Lead Co.: Laredo smelter.....		
Cadmium: American Smelting & Refining Co.: Electrolytic.....	Webb.....	Ore.
	Nueces.....	Flue dust.
<b>Copper:</b>		
American Smelting & Refining Co.: El Paso smelter.....	El Paso.....	Ore and concentrates.
Phelps Dodge Refining Corp.: Nichols refinery..	do.....	Blister and anode.
<b>Iron:</b>		
Lone Star Steel Co.: Daingerfield plant.....	Morris.....	Ore and scrap.
Armco Steel Corp.: Houston plant.....	Harris.....	Do.
Lead: American Smelting & Refining Co.: El Paso smelter.....	El Paso.....	Ore and concentrates.
<b>Magnesium:</b>		
American Magnesium Co.: Snyder plant, Electrolytic.....	Scurry.....	Brine
The Dow Chemical Co.: Freeport plants, Electrolytic.....	Brazoria.....	Sea water.
<b>Manganese: Tenn-Tex Alloy Chemical Corp.....</b>		
Tin-tungsten: Gulf Chemical & Metallurgical Corp.: Texas City smelter.....	Harris.....	Ore.
	Galveston.....	Do.
<b>Zinc:</b>		
American Smelting & Refining Co.:		
Amarillo retort smelter.....	Potter.....	Ore and concentrates.
Corpus Christi electrolytic.....	Nueces.....	Do.
El Paso fuming plant.....	El Paso.....	Dusts and residues.
American Zinc Co.: Dumas retort smelter.....	Moore.....	Concentrates and fumes.

Table 22.—Texas: Secondary metal recovery plants

County and company	Material	Products
<b>Dallas:</b>		
ABASCO, Inc.....	Aluminum scrap.....	Aluminum ingots, dioxidizing bars and shot.
American Smelting and Refining Co.	Lead and zinc scrap..	Lead and zinc ingots, pigs, alloys.
Dixie Lead Co.....	Lead scrap.....	Lead pigs, alloys, chemicals.
National Lead Co., Southwestern Branch.....	Battery plates.....	Lead products.
Southern Lead Co.....	do.....	Lead pigs, alloys.
El Paso: Border Steel Mills, Inc.....	Steel scrap.....	Steel shapes, reinforcing bars.
Gregg: R. G. LeTourneau, Inc.....	do.....	Heavy mobile equipment.
Guadalupe: Structural Metals, Inc.....	do.....	Structural steel reinforcing bars.
<b>Harris:</b>		
A & B Metal & Smelting Co.....	Aluminum, lead scrap..	Lead pigs, ingots, aluminum ingots, alloys.
Federated Metals.....	Various metals.....	Lead products, alloys of copper, lead, zinc, magnesium, tin.
Gulf Reduction Corp.....	Aluminum, zinc scrap..	Aluminum and zinc ingots, alloys.
Houston Lead Co.....	Lead scrap.....	Lead pigs, ingots, alloys.
Houston Fishing Tackle Co.....	Soft lead scrap.....	Lead products.
Lead Products, Inc.....	Lead scrap.....	Lead pigs, ingots, alloys.
Magnus Metal.....	Various metal scrap..	Lead, brass, bronze bearing metal.
Southwest Saw Corp.....	Steel scrap.....	Steel alloys.
Sterling Type, Rule, & Metals Co.....	Type metal.....	Type metal.
Valcan Detinning Co.....	Tinned scrap.....	Refined tin, baled detinned steel.
<b>Tarrant:</b>		
National Metal & Smelting Co.....	Battery lead and aluminum scrap.....	Lead pigs, ingots, battery metal, aluminum ingots.
Texas Steel Co.....	Steel scrap.....	Carbon and alloy steel bars and shapes, reinforcing bars.

\$8-per-pound price. They ranked third in the country, up from fourth place in 1969. Although drilling footage declined to 6,075,000 feet in 1970 from 6,411,708 feet in 1969, Texas continued to rank second in drilling for uranium in the United

States. Its share of the total footage was 25.8 percent, compared with 21.5 percent in 1969. In mid-1970, 22 drilling rigs and 10 logging units were operating along the uranium trend from Fayette to Starr County, a distance of over 250 miles. Ap-

proximately 1.1 million acres were under lease at yearend. About 18 major companies and numerous independent operators were involved in leasing activities.

Continental Oil Company (Conoco) and Pioneer Nuclear Corp. began work on a \$12 million joint venture to mine uranium and build a 1,750-ton-per-day processing mill about 8 miles southwest of Falls City, Karnes County. Conoco will operate the project, which is called the Conquista project. Ore will be mined by open pit methods within a radius of about 35 miles from the plant and be hauled by truck. Mining operations are scheduled to begin during the latter half of 1971. Production is planned for 1972 at an initial rate of 1.5 million pounds per year of uranium concentrate. More than two-thirds of the total output is committed for processing into nuclear fuel elements for use in generating electric power.<sup>4</sup> The entire project will require a labor force of about 125.

The new 1,000-ton-per-day uranium mill

of Susquehanna-Western, Inc., began operation at Ray Point in June. The company has another mill of the same capacity at Falls City.

**Zinc.**—The 100,000-ton-per-year electrolytic zinc plant of Asarco, at Corpus Christi, was damaged in August by Hurricane Celia. The damage totaled almost \$500,000. About 2 weeks' production was lost. The plant produces special high-grade zinc, primarily for use in die casting. Fluid-bed roasting facilities were being installed during the year. They are scheduled to be completed early in 1972.

Production from Asarco's retort smelter at Amarillo was reported as slightly below normal for about half the year because of a labor shortage. Studies are underway to find an economical technique to reduce emissions to meet the standards established by the State Air Control Board.

<sup>4</sup> Engineering and Mining Journal. V. 172, No. 3, March 1971, p. 32.

Table 23.—Principal producers

Commodity and company	Address	Type of Activity	County
<b>Asphalt (native):</b>			
Uvalde Rock Asphalt Co.---	P.O. Box 531 San Antonio, Tex. 78206	Mine-----	Uvalde.
White's Uvalde Mines, Inc.---	P.O. Box 499 San Antonio, Tex. 78206	---do-----	Do.
<b>Barite:</b>			
Dresser Minerals-----	P.O. Box 6504 Houston, Tex. 77005	Grinding plant---	Cameron.
The Milwhite Co., Inc.-----	P.O. Box 15038 Houston, Tex. 77020	---do-----	Harris.
National Lead Co.-----	P.O. Box 1675 Houston, Tex. 77001	---do-----	Nueces.
<b>Carbon black:</b>			
Ashland Chemical Co.-----	P.O. Box 1503 Houston, Tex. 77005	Furnace-----	Aransas and Wheeler.
Cabot Corp.-----	125 High St. Boston, Mass. 02110	Channel-----	Carson.
Do-----	do-----	Furnace-----	Gray and Howard.
Columbian Carbon Co.-----	380 Madison Ave. New York, N.Y. 10017	---do-----	Montgomery and Terry.
Do-----	do-----	Channel-----	Gaines.
Continental Carbon Co.-----	P.O. Box 22085 Houston, Tex. 77027	Furnace-----	Moore.
J.M. Huber Corp.-----	P.O. Box 831 Borger, Tex. 79006	---do-----	Harris and Hutchinson.
Phillips Petroleum Co.-----	Bartlesville, Okla. 74003	---do-----	Hutchinson and Orange.
Sid Richardson Carbon & Gasoline Co.	1200 Ft. Worth National Bank Bldg. Ft. Worth, Tex. 76102	Channel-----	Ector.
Do-----	do-----	Furnace-----	Howard.
<b>Cement:</b>			
Alpha Portland Cement Co.--	15 South Third St. Easton, Pa. 18042	Quarry and plant.	Orange.
Capitol Aggregates, Inc.---	Route 13, Box 412 San Antonio, Tex. 78209	Plant-----	Bexar.
Centex Cement Corp.-----	P.O. Box 9294 Corpus Christi, Tex. 78408	Quarry and plant.	Nueces.
General Portland Cement Co.	2800 Republic Bank Tower Dallas, Tex. 75201	---do-----	Dallas, Harris, Tarrant.
Gifford-Hill & Co., Inc.-----	P.O. Box 520 Midlothian, Tex. 76065	---do-----	Ellis.
Gulf Coast Portland Cement Co., Div. of McDonough Co.	P.O. Box 262 Houston, Tex. 77001	---do-----	Harris.

Table 23.—Principal producers—Continued

Commodity and company	Address	Type of Activity	County
<b>Cement—Continued</b>			
Ideal Cement Co., Div. Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	Quarry and plant.	Harris.
Kaiser Cement & Gypsum Corp.	Permanente Rd. Permanente, Calif. 95014	Plant.	Bexar.
Lone Star Cement Corp.	P.O. Box 47327 Dallas, Tex. 75247	Quarry and plant.	Harris and Nolan.
San Antonio Portland Cement Co.	P.O. Box 6925 San Antonio, Tex. 78209	do.	Bexar.
Southwestern Portland Cement Co.	P.O. Box 392 El Paso, Tex. 79943	do.	Ector and El Paso.
Texas Industries, Inc.	P.O. Box 145 Midlothian, Tex. 76065	do.	Ellis.
Universal Atlas Cement Div., United States Steel Corp.	600 Grant St. U.S. Steel Bldg. Pittsburgh, Pa. 15230	do.	McLennan.
<b>Clays and shale:</b>			
Acme Brick Co.	P.O. Box 425 Ft. Worth, Tex. 76101	Mine and plant.	Denton, Guadalupe, Henderson, Nacogdoches, Parker, Wise.
Alpha Portland Cement Co.	15 South Third St. Easton, Pa. 18042	do.	Orange.
Dresser Minerals	P.O. Box 6504 Houston, Tex. 77005	do.	Angelina and Limestone.
Elgin Butler Brick Co.	4000 East Ave. Austin, Tex. 78767	do.	Bastrop.
Featherlite Corp.	P.O. Box 141 Ranger, Tex. 76470	do.	Bexar and Eastland.
General Portland Cement Co.	P.O. Box 2698 Dallas, Tex. 75201	do.	Dallas, Harris, Limestone.
General Refractories Co.	1520 Locust St. Philadelphia, Pa. 19102	do.	Cherokee.
Gulf Coast Portland Cement Co. Div. of McDonough Co.	P.O. Box 262 Houston, Tex. 77001	do.	Chambers.
Henderson Clay Products Co.	P.O. Box 1251 Henderson, Tex. 75652	do.	Rusk.
Ideal Cement Co., Div. of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	do.	Galveston.
Lone Star Cement Corp.	P.O. Box 47327 Dallas, Tex. 75247	do.	Fisher and Harris.
The Milwhite Co., Inc.	P.O. Box 15038 Houston, Tex. 77020	Mine.	Fayette and Walker.
Reliance Clay Products Co.	P.O. Box 20237 Dallas, Tex. 75221	Mine and plant.	Ellis, Palo Pinto, Smith.
Southern Clay Products, Inc.	P.O. Box 44 Gonzales, Tex. 78629	do.	Cherokee and Gonzales.
Texas Clay Products, Inc.	P.O. Box T Malakoff, Tex. 75148	do.	Henderson.
Texas Industries, Inc.	8100 Carpenter Freeway Dallas, Tex. 75247	do.	Dallas, Eastland, Ellis, Fort Bend.
<b>Coal (lignite):</b>			
Atlas Chemical Indust., Inc.	P.O. Box 790 Marshall, Tex. 75670	Strip mine.	Harrison.
Industrial Generating Co.	P.O. Box 1111 Rockdale, Tex. 76567	do.	Milam.
Graphite: Southwestern Graphite Co.	Burnet, Tex. 78611	Mine.	Burnet.
<b>Gypsum:</b>			
The Celotex Corporation	1500 North Dale Mabry Tampa, Fla. 33607	Open pit mine and calcining plant.	Fisher.
The Flintkote Co.	480 Central Ave. East Rutherford, N.J. 07073	do.	Nolan.
Georgia-Pacific Corp.	P.O. Box 311 Portland, Ore. 97207	do.	Hardeman.
National Gypsum Co.	325 Delaware Ave. Buffalo, N.Y. 14202	do.	Fisher.
United States Gypsum Co.	101 South Wacker Dr. Chicago, Ill. 60606	do.	Nolan.
Do.	do.	Plant.	Harris.
<b>Iron ore:</b>			
Lone Star Steel Co.	P.O. Box 12226 Dallas, Tex. 75225	Open pit.	Morris.
Tex-Iron, Inc.	Cushing, Tex. 75760	do.	Nacogdoches.
<b>Lime:</b>			
Aluminum Co. of America	1028 Alcoa Bldg. Pittsburgh, Pa. 15219	Plant.	Calhoun.
Armco Steel Corp.	P.O. Box 1367 Houston, Tex. 77001	do.	Harris.

Table 23.—Principal producers—Continued

Commodity and company	Address	Type of Activity	County
<b>Lime—Continued</b>			
Austin White Lime Co.....	General Delivery McNeil, Tex. 78651	Plant.....	Travis.
Champion Papers, Inc.....	P.O. Box 872 Pasadena, Tex. 77501	...do.....	Harris.
The Dow Chemical Co.....	2020 Dow Center Midland, Mich. 48640	...do.....	Brazoria.
Eastex, Inc.....	P.O. Box 816 Silsbee, Tex. 77656	...do.....	Jasper.
McDonough Bros., Inc.....	Fredericksburg Rd. Route 8, Box 222 San Antonio, Tex. 78228	...do.....	Bexar.
PPG Industries, Inc.....	P.O. Box 4026 Corpus Christi, Tex. 78408	...do.....	Nueces.
Round Rock Lime Co.....	P.O. Box 218 Round Rock, Tex. 78764	...do.....	Hill and Williamson.
Texas Lime Co.....	P.O. Box 851 Cleburne, Tex. 76031	...do.....	Johnson.
United States Gypsum Co....	101 South Wacker Dr. Chicago, Ill. 60606	...do.....	Comal and Harris.
<b>Magnesium compounds:</b>			
The Dow Chemical Co.....	Midland, Mich. 48640	...do.....	Brazoria.
A.P. Green Refractories Co..	Freeport, Tex. 77541	...do.....	Do.
E. J. Lavino & Co.....	Three Penn Center Plaza Philadelphia, Pa. 19102	...do.....	Do.
<b>Mercury:</b>			
Butte Mining Corp.....	P.O. Box 3 Terlingua, Tex. 79852	Mine.....	Brewster and Presidio.
Study Butte Mining Co.....	300 Union Commerce Bldg. Cleveland, Ohio 44115	...do.....	Brewster.
<b>Mica: Western Mica Company, Div. United States Gypsum Co.</b>			
Chicago, Ill. 60606	101 South Wacker Dr.	Plant.....	Tarrant.
<b>Perlite:</b>			
Filter Media, Inc.....	P.O. Box 19156 Houston, Tex. 77024	Expanding plant.....	Harris.
Perlite of Houston, Inc.....	P.O. Box 8386 Houston, Tex. 77004	...do.....	Do.
Perlite Industries, Inc.....	P.O. Box 6216 Midland, Tex. 79701	...do.....	Midland.
Perlite Products Co.....	2651 Manila Dallas, Tex. 75212	...do.....	Dallas.
Sil-Flo Corp.....	3405 North Sylvania Ave. P.O. Box 7086 Ft. Worth, Tex. 76111	...do.....	Tarrant.
Texas Lightweight Products Co.	117 North Britain Rd. Irving, Tex. 75060	...do.....	Dallas.
United States Gypsum Co....	101 South Wacker Dr. Chicago, Ill. 60606	...do.....	Nolan.
<b>Roofing granules: H.B. Reed &amp; Co., Inc.</b>			
Highland, Ind. 46322	8149 Kennedy Ave.	Plant.....	Milam.
<b>Salt:</b>			
Diamond Shamrock Chemical Co.	300 Union Commerce Bldg. Cleveland, Ohio 44115	Brine wells.....	Chambers.
The Dow Chemical Co.....	Midland, Mich. 48640	...do.....	Brazoria.
Montex Chemical Co.....	104 East Third Monahans, Tex. 79756	...do.....	Ward.
Morton Salt Co.....	110 North Wacker Dr. Chicago, Ill. 60606	Underground mine and brine wells.	Van Zandt.
PPG Industries, Inc.....	P.O. Box 4026 Corpus Christi, Tex. 77704	Brine wells.....	Duval.
Phillips Petroleum Co.....	Bartlesville, Okla. 74003	...do.....	Hutchinson.
Texas Brine Corp.....	4614 Montrose Blvd. Houston, Tex. 77006	...do.....	Harris, Jefferson, Matagorda.
United Salt Corp.....	...do.....	Underground mine and brine wells.	Fort Bend and Harris.
Vulcan Materials Co.....	P.O. Box 1060 Denver City, Tex. 79323	Brine wells.....	Yoakum.
<b>Sand and gravel:</b>			
Barrett Industries.....	2718 SW Military Dr. San Antonio, Tex. 78221	Stationary.....	Bexar.
Capitol Aggregates, Inc.....	Route 13, Box 412 San Antonio, Tex. 78209	...do.....	Guadalupe and Travis.
Dresser Minerals.....	Kosse, Tex. 76653	...do.....	Limestone.
The Fordyce Co.....	P.O. Box 1981 San Antonio, Tex. 78206	...do.....	Hidalgo and San Patricio.
Ft. Worth Sand & Gravel Co..	P.O. Box 400 Arlington, Tex. 76010	...do.....	Dallas, Denton, Tarrant.
Gifford-Hill & Co., Inc.....	P.O. Box 47127 Dallas, Tex. 75247	...do.....	Brazos, Dallas, McLennan, Tarrant, Wharton, Wichita.

Table 23.—Principal producers—Continued

Commodity and company	Address	Type of Activity	County
<b>Sand and gravel—Continued</b>			
H & H Materials, Inc.....	3200 Edgar Park El Paso, Tex. 79901	Stationary.....	El Paso.
Heldenfels Bros.....	Box 4957 Corpus Christi, Tex. 78408	.....do.....	Nueces and Victoria.
Horton & Horton.....	P.O. Box 1669 Houston, Tex. 77001	Portable and dredge.	Colorado, Harris, Victoria.
Janes-Prentice, Inc.....	P.O. Box 2155 Austin, Tex. 78767	Stationary.....	Crosby.
Mineral Wells Sand & Gravel, Inc.	Box 788 Mineral Wells, Tex. 76067	.....do.....	Palo Pinto
Neeley Sand & Gravel Inc..	Box 1313 Waco, Tex. 76703	Stationary and dredge.	McLennan.
Panhandle Gravel West, Inc.	P.O. Box 807 Amarillo, Tex. 79105	Stationary.....	Armstrong.
Parker Bros. & Co., Inc.....	P.O. Box 107 Houston, Tex. 77001	Stationary and dredge.	Colorado and Harris.
Texas Construction Materials Co.	P.O. Box 86 Houston, Tex. 77001	Stationary, portable, dredge.	Colorado and Liberty.
Thorstenberg Materials Co..	1435 Bank of the Southwest Bldg. Houston, Tex. 75247	.....do.....	Colorado, Fayette, San Jacinto.
Trinity Concrete Products Co.	P.O. Box 47524 Dallas, Tex. 75247	Stationary.....	Dallas and Johnson.
Wesco-Wamix, Inc.....	105 Empire Center 8383 Stemmons Freeway Dallas, Tex. 75247	.....do.....	Dallas, Denton, Tarrant.
<b>Shell:</b>			
General Dredging Corp.....	P.O. Box 9294 Corpus Christi, Tex. 78408	Dredge.....	Nueces.
Lone Star Cement Corp.....	P.O. Box 86 Houston, Tex. 77001	.....do.....	Calhoun.
Parker Bros. & Co., Inc.....	5303 Navigation Bldg. P.O. Box 107 Houston, Tex. 77001	.....do.....	Do.
<b>Sodium sulfate (natural):</b>			
Ozark-Mahoning Co.....	1870 South Boulder Tulsa, Okla. 74119	Plant.....	Gaines and Terry.
<b>Stone:</b>			
Barrett Industries.....	2718 SW Military Dr. Box 21070 San Antonio, Tex. 78221	Quarry.....	Bexar.
General Portland Cement Co.	2800 Republic Bank Tower Dallas, Tex. 75201	.....do.....	Dallas and Tarrant.
Gifford-Hill & Co., Inc.....	P.O. Box 47127 Dallas, Tex. 75247	.....do.....	Wise.
Lone Star Cement Corp.....	P.O. Box 47327 Dallas, Tex. 75247	.....do.....	Burnet, Calhoun, Nolan, Wise.
McDonough Bros., Inc.....	Fredericksburg Rd. Route 8, Box 222 San Antonio, Tex. 78228	.....do.....	Bexar.
Olmos Rock Products Corp..	P.O. Box 7776 San Antonio, Tex. 78200	.....do.....	Do.
Texas Crushed Stone Co.....	P.O. Box 9345 Austin, Tex. 78717	.....do.....	Llano and Williamson.
Texas Industries, Inc.....	P.O. Box 146 Midlothian, Tex. 76065	.....do.....	Ellis and Wise.
Trinity Concrete Products Co.	P.O. Box 47524 Dallas, Tex. 75247	.....do.....	Johnson and Wise.
White's Mines, Inc.....	P.O. Box 500 Brownwood, Tex. 76801	.....do.....	Brown, Taylor, Uvalde.
<b>Sulfur (native):</b>			
Atlantic Richfield Co.....	P.O. Box 2819 Dallas, Tex. 75221	Frash process...	Pecos.
Duval Corp.....	1906 First City National Bank Bldg. Houston, Tex. 77002	.....do.....	Fort Bend, Culberson, Pecos.
Jefferson Lake Sulphur Co...	P.O. Box 1185 Houston, Tex. 77001	.....do.....	Fort Bend.
Amoco Production Co.....	P.O. Box 591 Tulsa, Okla. 74102	.....do.....	Galveston.
Texas Gulf Sulphur Co.....	200 Park Ave. New York, N.Y. 10017	.....do.....	Jefferson, Liberty, Matagorda, Wharton.
<b>Sulfur (byproduct):</b>			
Cities Service Oil Co.....	P.O. Box 300 Tulsa, Okla. 74102	Secondary recovery.	Cochran and Van Zandt.
Elcor Chemical Corp.....	Wilco Bldg. Midland, Tex. 79701	.....do.....	Atascosa, Cass, Crane.
Getty Oil Co.....	P.O. Box 8 Scroggins, Tex. 75480	.....do.....	Franklin and Freestone.

Table 23.—Principal producers—Continued

Commodity and company	Address	Type of Activity	County
Sulfur (byproduct)—Continued			
Gulf Oil Corp.....	P.O. Box 701 Port Arthur, Tex. 77640	Secondary recovery.	Jefferson.
Amoco Production Co.....	P.O. Box 591 Tulsa, Okla. 74102	do.....	Andrews, Ector, Hockley, Van Zandt, Wood.
Phillips Petroleum Co.....	Bartlesville, Okla. 74003.....	do.....	Brazoria, Crane, Ector, Hutchinson.
Shell Oil Co.....	P.O. Box 2099 Houston, Tex. 77001	do.....	Cass, Karnes, Harris.
Warren Petroleum Corp.....	P.O. Box 1589 Tulsa, Okla. 74101	do.....	Crane, Hopkins, Karnes.
Talc and soapstone:			
Texas Talc Co.....	Allamore, Tex. 79829.....	Mine and plant.	Hudspeth.
Pioneer Talc Co.....	Chatsworth, Ga. 30705.....	do.....	Do.
Southern Clay Products, Inc.	Box 44 Gonzales, Tex. 78629	do.....	Do.
The United Sierra Div., Cyrus Mines Corp.	P.O. Box 1201 Trenton, N.J. 08606	Mine.....	Gillespie and Hudspeth.
Do.....	do.....	Mine and plant.	Llano.
Westex Talc Co.....	P.O. Box 15038 Houston, Tex. 77020	do.....	Hudspeth.
Uranium:Susquehanna-Western, Inc.	P.O. Box 217 Falls City, Tex. 78113	Mine and mill.....	Karnes.
Vermiculite:			
Texas Vermiculite Co.....	2651 Manila Rd. Dallas, Tex. 75200	Exfoliating plant.	Bexar and Dallas.
Vermiculite Products, Inc. ...	P.O. Box 7327 Houston, Tex. 77008	do.....	Harris.
Volcanic ash (pumicite): Nordmeyer, Inc.	P.O. Box 949 Mission, Tex. 78572	Mine and plant.	Starr.

# The Mineral Industry of Utah

This chapter has been prepared under a cooperative agreement for collecting mineral data, except mineral fuels, between the Bureau of Mines, U.S. Department of the Interior, and the Utah Geological and Mineralogical Survey.

By Gertrude N. Greenspoon <sup>1</sup>

The value of mineral production in Utah in 1970 rose for the third successive year and totaled \$602 million, an increase of 11 percent over that of 1969. Increases in value of mineral fuels and metals groups offset a decrease in value in the nonmetals group.

The total value of the metals commodities was 17 percent more than in 1969, owing to increases in copper, iron ore,

lead, and uranium. In 1970 beryllium was produced for the first full year, and man-ganiferous ore was produced for the first time since 1954.

Production of mineral fuels increased 5 percent in total value. The value of bitu-minous coal rose markedly.

Values in the nonmetals group de-

<sup>1</sup> Mineral specialist, Division of Nonferrous Metals.

Table 1.—Mineral production in Utah <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Carbon dioxide (natural).....thousand cubic feet...	64,839	\$5	60,754	\$4
Clays.....thousand short tons...	179	1,286	189	1,237
Coal (bituminous).....do.....	4,657	29,396	4,733	34,472
Copper (recoverable content of ores, etc.).....short tons...	296,699	282,066	295,738	341,282
Fluorspar.....do.....	6,667	207	19,214	595
Gem stones.....do.....	NA	85	NA	85
Gold (recoverable content of ores, etc.).....troy ounces...	433,385	17,990	408,029	14,848
Iron ore (usable).....thousand long tons, gross weight...	1,921	12,552	1,990	13,837
Lead (recoverable content of ores, etc.).....short tons...	41,332	12,313	45,377	14,175
Lime.....thousand short tons...	191	3,947	186	3,756
Manganiferous ore (5 to 35 percent Mn).....short tons...	---	---	700	W
Natural gas (marketed).....million cubic feet...	46,733	7,197	42,781	6,460
Petroleum (crude).....thousand 42-gallon barrels...	23,295	65,320	23,370	65,603
Pumice.....thousand short tons...	10	21	W	18
Salt.....do.....	481	4,439	366	3,638
Sand and gravel.....do.....	19,151	16,042	12,010	10,439
Silver (recoverable content of ores, etc.).....thousand troy ounces...	5,954	10,661	6,030	10,678
Stone.....thousand short tons...	2,582	4,434	1,650	4,320
Tungsten concentrate (60-percent WO <sub>3</sub> basis) short tons...	3	6	W	W
Uranium (recoverable content U <sub>3</sub> O <sub>8</sub> ).....thousand pounds...	1,140	<sup>2</sup> 6,824	1,635	10,023
Vanadium.....short tons...	W	W	257	W
Zinc (recoverable content of ores, etc.).....do.....	34,902	10,191	34,688	10,628
Value of items that cannot be disclosed:				
Asphalt and related bitumens, beryllium concentrate (1970), cement, gypsum, magnesium compounds, molybdenum, natural gas liquids, perlite, phosphate rock, potassium salts, sodium sulfate (1970), and values indicated by symbol W.....	XX	57,507	XX	55,899
Total.....	XX	542,489	XX	601,997
Total 1967 constant dollars.....	XX	512,272	XX	<sup>p</sup> 544,807

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

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

<sup>2</sup> Value estimated based on \$5.86 (1969) per pound for sales to the Atomic Energy Commission and assumed price of \$6.10 (1969) per pound for commercial sales; includes value of U<sub>3</sub>O<sub>8</sub> obtained from Utah ores processed at out-of-State mills.



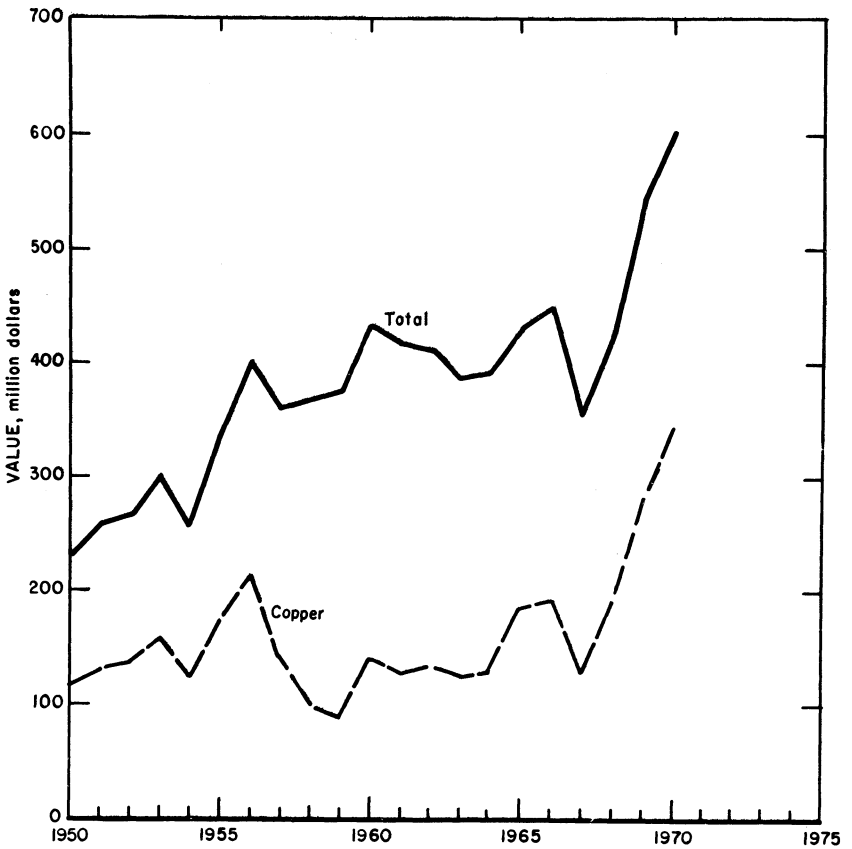


Figure 1.—Value of mine production of copper, and total value of mineral production in Utah.

Table 2.—Value of mineral production in Utah, by counties  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Beaver.....	\$336	\$883	Copper, sand and gravel, perlite, pumice.
Box Elder.....	2,910	W	Sand and gravel, stone, lime.
Cache.....	W	W	Stone, sand and gravel, lime.
Carbon.....	21,382	W	Coal, natural gas, sand and gravel, carbon dioxide.
Daggett.....	250	441	Natural gas, stone, sand and gravel, petroleum.
Davis.....	1,593	911	Sand and gravel.
Duchesne.....	4,298	W	Petroleum, sand and gravel, stone, natural gas.
Emery.....	8,344	W	Coal, sand and gravel, natural gas, uranium, petroleum.
Garfield.....	4,525	4,618	Petroleum, sand and gravel, uranium, copper, vanadium, silver.
Grand.....	7,145	4,365	Potassium salts, natural gas, sand and gravel, petroleum, uranium, copper, vanadium, silver, zinc.
Iron.....	13,115	14,040	Iron ore, sand and gravel, pumice, stone.
Juab.....	1,399	1,328	Clays, fluorspar, sand and gravel, stone, beryllium concentrates, silver, copper, lead, zinc.
Kane.....	W	W	Sand and gravel.
Millard.....	172	38	Do.
Morgan.....	W	W	Cement, stone, sand and gravel.
Piute.....	1,027	1,043	Zinc, silver, lead, gold, sand and gravel, clays.
Rich.....	W	W	Phosphate rock, sand and gravel.
Salt Lake.....	348,583	402,459	Copper, molybdenum, gold, silver, lead, sand and gravel, cement, zinc, salt, lime, stone.
San Juan.....	51,288	52,039	Petroleum, uranium, natural gas liquids, natural gas, vanadium, copper, sand and gravel.
Sanpete.....	116	183	Sand and gravel, salt, natural gas, clays.
Sevier.....	1,524	1,751	Gypsum, coal, sand and gravel, clays, salt.
Summit.....	9,053	7,082	Petroleum, zinc, lead, silver, stone, clays, sand and gravel, copper, natural gas, coal, gold.
Tooele.....	12,159	9,263	Lime, potassium salts, salt, stone, sand and gravel, lead, zinc, silver, copper, magnesium compounds, tungsten, gold, clays.
Uintah.....	27,274	27,915	Petroleum, gilsonite, natural gas, phosphate rock, natural gas liquids, sand and gravel.
Utah.....	6,846	12,567	Lead, zinc, silver, stone, sand and gravel, gold, lime, manganiferous ore, clays, copper.
Wasatch.....	7,346	W	Gold, lead, copper, silver, zinc, sand and gravel, stone.
Washington.....	131	84	Sand and gravel, pumice, petroleum.
Wayne.....	16	W	Sand and gravel, copper, silver.
Weber.....	844	790	Sand and gravel, sodium sulfate, potassium salts, salt, stone, clays.
Undistributed <sup>1</sup> .....	10,811	60,191	
Total <sup>2</sup> .....	542,489	601,997	

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

<sup>1</sup> Includes gem stones and sand and gravel that cannot be assigned to specific counties and values indicated by symbol W.

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

creased for 10 of the 15 commodities, increased for four. Output and value for fluorspar and phosphate rock rose substantially. Potassium salts and salt recorded decreases of 21 and 24 percent, respectively, in quantity and 41 and 18 percent, respectively, in value. As a result, total value of the nonmetals group fell 17 percent.

A total of 165.4 million tons of material was handled in the metals and nonmetals industries, which included 63.5 million tons of ore, 96.3 million tons of leach material, and 5.7 million tons of waste material. Underground mining operations accounted for 2.0 million tons of the total tonnage handled.

Construction of the chemical-industrial plant of NL Industries, Inc. on the southwestern shore of the Great Salt Lake, at Rowley, northwest of Grantsville, Tooele

County, was proceeding on schedule. The plant is scheduled for operation in late 1971 with an annual capacity of 45,000 tons of magnesium metal. Other products to be recovered are chlorine, lithium, calcium sulfate, and potassium sulfate.

United Park City Mines Co. completed a purchase-option agreement on the company's recreational facilities at Park City with Royal Street Development Co., Inc., a Newport Beach, Calif., real estate, hotel development, and management company. The option includes the base station, golf course, ski lifts, summit restaurant, and 4,200 acres of land. All mineral rights will be retained by United Park City Mines Co.

Utah Power & Light Co. announced plans to spend \$275 million for construction during the next 5 years. The major project was a thermoelectric power plant

Table 3.—Indicators of Utah business activity

	1969	1970	Change, percent	
<b>Employment and labor force, annual average:</b>				
Total labor force.....	thousands..	410.1	433.9	+5.8
Employment.....	do.....	388.8	408.5	+5.1
Unemployment.....	do.....	21.3	25.4	+19.2
Nonagricultural employment.....	do.....	349.8	358.6	+2.5
Mining.....	do.....	12.5	12.7	+1.6
Construction.....	do.....	14.0	14.5	+3.6
Manufacturing.....	do.....	54.0	54.9	+1.7
Government.....	do.....	99.6	100.3	+0.7
Other nonagricultural employment <sup>1</sup> .....	do.....	169.8	176.2	+3.8
<b>Personal income:</b>				
Total.....	millions..	\$3,132	\$3,416	+9.1
Per capita.....	do.....	\$2,991	\$3,210	+7.3
<b>Construction activity:</b>				
Total construction valuation.....	millions..	\$292.6	\$333.8	+14.1
Residential.....	do.....	\$87.4	\$124.7	+42.7
Nonresidential.....	do.....	\$117.8	\$104.9	-11.0
Nonbuilding.....	do.....	\$87.4	\$104.2	+19.2
Highway construction contracts awarded.....	do.....	\$58.9	\$66.2	+12.4
Cement shipments to and within the State.....	thousand 376-pound barrels..	2,444.3	2,228.9	-8.9
Farm marketing receipts.....	millions..	\$209.4	\$216.9	+3.6
Mineral production.....	do.....	\$542.5	\$602.0	+11.0
Production of electrical energy utilized.....	million kilowatt hours..	6,941.1	7,436.5	+7.1

<sup>1</sup> Includes transportation and public utilities; wholesale and retail trade; finance, insurance, and real estate; and services.

Sources: Bureau of Economic and Business Research, University of Utah; U.S. Department of Commerce, Bureau of the Census; Farm Income Situation; Employment and Earnings, Bureau of Labor Statistics; Survey of Current Business; Area Trends in Employment and Unemployment; and U.S. Bureau of Mines.

in Huntington Canyon, south of Price, Utah. Construction was to start in 1971, and the first 450-megawatt unit is scheduled for completion in 1974. Coal for the plant will be provided by Peabody Coal Co. from underground mines near the plant site. Approximately 1 million tons per year will be required in the first unit of the plant. Other projects are the 330-megawatt Naughton No. 2 plant near Kemmerer, Wyo., the 345,000-volt transmission line from Salt Lake City to the Four Corners area in New Mexico, and the 230,000-volt transmission line from central Utah to the Nevada border.

**Employment and Injuries.**—Final employment and injury data, compiled by the Bureau of Mines for 1969, with preliminary data for 1970, are shown in table 4. Information presented excludes all mineral fuels, except the coal and asphalt-gilsonite industries.

**Legislation and Government Programs.**—The Office of Coal Research, U.S. Department of the Interior, issued a report on western coal entitled, "Project Western Coal: Conversion of Coal into Liquid." The report was prepared at the School of Mineral Industries of the University of Utah, as a result of a contract arrangement between the Department of the Interior and the University. The report sum-

marizes laboratory investigations of coal processing including flash heating and plasma pyrolysis, hydrogenation process, solvent extraction, microwave radiation processing, and catalytic studies.

The National Science Foundation awarded \$342,200 in grants to the University of Utah for basic research in geology, biology, chemistry, and mathematics. A total of \$52,500 was granted to the Department of Geological and Geophysical Sciences for research in new methods for making electromagnetic determinations of underground water-bearing strata.

Bureau of Mines personnel at the Salt Lake City Metallurgy Research Center have developed processes for separate recovery of molybdenum and rhenium from molybdenum rougher concentrates. In normal commercial practice, molybdenum and rhenium are concentrated together in a process involving repeated, inefficient cleaning steps that result in final recoveries of less than 50 percent of the molybdenum and rhenium. In many cases, recovery of rhenium is not attempted. In the Bureau process, the rougher concentrates are leached with a sodium carbonate buffered-sodium hypochlorite solution that dissolves 96 percent of the molybdenum and rhenium in an hour but only 0.2 percent of the copper. Passing the leach solution through activated charcoal resulted in

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1969:								
Coal.....	1,193	236	281	2,207	1	123	56.17	4,847
Metal.....	5,278	303	1,598	12,790	2	221	17.44	1,726
Native asphalt (gilsonite).....	262	276	72	578	--	23	39.80	744
Nonmetal.....	869	275	239	1,914	1	70	37.10	4,133
Sand and gravel.....	723	194	140	1,146	2	21	20.08	10,868
Stone.....	443	266	118	959	--	14	14.61	628
Total <sup>1</sup> .....	8,768	279	2,449	19,593	6	472	24.40	2,764
1970: <sup>2</sup>								
Coal.....	1,325	240	318	2,476	5	175	72.69	14,801
Metal.....	5,180	315	1,632	13,058	3	239	18.53	2,351
Nonmetal <sup>2</sup> .....	1,065	258	276	2,200	1	80	36.82	4,716
Sand and gravel.....	710	206	147	1,205	1	20	17.43	5,143
Stone.....	445	261	116	946	--	12	12.68	630
Total.....	8,725	285	2,489	19,885	10	526	26.95	4,250

<sup>2</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

<sup>2</sup> Beginning in 1970, data on gilsonite operations, which formerly were included in "Native Asphalt," have been included in "Nonmetal" on a continuing basis.

selective extraction of over 95 percent of the rhenium. Ninety-eight percent of the molybdenum is then removed from the so-

lution by ion exchange. Overall recovery from the ore approximates 85 percent for both molybdenum and rhenium.

## REVIEW BY MINERAL COMMODITIES

### METALS

**Beryllium.**—Since August 1969 the Brush Beryllium Co. has been treating bertrandite ore from the Spor Mountain open pit mine in Juab County, at its mill near Delta. The ore ranges from 0.6 to 0.7 percent beryllium oxide. The company conducted mill tests on lower grade ore, which increased ore reserves and will enable the company to mine more ore from the Roadside open pit mine before underground mining becomes necessary. The mill produced beryllium hydroxide, which was shipped to company plants in Ohio for further processing into metal, alloys, and compounds.

**Copper.**—Production of copper was unchanged in quantity, from 1969, but value rose 21 percent. The open pit mine of the Utah Copper Division, Kennecott Copper Corp. at Bingham was the largest copper-producing mine in the United States. Other leading producers included the Mayflower mine of Hecla Mining Co.; the U.S. and Lark mine, United States Smelting Refining and Mining Co. (USSR&M); and the OK mine of Shield Development Co.

Copper was produced from 17 mines in 11 counties.

Keystone-Wallace Resources Co. operated a leaching plant at the Big Indian mine. In 1969 the company assumed control of copper properties formerly held by Cliffs Copper Co. in San Juan County. Ores are mined at several properties 5 to 10 miles south of the Big Indian mine and trucked to the leaching plant for treatment. The resulting cement copper is processed by Kennecott Copper Corp. at McGill, Nev.

The new sulfuric acid plant at the Kennecott Garfield smelter was placed in operation during the fourth quarter of 1970. Under optimum conditions, this new plant, sixth in operation at Utah Copper Division, can convert 163 tons of sulfur into 500 tons of sulfuric acid per day.

Drilling at The Anaconda Company Carr Fork properties in the Bingham district revealed copper mineralization averaging 1 to 3 percent copper, with important amounts of molybdenum, gold, and silver. The company plans to reopen old workings and drive new ones to gain access to the area of mineralization to delineate and evaluate this new copper deposit.



Table 7.—Utah: Mine production of gold, silver, copper, lead, and zinc in 1970, by types of material processed and methods of recovery, in terms of recoverable metals

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Acid leaching (heap): Ore.....			253		
Smelting of concentrates from—Ore <sup>1</sup> .....	404,697	5,508,115	242,797	40,647	33,119
Direct smelting of—					
Ore.....	3,316	520,043	572	4,706	1,519
Precipitates.....			52,115		
Cleanup and tailings.....	16	1,579	2	24	51
Total.....	3,332	521,622	52,689	4,730	1,570
Grand total <sup>2</sup> .....	408,029	6,029,737	295,738	45,377	34,688

<sup>1</sup> Includes concentrate from uranium ore.

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

**Gold.**—Output of gold, nearly all produced as a byproduct of base metal ores, declined 6 percent in 1970. Value decreased 17 percent because of lower market prices. The open-pit copper mine at Bingham was the principal gold producer. The Mayflower mine was second in gold production.

**Iron Ore.**—Iron ore was produced at five mines, all in Iron County. These mines were as follows: the Comstock mine operated by Utah Construction & Mining Co. for CF&I Steel Corp. (CF&I); the Desert Mound mine of United States Steel Corp. (USS); and the Iron Springs, McCahill-Thompson, and Alluvial mines of Utah Construction & Mining Co. Total production rose 4 percent, and value increased 10 percent.

Ores and concentrates shipped during the year contained an average of 53.8 percent iron. The iron and steel industry utilized 99 percent of the total ore and concentrate shipments. The remainder was used in making cement and paint.

**Lead.**—Lead production from 12 mines rose 10 percent. The leading producers, in order of output, were the U.S. and Lark mine of USSR&M Co.; Burgin mine, Tintic Division, Kennecott Copper Corp.; Mayflower mine of Hecla Mining Co.; United Park City mines, United Park City Mines Co.; and the Ophir mine of USSR&M Co., operated by McFarland & Hullinger. Of the five leading producing mines only the Burgin reported increased output; production was double the 1969 rate.

United Park City Mines Co. approved a lease arrangement with The Anaconda Company and The American Smelting and Refining Company covering the United Park City mining property in the Park City district. These two companies, operating under the name Park City Ventures are joint owners of 30.5 percent of United Park City stock. Under terms of the 25-year lease, Park City Ventures will spend at least \$2.5 million during the first 2 years of the lease on exploration and development of lead-zinc-silver reserves in

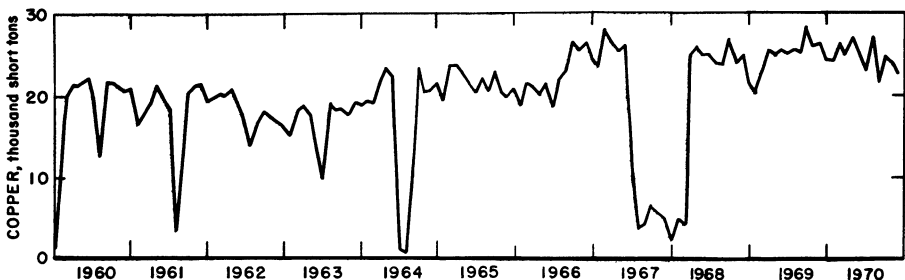


Figure 2.—Mine production of copper in Utah, by months, in terms of recoverable metals.

Utah for United Park City Mines Co. and not less than \$250,000 each year thereafter.

**Manganiferous Ore.**—Production of manganiferous ore (ore containing 5 percent or more manganese, natural) was reported for the first time since 1954. Output was all from the Burgin mine, Tintic Division, Kennecott Copper Corp. in Utah County. Production totaled 625 long tons, containing 28 percent manganese and 12 percent iron.

**Magnesium Compounds.**—Production of magnesium chloride from Great Salt Lake was reported by Kaiser Aluminum & Chemical Corp. at its Bonneville plant near Wendover, Tooele County. Output was used for sugar refining and as an anti-freeze reagent.

**Molybdenum.**—Molybdenum production in Utah, 1 percent less than in 1969, was recovered as a byproduct from concentration of copper ore mined by Kennecott Copper Corp. at Bingham.

**Selenium.**—All of the output of selenium was recovered as a byproduct from the Kennecott Copper Corp. electrolytic refinery at Garfield. Production decreased 23 percent.

**Silver.**—Production of silver in Utah was slightly more than in 1969. Output was reported by 17 mines in 10 counties. The leading producer was the Kennecott Copper Corp. Utah Copper mine at Bingham followed by the company's Burgin mine in Utah County.

**Uranium.**—Although fewer uranium mines operated during the year—66 operations compared with 71 in 1969—output rose 43 percent and value increased 47 percent. Value was calculated on a basis of

\$5.78 per pound recoverable content ( $U_3O_8$ ) marketed through the U.S. Atomic Energy Commission and \$6.20 per pound for commercial sales. The average grade of the ores mined was 0.22 percent  $U_3O_8$ , compared with 0.20 percent in 1969.

Development of the Rio Algom Corp. Humecca uranium property in San Juan County was nearly 50 percent complete by yearend. Construction was begun on the \$2.3 million, 500-ton-per-day mill, and operations were expected to begin in 1972.

**Vanadium.**—Vanadium output recovered from Utah ores fell sharply in 1970. Vanadium-bearing ores from mines in three counties were processed at mills in Colorado.

**Zinc.**—Zinc production reported from 10 mines in eight counties decreased slightly in 1970. The Burgin mine of Kennecott Copper Corp. displaced the U.S. and Lark mine, USSR&M Co., as the principal zinc producer in the State. Other leading producers were United Park City mines, United Park City Mines Co.; Mayflower mine of Hecla Mining Co.; and Deer Trail mine operated by Deer Trail Mines and Arundel Mining Co.

#### MINERAL FUELS

**Asphalt and Related Bitumens.**—Output from three gilsonite-producing companies rose 14 percent in tonnage and 12 percent in value in 1970.

**Carbon Dioxide.**—Production of carbon dioxide declined 6 percent; the entire output continued to come from the one-well Farnham Dome field, Carbon County.

**Coal (Bituminous).**—Coal production from 20 properties in four counties in-

Table 8.—Utah: Mine production of uranium oxide ( $U_3O_8$ ), by counties, in terms of recoverable content

County	1969			1970		
	Number of operations	Pounds	Value <sup>1</sup> (thousands)	Number of operations	Pounds	Value <sup>2</sup> (thousands)
Emery.....	8	49,844	\$293	3	<sup>3</sup> 14,760	<sup>3</sup> \$89
Garfield.....	4	523	3	6	( <sup>3</sup> )	( <sup>3</sup> )
Grand.....	10	45,989	274	8	63,760	377
Piute.....	1	842	5	--	--	--
San Juan.....	48	1,043,143	6,249	49	1,556,059	9,557
Total.....	71	1,140,341	6,824	66	1,634,579	10,023

<sup>1</sup> Value estimated, based on \$5.86 per pound for sales to the Atomic Energy Commission and on assumed price of \$6.10 per pound for commercial sales; includes value of  $U_3O_8$  obtained from Utah ores processed at out-of-State mills.

<sup>2</sup> Value estimated, based on \$5.78 per pound for sales to the Atomic Energy Commission and an assumed price of \$6.20 per pound for commercial sales; includes value of  $U_3O_8$  obtained from Utah ores processed at out-of-State mills.

<sup>3</sup> Emery and Garfield Counties combined to avoid disclosing individual company confidential data.

creased 2 percent in quantity; a 17-percent increase in total value was caused by an increase in the average price from \$6.31 to \$7.28 per ton. Carbon and Emery Counties continued to supply 98.1 percent of the total output.

Coal was mined at the Browning mine, 46 miles east of Salina, Sevier County, for shipment to Japan. The agreement between Browning Coal Co. and Japanese steel mill officials calls for shipment of 56,000 tons for experimental purposes. If use of the coal is successful, a 10-year contract for continued shipment of coal will be executed. The coal will be transported by rail from Salina to Long Beach, Calif., and then loaded on ships to Japan.

Resources Co. was to start underground mining research on the Kaiparowits coal deposits, Kane County, in early 1971. The 5-year extension granted by the State Engineer on the use of appropriated water from the Colorado River will permit Resources Co. to study the economic feasibility of the project and provide additional data on the character of the beds in which the coal occurs. Coal mined in the Kaiparowits Plateau field will be used in the proposed coal-burning power plant to be constructed on Nipple Bench in Utah, 18 miles northwest of Glen Canyon Dam at Page, Ariz.

**Natural Gas.**—Marketed natural gas declined 8 percent from the 46.7 billion cubic feet marketed in 1969. The State Division of Oil and Gas Conservation<sup>2</sup> reported production of 71.9 billion cubic feet. Of this output, 27.5 billion cubic feet was injected into reservoirs for storage. San Juan County was the largest gas producer with 37.9 billion cubic feet; however, 23.9 billion cubic feet from the Lisbon field was processed for liquids removal and re-

turned to the reservoir for pressure maintenance. Uintah County ranked second with output of 19.6 billion cubic feet; 789 million cubic feet was injected into the reservoir of the Red Wash field. Grand County ranked third with 8.6 billion cubic feet.

Royalty receipts by State and Federal Government agencies from natural gas production totaled \$758,287 during 1970 (\$851,832 in 1969). Of the total, \$155,503 (\$336,111 in 1969) was from production on Indian lands, \$543,532 (\$462,294 in 1969) from public domain, and \$59,252 (\$53,427 in 1969) from State lands.<sup>3</sup> Under the Mineral Leasing Act of 1920, the State receives 37.5 percent of the royalties paid on production from public domain. Royalties paid on production from privately owned lands are not included in the above data.

Natural gas reserves estimated by the American Petroleum Institute (API) and the American Gas Association, Inc. (AGA) totaled 1.065 trillion cubic feet. Reserves declined 25.6 billion cubic feet; new fields and new pools added 2.9 billion cubic feet, and revisions and extensions added 16.1 billion cubic feet.

Only six development gas wells were completed in 1970, compared with 16 in 1969; three in Uintah County, two in Grand County, and one in Daggett County. Three exploratory wells were completed in Carbon County and one in Uintah County.

**Natural Gas Liquids.**—Production of natural gas liquids decreased 4 percent in

<sup>2</sup> Utah Department of Natural Resources, Division of Oil and Gas Conservation. Monthly Oil and Gas Production Report, December 1970.

<sup>3</sup> Utah Department of Natural Resources, Division of Oil and Gas Conservation. Monthly Royalty Report, December 1970.

Table 9.—Utah: Coal (bituminous) sold or used,<sup>1</sup> by counties

County	1969		1970	
	Number of mines operating (all underground)	Thousand short tons	Number of mines operating (all underground)	Thousand short tons
Carbon.....	10	3,867	10	3,349
Emery.....	7	1,200	8	1,292
Iron.....	1	4	--	--
Kane.....	1	2	--	79
Sevier.....	1	72	1	13
Summit.....	1	12	1	13
Total.....	21	4,657	20	4,733

<sup>1</sup> Excludes mines producing less than 1,000 short tons.



1970. According to estimates by API and AGA, reserve of gas liquids totaled 36.3 million barrels, a decrease of 2.5 million barrels at yearend.

**Petroleum.**—Output of crude petroleum increased slightly, by 75,000 barrels. San Juan and Uintah Counties continued to rank first and second, respectively, in the State, supplying 53 and 27 percent, respectively, of the total output. Output rose 19 percent at the Bluebell field, Duchesne County, which displaced Garfield County as the third leading producer. A 2-percent increase in output was recorded in the Upper Valley field, Garfield County, and the county ranked fourth in total output.

The Greater Aneth field, San Juan County, continued as the principal producing area in the State with 8.5 million barrels of oil; largest individual fields within the area were Aneth, McElmo Creek, and Rutherford. The Greater Red Wash area, Uintah County, was second and produced 5.7 million barrels; its largest fields were Wonsits Valley, Red Wash Unit, and Walker Hollow. Lisbon field, San Juan County, ranked third, producing 2.8 million barrels. The Upper Valley field, Garfield County, was fourth, producing 1.6 million barrels, and the Bluebell field, Duchesne County, ranked fifth with 1.4 million barrels.

Proved crude oil reserves in the State at yearend 1970 were 181.5 million barrels, a decrease of 13.8 million barrels. In addition 36.2 million barrels are considered available by fluid injection. New fields added 1.2 million barrels, and revisions and extensions added 8.2 million barrels.

State and Federal Government agencies received \$8,759,339 (\$8,530,712 in 1969) in royalties paid on crude oil production in 1970. Of the total, \$4,758,345 (\$5,171,354 in

1969) was from production on Indian lands, \$3,616,926 (\$2,959,485 in 1969) was from public domain, and \$384,068 (\$399,873 in 1969) was from State lands.<sup>4</sup> As with natural gas, these figures do not include royalties paid for production on private land; moreover, the State receives 37.5 percent of the royalties paid on production from the public domain.

Five oil refineries in the State processed 40.1 million barrels of crude oil. Utah fields provided 10.2 million barrels; 29.9 million were received from other States. Colorado and Wyoming were the principal sources of out-of-State crude oil, providing 13.7 million and 15.9 million barrels, respectively. Out-of-State shipments totaled 14.6 million barrels, of which 10.9 million went to California and 3.1 million to Texas.

In 1970 drilling activity declined sharply—59 fewer wells than in 1969. Most of the decrease was in development wells. San Juan and Uintah Counties reported substantially fewer wells than in the previous year. Duchesne, Uintah, and Grand Counties had the largest number of successful development well completions. Numerous wells recorded activity along Utah's newest Tertiary trend, extending more than 45 miles across the deepest portion of the Uinta Basin from the Bluebell and Roosevelt fields on the northeast through the Cedar Rim-Sink Draw area on the southwest.

Four counties reported exploratory drilling of five or more wells with successful completions of nine oil and four gas wells. Duchesne County completed six oil wells, followed by Carbon County, which completed three gas wells. Exploratory success

<sup>4</sup> Work cited in footnote 3.

**Table 10.—Utah: Crude petroleum production, by counties**

(Thousand 42-gallon barrels)

County	1969	1970	Principal fields in 1970, in order of production
Daggett.....	3	3	Clay Basin.
Duchesne.....	1,356	1,902	Bluebell, Altamont, Cedar Rim.
Emery.....	6	4	Grassy Trail, Ferron.
Garfield.....	1,564	1,601	Upper Valley.
Grand.....	126	158	Salt Wash, Long Canyon, Agate.
San Juan.....	12,887	12,436	Aneth, Lisbon.
Summit.....	1,026	1,001	Bridger Lake.
Uintah.....	6,326	6,265	Red Wash, Ashley Valley.
Washington.....	1	( <sup>1</sup> )	Anderson Junction.
Total.....	23,295	23,370	

<sup>1</sup> Less than ½ unit.

Source: Utah Oil & Gas Conservation Commission.

was 30.2 percent compared with a low of 3.6 percent in 1969. Two of the discoveries in Duchesne County were the Altamont field discovered in May and the Sink Draw field completed in July. Shell Oil Co. 1 Miles well in the Altamont field had a completion gage of 1,100 barrels of oil per day from the Green River formation (Tertiary) from a depth of 12,970 feet. Mountain Fuel Supply completed its Sink Draw discovery, with a completion gage of 925 barrels of oil and 714,000 cubic feet of gas per day from the Wasatch. Globe Minerals Corp. completed a gas discovery, Uintah County, at 1.4 million cubic feet per day.

The Uintah-Ouray Indian Agency lease sale in September was one of the most successful sales in recent years. A total of \$1,928,261 was bid in bonuses for 16,987 acres, and bids ranged from \$17.89 to \$153.84 per acre. Several major oil companies acquired lease blocks in central Utah in the "hinge line" separating the Colorado Plateau from the Basin and Range province. The leasing activity may be the forerunner of exploratory drilling in the area of rock deformation separating the two geologic provinces.

## NONMETALS

**Barite.**—Crude barite was not produced in Utah in 1970. However, barite mined in Lander County, Nev., was processed for well drilling mud by Yuba Minerals & Milling Co. at Salt Lake City.

**Cement.**—Output of portland cement fell 14 percent in quantity and 7 percent in value. Decreases were recorded also in production of masonry cement. The average unit value, however, rose 8 percent owing to a price increase effective January 1. The two companies that accounted for the entire output were Ideal Cement Co., a division of Ideal Basic Industries, Inc., with a plant near Devil's Slide, Morgan County, and Portland Cement Co. of Utah at Salt Lake City. Of the total cement produced, only 0.2 percent was masonry cement. Ninety-one percent of the portland cement was purchased by ready-mix-concrete companies, manufacturers of concrete products, and building material dealers. Five percent was used in highway construction, and the remainder was sold for miscellaneous purposes.

Table 11.—Utah: Oil and gas well drilling, by counties

1969:					1970:				
County	Oil	Gas	Dry	Total Footage	County	Oil	Gas	Dry	Total Footage
<b>1969:</b>					<b>1970:</b>				
<b>Exploratory completions:</b>					<b>Exploratory completions:</b>				
Duchesne	2	--	1	3 26,610	Carbon	--	3	3	6 6,226
Emery	--	--	5	5 19,719	Duchesne	6	--	1	7 83,504
Garfield	--	--	6	6 19,901	Emery	--	--	3	3 15,472
Grand	--	--	11	11 57,094	Garfield	1	--	4	5 30,388
Kane	--	--	2	2 12,586	Grand	--	--	4	4 37,721
Millard	--	--	2	2 7,025	Juab	--	--	1	1 3,418
San Juan	--	--	9	9 44,296	Kane	--	--	2	2 12,869
Uintah	--	--	10	10 40,991	Millard	--	--	2	2 13,025
Utah	--	--	2	2 973	San Juan	1	--	1	2 16,568
Washington	--	--	1	1 5,606	Uintah	1	1	3	5 31,398
Wayne	--	--	4	4 11,124	Utah	--	--	1	1 11,750
					Wasatch	--	--	2	2 15,398
					Wayne	--	--	3	3 13,578
Total	2	--	53	55 245,925	Total	9	4	30	43 291,315
<b>Development completions:</b>					<b>Development completions:</b>				
Daggett	--	1	1	2 12,996	Daggett	1	1	--	2 20,351
Duchesne	13	1	1	15 104,662	Duchesne	11	--	1	12 122,934
Garfield	5	--	2	7 49,159	Garfield	--	--	1	1 8,100
Grand	1	5	4	10 15,712	Grand	3	2	5	10 19,449
San Juan	14	--	5	19 38,057	San Juan	--	--	2	2 11,497
Summit	1	--	--	1 17,910	Summit	1	--	--	1 15,800
Uintah	17	9	6	32 149,281	Uintah	4	3	4	11 49,207
Washington	1	--	--	1 4,124	Washington	--	--	1	1 649
Total	52	16	19	87 391,901	Total	20	6	14	40 247,987
<b>Total all drilling</b>					<b>Total all drilling</b>				
	54	16	72	142 637,826		29	10	44	83 539,302

Sources: Petroleum Information Corp., 1969 Résumé Oil and Gas Operations in the Rocky Mountain Region. American Petroleum Institute, 1970.

**Clays.**—Although output of clays rose 6 percent, value fell 4 percent. Sixteen operations in eight counties contributed to total production. The major producing companies were Utelite Corp., Filtrol Corp., Interstate Brick Co., and Interpace Corp. The materials listed as clays included shale, common clay, kaolin, fire clay, bentonite, and fuller's earth. Most of the clays were used as expanded material in making lightweight aggregate, in manufacturing building brick, and as catalysts in oil refining.

**Fluorspar.**—Shipments of fluorspar for use at steel mills nearly tripled those in 1969, in both quantity and value. The entire output was from four mines on Spor Mountain, Juab County.

The Monarch and Eureka uranium-fluorspar property in the Wah Wah Mountains, Beaver County, was reactivated after a lapse of 12 years. Lessee and operator of the property is Northern Resources Corp., a Salt Lake City based company. Small tonnages of fluorspar ore were mined and sold direct as metallurgical grade.

**Gem Stones.**—Total value of gem stones recovered in the State during 1970 was estimated at \$85,000, unchanged from 1969.

**Gypsum.**—Gypsum was produced from open pit mines near Sigurd, Sevier County, by Georgia-Pacific Corp., Gypsum Division, and United States Gypsum Co. The tonnage produced rose 11 percent and the value of crude gypsum increased 19 percent. Most of the output was calcined. Small quantities were sold for use as a portland cement retarder and for agricultural requirements.

**Lime.**—Lime production came from seven operations; output decreased 3 percent in quantity and 5 percent in value. The principal uses for lime were in concentration of copper ore, sugar refining, the phosphate industry, steelmaking, water purification and softening, and petroleum refining. Utah Marblehead Lime Co. produced dead-burned dolomite at the company plant northwest of Grantsville, Tooele County.

**Perlite.**—Bradshaw Pumice & Perlite Co. was the only source of crude perlite in 1970. Two plants, Acme Lite Wate Products, Inc., Salt Lake City, and Georgia-Pacific Corp., Gypsum Division, at Sigurd, expanded perlite for use as a plaster aggregate and for building purposes.

**Phosphate Rock.**—The Stauffer Chemical

Co., the only company producing phosphate rock, operated mines in Rich and Uintah Counties. Phosphate rock from the Cherokee mine was processed in the company plant at Leefe, Wyo. Marketable production increased 19 percent and total value rose 21 percent.

**Potash.**—Three operations reported production of potash salts in 1970. Texas Gulf Sulphur Co. near Moab, Grand County; Kaiser Aluminum & Chemical Corp., Bonneville, Ltd. Division, at Wendover, Tooele County; and the Great Salt Lake Minerals & Chemical Corp., where production began in the last half of 1970. The latter company had operated solar evaporation ponds on Great Salt Lake for the production of salts and for concentrating brines for future pond and plant operations. All plant units were completed and formally dedicated in early December. The operations will now yield potash salts, magnesium chloride, and sodium sulfate.

Texas Gulf Sulphur Co. terminated conventional underground mining operations on August 1 at its Cane Creek potash property. Research in recent years indicated that solution mining is feasible and practical and will permit production of potash at a cost below that of conventional mining. A decision was made, therefore, to convert the mine to a solution method. Conversion was started in August and is expected to require about 1 year for completion.

**Pumice.**—Four mines in three counties of southwestern Utah produced pumice and related volcanic materials, all of which were used in road construction. Total tonnage produced rose substantially, but value declined.

**Salt.**—Salt, from eight operations in five counties, decreased 24 percent in quantity and 18 percent in value. Evaporated salt was produced by six companies at ponds in three counties. Two mines in Sanpete County and one in Sevier County accounted for all rock salt production. The salt was sold for use in many industries, principally, chemical and animal feed processing industries.

**Sand and Gravel.**—Output and value of sand and gravel, from 154 operations in 29 counties, fell sharply in 1970. Production dropped 37 percent and value decreased 35 percent. The average value of sand and gravel produced, however, was \$0.87 per

ton compared with \$0.84 per ton in 1969. Salt Lake County reported output from 28 operations, followed by Weber County with 13, and Davis County with 10 mines. Sand and gravel continued to lead the nonmetallic group in total value of commodity production.

**Stone.**—Production of stone from 35 quarries dropped 36 percent in quantity in 1970. Value of output, however, fell only 3

percent, and the average value rose from \$1.72 to \$2.62 per ton.

**Vermiculite.**—Vermiculite was not produced in Utah in 1970, but out-of-State material was exfoliated at one plant in Salt Lake City. The product was sold and used principally as plaster aggregate and as block and loose fill insulation. Other uses included concrete aggregate, pipe covering, and soil conditioning.

Table 12.—Utah: Sand and gravel sold or used by producers, by counties  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Beaver.....	4	313	\$311	3	W	W
Box Elder.....	7	819	801	5	547	\$343
Cache.....	8	134	171	9	366	317
Carbon.....	3	38	40	2	W	W
Daggett.....	3	26	26	4	W	W
Davis.....	11	1,939	1,593	10	919	911
Duchesne.....	6	459	349	3	840	491
Emery.....	6	267	277	8	616	817
Garfield.....	4	112	124	3	W	W
Grand.....	3	W	W	5	618	571
Iron.....	9	466	530	4	207	187
Juab.....	3	111	96	1	45	30
Kane.....	6	132	121	3	48	W
Millard.....	2	172	172	2	49	38
Piute.....	3	8	4	3	6	3
Rich.....	1	2	2	3	210	130
Salt Lake.....	33	4,417	3,231	28	3,979	3,677
San Juan.....	2	305	305	2	20	49
Sanpete.....	4	53	40	2	W	W
Sevier.....	6	182	247	4	508	343
Summit.....	8	735	918	3	W	W
Tooele.....	9	6,761	4,214	8	1,062	807
Uintah.....	3	326	306	2	W	W
Utah.....	12	371	290	5	265	152
Wasatch.....	3	10	15	8	83	166
Washington.....	6	82	920	5	83	81
Wayne.....	2	16	16	3	219	220
Weber.....	13	813	826	13	468	397
Undistributed <sup>1</sup> .....	1	83	96	3	854	707
Total <sup>2</sup> .....	181	19,151	16,042	154	12,010	10,439

<sup>1</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

<sup>2</sup> Includes Morgan County, and some sand and gravel that cannot be assigned to specific counties.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

**Table 13.—Utah: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building .....	859	\$933	1,117	\$1,252
Fill .....	119	66	245	70
Paving .....	681	627	569	479
Other uses <sup>1</sup> .....	24	62	298	412
Total <sup>2</sup> .....	1,683	1,688	2,230	2,213
Gravel:				
Building .....	1,204	1,348	1,400	1,573
Fill .....	287	148	184	88
Paving .....	2,417	2,648	4,973	4,475
Railroad ballast .....	1	1	114	14
Miscellaneous .....	24	39	10	7
Other uses .....	34	40	83	96
Total <sup>2</sup> .....	3,966	4,223	6,763	6,253
<b>Government-and-contractor operations:</b>				
Sand:				
Building .....	1	2	8	12
Fill .....	80	40	80	2
Paving .....	2,279	1,975	420	262
Other uses .....	24	24	11	8
Total <sup>2</sup> .....	2,384	2,040	520	283
Gravel:				
Building .....	2	3	7	16
Fill .....	853	604	858	346
Paving .....	10,264	7,484	1,625	1,311
Other uses .....	--	--	7	16
Total <sup>2</sup> .....	11,118	8,091	2,497	1,690
Total sand and gravel .....	19,151	16,042	12,010	10,439

<sup>1</sup> Includes blast, engine, foundry, and other sands.

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

**Table 14.—Utah: Stone sold or used by producers, by counties**

(Thousand short tons and thousand dollars)

County	1969			1970			Kind of stone produced in 1970
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value	
Box Elder .....	7	1,460	\$1,563	6	W	\$311	Quartz, quartzite, other stone.
Cache .....	3	184	279	3	W	W	Limestone, sandstone, other stone.
Daggett .....	1	34	66	1	W	W	Limestone.
Duchesne .....	4	21	92	2	W	W	Other stone, sandstone.
Iron .....	2	( <sup>1</sup> )	( <sup>1</sup> )	1	W	W	Limestone.
Juab .....	1	6	W	1	W	W	Sandstone.
Millard .....	1	( <sup>1</sup> )	( <sup>1</sup> )	--	--	--	--
Morgan .....	1	W	W	1	W	W	Limestone, sandstone.
Salt Lake .....	4	W	W	5	242	393	Limestone, other stone, quartzite.
Summit .....	5	112	466	5	113	518	Other stone, sandstone.
Tooele .....	3	242	774	3	W	825	Dolomite, limestone, marble.
Utah .....	4	W	W	4	W	W	Limestone, other stone.
Wasatch .....	2	48	56	2	W	W	Limestone, sandstone.
Weber .....	1	4	18	1	W	W	Other stone.
Undistributed .....	--	469	1,120	--	1,295	2,273	--
Total <sup>2</sup> .....	39	2,582	4,434	35	1,650	4,320	--

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

<sup>1</sup> Less than ½ unit.

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

**Table 15.—Utah: Stone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars unless otherwise specified)

Use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension stone:</b>				
Irregular-shaped stone.....	W	W	W	W
Rough blocks..... short tons.....	5	( <sup>1</sup> )	W	\$20
Rough flagging..... thousand cubic feet.....	( <sup>1</sup> )	( <sup>1</sup> )	W	6
Sawed stone..... do.....	11	\$26	18	W
House stone veneer..... do.....				
Cut stone..... do.....				
Total..... (approximate short tons).....	2	69	3	119
<b>Crushed and broken stone:</b>				
Riprap and jetty stone.....	1,599	2,088	207	683
Roofing aggregates.....	W	W	( <sup>2</sup> )	( <sup>2</sup> )
Dense graded roadbase stone.....	132	147	180	468
Surface treatment aggregate.....	W	W	( <sup>2</sup> )	( <sup>2</sup> )
Lime.....	297	709	( <sup>2</sup> )	( <sup>2</sup> )
Other uses <sup>3</sup> .....	488	1,278	1,260	3,050
Total <sup>4</sup> .....	2,580	4,365	1,646	4,201
Grand total <sup>4</sup> .....	2,582	4,434	1,650	4,320

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

<sup>1</sup> Less than ½ unit.

<sup>2</sup> Included in "Other uses."

<sup>3</sup> Includes stone used in cement, flux, mine dusting, poultry grit, refractories, roofing aggregates, surface treatment aggregates, terrazzo, stone sand (1969), whiting (1970), ferrosilicon (1970), agricultural lime (1970), rubble (1970), and flagging.

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

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

Kind of stone	1969		1970	
	Quantity	Value	Quantity	Value
Dimension stone total <sup>1</sup> .....	2	\$69	3	\$119
<b>Crushed and broken:</b>				
Limestone.....	779	1,874	1,164	2,361
Dolomite.....	W	W	W	W
Marble.....	W	W	W	W
Sandstone.....	W	W	W	W
Quartz.....	( <sup>2</sup> )	W	( <sup>2</sup> )	W
Quartzite.....	W	W	6	W
Other stone.....	W	W	180	439
Undistributed.....	1,801	2,491	296	1,401
Crushed total <sup>3</sup> .....	2,580	4,365	1,646	4,201
Grand total <sup>3</sup> .....	2,582	4,434	1,650	4,320

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

<sup>1</sup> Includes limestone, marble, sandstone, and quartzite.

<sup>2</sup> Less than ½ unit.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

Table 17.—Principal producers

Commodity and company	Address	Type of activity	County
Asphalt and related bitumens:			
American Gilsolite Co.	Suite 1150, Kennecott Bldg. Salt Lake City, Utah 84110	Underground mine	Utah.
Beryllium: Brush Wellman, Inc.	67 W. 2950 S. Salt Lake City, Utah 84115	Open pit mine	Mesa. Juab.
Carbon dioxide (natural): Equity Oil Co.	806 American Oil Bldg. Salt Lake City, Utah 84101	Chemical processing plant Well and plant, Farnham Dome field	Millard. Carbon.
Cement: Ideal Cement Co., Div. of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	Wet process, 2-rotary-kiln plant	Morgan.
Clays:			
Filtrol Corp.	3250 E. Washington Blvd. Los Angeles, Calif. 90023	Open pit-underground mine	Juab.
Interstate Brick Co.	Box 6239 Salt Lake City, Utah 84106	Open pit mines	Sevier, Summit, Tooele, Utah.
Utelite Corp.	R.F.D. Coalville, Utah 84017	Open pit mine and expanding plant	Summit.
Western Clay & Metals Co.	1200 S. Atlantic Blvd. Alhambra, Calif. 91803	2 open pit mines	Sevier.
Coal (bituminous):			
Kaiser Steel Corp.	Sunnyside Coal Mines Sunnyside, Utah 84539	3 underground mines and cleaning plant	Carbon.
The North American Coal Corp.	12800 Spalter Blvd Cleveland, Ohio 44120	Underground mine and cleaning, thermal drying, and oil treatment plant	Do.
United States Fuel Co.	1910 University Club Bldg. Salt Lake City, Utah 84111	Underground mine	Carbon, Emery.
United States Steel Corp., Western District.	Box 807 Drigerton, Utah 84520	Cleaning, crushing, and oil treatment plant Underground mine	Carbon. Carbon, Emery.
Copper:			
Hecla Mining Co.	Box 320 Wallace, Idaho 83873	See Gold	Wasatch.
Kennecott Copper Corp., Utah Copper Division.	Box 11299 Salt Lake City, Utah 84111	Open pit mine, crusher, 2 flotation mills, precipitation plant, smelter, and electrolytic refinery.	Salt Lake
United States Smelting Refining and Mining Co.	136 E. South Temple St. Salt Lake City, Utah 84111	See Lead	Salt Lake.
Fluorspar:			
Centennial Development Co.	Eureka, Utah 84628	Open pit and underground mines	Juab.
Chesley & Black, Inc.	Delta, Utah 84624	Open pit mine	Do.
Spor Bros.	Box 276 Delta, Utah 84624	Open pit and underground mines	Do.
Willden Fluorspar Co.	Box 556 Delta, Utah 84624	Underground mine	Do.
Gold:			
Hecla Mining Co.	Box 320 Wallace, Idaho 83873	Underground mine and flotation mill	Wasatch.
Kennecott Copper Corp., Utah Copper Division.	Box 11299 Salt Lake City, Utah 84111	See Copper	Salt Lake.
United Park City Mines Co.	Rear Route 1, Box 40 Heber City, Utah 84082	See Zinc	Summit.
United States Smelting Refining and Mining Co.	136 E. South Temple St. Salt Lake City, Utah 84111	See Lead	Salt Lake.





Table 17.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Natural gas and petroleum—Continued			
Humble Oil & Refining Co., Central Division	2000 Classen Center North Oklahoma City, Okla. 73106	Crude oil and natural gas wells, Walker Hollow field	Uintah.
Husky Oil Co.	Box 380 Cody, Wyo. 82414	Refinery	Salt Lake.
Monsanto Co., Hydrocarbons & Polymers Division	800 N. Lindbergh Blvd. St. Louis, Mo. 63166	Crude oil wells, McElmo Mesa field	San Juan.
Phillips Petroleum Co.	431 S. 3d East Salt Lake City, Utah 84111	Crude oil wells, Ratherford field Bridger Lake field Refinery	Do. Summit. Salt Lake. San Juan.
The Superior Oil Co.	Box 1521 Houston, Tex. 77001	Crude oil wells, McElmo Creek field	
Tenneco Oil Co.	Box 251 Houston, Tex. 77001	Crude oil wells, Upper Valley field	Garfield.
Texaco Inc.	Box 2100 Denver, Colo. 80201	Natural gas wells, Clear Creek field	Carbon.
Union Oil Company of California, Western Region	Box 7600 Los Angeles, Calif. 90054	Natural gas wells, Fence Canyon field	San Juan.
Warren Petroleum Corp.	Box 1589 Tulsa, Okla. 74101	Crude oil wells and gas processing plant, Lisbon field	Uintah.
Perlite:		Gas processing plant	San Juan.
Bradshaw Pumice & Perlite Co.	Milford, Utah 84751	Open pit mine	Uintah.
Phosphate rock:			Beaver.
Stauffer Chemical Co.	636 California St. San Francisco, Calif. 94119	Open pit-underground mine	Rich.
Potassium salts:		Open pit mine and beneficiation plant	Uintah.
Kaiser Aluminum & Chemical Corp.	300 Lakeside Drive Oakland, Calif. 94604	Brine processing plant	Tooele.
Texas Gulf Sulphur Co.	200 Park Ave. New York, N.Y. 10017	Underground mine and flotation refinery	Grand.
Pumice: Thompson Block Co.	620 N. 400 W. Cedar City, Utah 84720	Open pit mine and crushing and screening plant	Beaver.
Salt:		do	Iron.
Hardy Salt Co.	P.O. Drawer 449 St. Louis, Mo. 63166	Solar evaporation	Salt Lake.
Morton Salt Co., a division of Morton International, Inc.	110 N. Wacker Drive Chicago, Ill. 60606	Lake brine processing plant	Do.
Solar Salt Co.	270 Crossroad Square Salt Lake City, Utah 84115	do	Tooele.
Sand and gravel:			
Bretling Bros. Construction, Inc.	3645 S. 500 W. Salt Lake City, Utah 84104	Pit and plant	Salt Lake.
Construction Materials Corp., Savage Bros., Inc., Division	R.F.D. 4, Box 611 American Fork, Utah 84003	do	Davis.
Dan R. Fogle Sand & Gravel Products	350 Hartwell Ave. Salt Lake City, Utah 84115	Pit and 3 plants	Salt Lake.

Gibbons & Reed Co., Concrete Products Co. Division.....	41 W. Central Ave. Murray, Utah 84107	Pit and plant.....	Davis. Salt Lake.
Pioneer Sand & Gravel.....	3200 W. 5400 S. Granger Dr. Salt Lake City, Utah 84118	do.....	Weber. Salt Lake.
Sorensen Sand & Gravel.....	Box 18545 Kerns, Utah 84118	do.....	Do.
Utah Sand & Gravel Products Corp.....	Box 587 Salt Lake City, Utah 84110	3 pits and plants.....	Do.
Selenium: Kennecott Copper Corp., Utah Copper Division.....	Box 11299 Salt Lake City, Utah 84111	See Copper.....	Do.
Silver:			
Deer Trail Mines & Arundel Mining Co.....	1834 S. Woodside Dr. Salt Lake City, Utah 84172	See Zinc.....	Piute.
Hecla Mining Co.....	Box 820 Wallace, Idaho 83873	See Gold.....	Wasatch.
Kennecott Copper Corp., Tintic Division.....	Box 250 Eureka, Utah 84628	See Zinc.....	Utah.
Kennecott Copper Corp., Utah Copper Division.....	Box 11299 Salt Lake City, Utah 84111	See Copper.....	Salt Lake.
Kennecott Copper Corp. (Ben Dixon & Christie, lessee).....	do.....	Underground mine.....	Do.
McFarland & Hullinger.....	Box 238 Tooele, Utah 84074	Tailings dump.....	Juab.
United Park City Mines Co.....	Star Route 1, Box 40 Heber City, Utah 84032	See Zinc.....	Summit.
United States Smelting Refining and Mining Co.....	136 E. South Temple St. Salt Lake City, Utah 84111	See Lead.....	Salt Lake.
United States Smelting Refining and Mining Co. (McFarland & Hullinger, lessee).....	do.....	do.....	Tooele.
Stone:			
Le Grand Johnson Corp.....	Box 248 Logan, Utah 84321	Quarry and plant.....	Cache.
Portland Cement Company of Utah.....	Box 1469 Salt Lake City, Utah 84110	do.....	Salt Lake.
Southern Pacific Railroad Co.....	65 Market St. San Francisco, Calif. 94105	Quarry.....	Box Elder.
United States Steel Corp.; Western Ore Operations.	Lander, Wyo. 82520	Quarry and plant.....	Utah.
Utah Marblehead Lime Co.....	300 W. Washington St. Chicago, Ill. 60606	do.....	Tooele.
W. W. Clyde & Co.....	Box 350 Springville, Utah 84663	do.....	Daggett. Duchesne. Summit.
Uranium:			
Atlas Corp., Atlas Minerals Division.....	Box 1207 Moab, Utah 84532	Quarry and plant.....	Emery. Grand.
Homestake Mining Co.....	Box 563 Moab, Utah 84532	Underground mine.....	San Juan.
Climax Uranium Co., American Metal Climax, Inc.	Box 1629 Grand Junction, Colo. 81501	14 underground mines.....	Do.
		Underground mine.....	Do.
		3 underground mines.....	Do.

See footnote at end of table.

Table 17.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Vanadium: Climax Uranium Co., American Metal Climax, Inc.	Box 1629 Grand Junction, Colo. 81501	See Uranium	San Juan.
Zinc: Deer Trail Mines & Arundel Mining Co.	1834 S. Woodside Dr. Salt Lake City, Utah 84172	Underground mine	Piute.
Hecla Mining Co.	Box 320 Wallace, Idaho 83873	See Gold	Wasatch.
Kennecott Copper Corp., Tintic Division.	Box 250 Eureka, Utah 84628	2 underground mines	Utah.
United Park City Mines Co.	Star Route 1, Box 40 Heber City, Utah 84032	do	Summit.
United States Smelting Refining and Mining Co.	136 E. South Temple St. Salt Lake City, Utah 84111	See Lead	Salt Lake.
United States Smelting Refining and Mining Co. (McFarland & Hullinger, lessee)	136 E. South Temple St. Salt Lake City, Utah 84111	See Lead	Tooele.

<sup>1</sup> Also stone.

# The Mineral Industry of Vermont

By Frank B. Fulkerson <sup>1</sup>

The value of mineral production in Vermont in 1970 was \$27.8 million, virtually identical with that of 1969. Sand and gravel output reached record proportions, but crushed and broken stone and asbestos production declined compared with the previous year. Production of dimension stone, the State's principal mineral product, decreased in tonnage, but value was unchanged. Other mineral commodities produced were clays, peat, talc, and a small quantity of mineral specimens. Rutland continued to be the leading county in

value of production. Grand Isle was the only county reporting no production during the year.

In 1970 the total labor force increased 2.8 percent. Unemployment increased from 3.1 percent of the work force in 1969 to 4.4 percent in 1970 during a year of general decrease in business activity. Manufacturing employment declined 5.8 percent. Average weekly earnings in manufacturing increased from \$114.54 in 1969 to \$120.13.

<sup>1</sup> Industry economist, Division of Nonmetallic Minerals.

Table 1.—Mineral production in Vermont <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Lime.....short tons.....	1,500	\$25	.....	.....
Peat.....thousand short tons.....	( <sup>2</sup> )	4	( <sup>2</sup> )	\$6
Sand and gravel.....do.....	3,336	3,028	4,046	4,122
Stone.....do.....	2,151	19,810	1,514	19,088
Value of items that cannot be disclosed: Asbestos, clays, gem stones, and talc.....	XX	4,892	XX	4,627
Total.....	XX	27,759	XX	27,843
Total 1967 constant dollars.....	XX	26,213	XX	P 25,198

P Preliminary. 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 ½ unit.

Table 2.—Value of mineral production in Vermont, by counties <sup>1</sup>

(Thousands)

County	1969	1970	Minerals produced in 1970, in order of value
Addison.....	W	\$128	Sand and gravel.
Bennington.....	W	610	Do.
Caledonia.....	W	W	Do.
Chittenden.....	\$1,314	938	Sand and gravel, stone, clay.
Essex.....	W	W	Sand and gravel.
Franklin.....	W	W	Stone, sand and gravel.
Lamoille.....	W	W	Talc, sand and gravel.
Orange.....	W	W	Stone, sand and gravel.
Orleans.....	W	W	Asbestos, sand and gravel, stone.
Rutland.....	W	W	Stone, sand and gravel.
Washington.....	W	W	Do.
Windham.....	W	W	Sand and gravel, talc.
Windsor.....	W	W	Talc, stone, sand and gravel, peat.
Undistributed.....	26,444	26,167	
Total.....	<sup>2</sup> 27,759	27,843	

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

<sup>1</sup> Grand Isle County is not listed because no production was reported.

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

Table 3.—Indicators of Vermont business activity

	1969	1970 <sup>p</sup>	Change, percent
Employment and labor force, annual average: <sup>1</sup>			
Total labor force .....	184,500	189,750	+2.8
Unemployment (percent of work force) .....	3.1	4.4	+41.9
Employment:			
Manufacturing .....	43,100	40,600	-5.8
Durable goods .....	29,350	27,200	-7.3
Nondurable goods .....	14,100	13,400	-5.0
Nonmanufacturing .....	102,100	107,350	+5.1
Mining and quarrying .....	1,000	1,000	-----
Payroll—average weekly earnings: <sup>1</sup>			
Manufacturing .....	\$114.54	\$120.13	+4.9
Personal income: <sup>2</sup>			
Total .....	millions .. \$1,426	\$1,557	+9.2
Per capita .....	\$3,262	\$3,491	+7.0
Construction activity:			
Nonresidential construction authorized <sup>3</sup> .....	millions .. \$17.8	\$16.2	-8.9
Residential construction <sup>3</sup> .....	units .. 1,551	1,708	+10.1
State highway construction contracts <sup>4</sup> .....	millions .. \$50.2	\$46.8	-6.8
Cement shipments to and within Vermont .....	thousand 376-pound barrels .. 692	575	-16.9
Mineral production value .....	thousands .. \$27,759	\$27,843	+0.3

<sup>p</sup> Preliminary.<sup>1</sup> Economics Development Division, Vermont Agency of Development and Community Affairs.<sup>2</sup> Survey of Current Business.<sup>3</sup> Construction Review.<sup>4</sup> Engineering News-Record.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours		
					Fatal	Nonfatal	Frequency	Severity	
1969:									
Nonmetal and peat .....	322	233	91	734	-----	19	25.87	296	
Sand and gravel .....	189	174	33	300	-----	5	16.66	177	
Stone .....	1,313	255	335	2,780	-----	2	101	37.05	7,352
Total .....	1,824	252	459	3,814	-----	2	125	33.29	5,429
1970: <sup>p</sup>									
Nonmetal and peat .....	335	277	92	743	-----	22	29.63	815	
Sand and gravel .....	185	173	32	299	-----	9	30.06	150	
Stone .....	1,230	253	324	2,679	-----	78	29.11	1,037	
Total .....	1,800	249	448	3,721	-----	109	29.29	921	

<sup>p</sup> Preliminary.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Asbestos.**—Chrysotile asbestos was mined in Orleans County by GAF Corp., Building & Industrial Floor Products Division. The output was shipped to out-of-State company plants for the manufacture of asbestos-cement roofing and siding, industrial board, corrugated sheets, and asbestos papers. Production decreased 9 percent.

**Clays.**—Common clay production declined in both tonnage and value in 1970. Densmore Brick Co., Inc., mined clay for the manufacture of building brick at Essex Junction, Chittenden County. Output decreased 10 percent.

**Gem Stones.**—Hobbyists and gem-collecting societies collected a variety of gem materials and other mineral specimens at various locations within the State.

**Lime.**—No lime was produced in Vermont in 1970, as Vermont Associated Lime Industries, Inc., suspended lime operations.

**Mica, Reconstituted.**—At Rutland, Samica Corp. manufactured reconstituted sheet mica. Made from specially delaminated natural mica scrap, the material replaces built-up mica in many applications, principally in electrical insulation.

**Sand and Gravel.**—Sand and gravel tonnage totaled 4.0 million tons valued at \$4.1 million, a new record. Compared with 1969

figures, this represented a 21-percent increase in tonnage and a 36-percent increase in value. The greater output resulted mainly from accelerated highway construction. The principal uses were for paving, building, fill, and sanding of roads. Value per ton advanced from \$0.91 to \$1.02. Bennington, Caledonia, Chittenden, Orange, Rutland, and Washington Counties all produced more than 400,000 tons of sand and gravel. Transportation was by truck. All counties except Grand Isle recorded some sand and gravel production.

Commercial producers sold 3.0 million tons valued at \$3.6 million. Of the 24 commercial operations, seven sold over 100,000 tons. Tonnage was up 13 percent, and value was up 29 percent. Value per ton rose from \$1.05 to \$1.20.

Noncommercial operations produced 1.1 million tons with value of \$0.5 million. Contractors operated 8 pits for the State Highway Department and 3 pits for the Green Mountain National Forest; in addition, State Highway Department crews produced from 6 pits. Tonnage increased 53 percent, and value increased 122 percent. Value per ton rose from \$0.36 to \$0.52.

**Table 5.—Sand and gravel production by Government-and-contractor operations, by counties**

(Thousand short tons)

County	1969	1970
Addison	7	7
Bennington	3	50
Caledonia	29	3
Chittenden	7	5
Essex	31	22
Franklin	61	37
Orange	2	262
Orleans	170	236
Rutland	203	242
Washington	75	189
Windham	25	---
Windsor	81	9
Total	694	11,061

<sup>1</sup> Data does not add to total shown because of independent rounding.

**Stone.**—Value of stone production dropped 4 percent, resulting from a 31-percent decrease in output of crushed and broken stone. Value of dimension stone was virtually identical with that of 1969, owing to an increase in average per-ton prices that offset lower output.

Dimension granite was the most valuable stone product. Almost 90 percent of the dimension granite was used for monumental purposes, including monuments, grave-

stones, and mausoleums. Rough monumental stone was valued at \$116.91 per ton. Some rough granite blocks, valued at \$63.25 per ton, were sold for building purposes. Dressed architectural granite was valued at \$204.12 per ton. Washington County continued to be the leading producer of dimension granite, with sizable production coming from Orange County.

Granite for road building and maintenance was crushed in Washington and Windsor Counties. Production of this material was down sharply from that of the previous year.

Dimension marble was produced mainly in Rutland County; some was produced in Windsor County. Output was shipped as dressed stone for architectural work; for monuments, gravestones, and mausoleums; and for flagging. Significant improvement was noted in price per ton for dimension marble in 1970. Some crushed and broken material was used for construction aggregate and miscellaneous other purposes.

Crushed and broken limestone and dolomite production totaled 1,051,000 tons with value of \$3,860,000. The average value per ton of \$3.67 was down 34 percent compared with that of 1969, owing to the fact that a greater proportion of the stone was used for road construction and maintenance. The greatest uses for limestone, produced in Chittenden, Franklin, Rutland, and Washington Counties, were for road-base material and surface-treatment aggregate. Large quantities of limestone were sold as fillers, paper mill stone, agricultural limestone, poultry grit, and mineral food; these were the higher unit-value uses. Other tonnages were used for terrazzo, exposed aggregate, and abrasive manufacture. Crushed and broken dolomite, produced in Rutland County, was used for road building and maintenance and as agricultural stone.

Dimension slate was produced by six companies in Rutland County. Output was flagging slate, standard roofing slate, and mill stock for structural and sanitary applications. Flagging sold for \$31.88 per ton. The average price for roofing was \$116.41 per ton. Structural and sanitary material was valued at \$158.72 per ton. A small quantity of crushed slate was produced by Vermont Light Aggregate Corp.

Miscellaneous stone for concrete and bituminous aggregate was produced in Orleans and Rutland Counties.

Kelley Construction Co. crushed granite near Barre, in Washington County, for road maintenance and construction purposes. Wilk Bros., Inc., at Rutland City, Rutland County, crushed miscellaneous stone for bituminous and concrete aggregate. Three miscellaneous stone quarries of Caledonia Sand & Gravel Co. in Caledonia, Orange, and Washington Counties were idle. Perini Corp. terminated its Sharon basalt quarry operation in Windsor County. In Rutland County, the F. W. Whitcomb marble quarry was idle, as was the C. R. Beach Slate Co. quarry. Rising & Nelson Slate Co., Inc., did stripping at its quarry in Rutland County but produced no slate.

Vermont Marble Company opened an ultramodern calcium products plant at Florence to process 200,000 tons of white marble per year. The plant will turn out marble sand and chips, terrazzo aggregates, fillers for paint, putty, linoleum, soap powder and other products, filtration media,

and agricultural stone. The plant features two electronic color sorting devices and a 30 x 6 foot rotary dryer. The installation doubles Vermont Marbles's crushed and ground marble capacity.

**Talc.**—Windsor County was the principal producer of talc in Vermont, followed by Lamoille and Windham Counties. Compared with 1969 figures, tonnage and value each increased 11 percent. Windsor Minerals, Inc., Eastern Magnesia Talc Co., and Vermont Talc Co. operated four mines for the production of crude talc. Crude talc is subsequently ground and used in the manufacture of roofing, paper, paint, insecticides, plastics, rubber, and miscellaneous other products.

#### MINERAL FUELS

**Peat.**—Kirks Green Mountain Peat was the only peat producer. Sales of reed-sedge peat for general soil improvement comprised 180 tons of bulk peat and 64 tons of packaged material.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Asbestos:</b>			
GAF Corporation Bldg., Industrial & Floor Products Division. <sup>1</sup>	140 West 51st St. New York, N.Y. 10020	Pit.....	Orleans.
<b>Clays:</b>			
<b>Miscellaneous:</b>			
Densmore Brick Co., Inc.....	Hanover St. Lebanon, N.H. 03766	Pit.....	Chittenden.
<b>Lime:</b>			
Vermont Associated Lime Industries, Inc. <sup>2</sup>	25 Airport Drive Winooski, Vt. 05404	Plant.....	Do.
<b>Peat:</b>			
Kirks Green Mountain Peat.....	P.O. Box 456 Woodstock, Vt. 05091	Bog.....	Windsor.
<b>Sand and gravel:</b>			
Brattleboro Sand & Gravel, Inc.....	P.O. Box 358 Brattleboro, Vt. 05301	Pit.....	Windham.
Caledonia Sand & Gravel Co, Inc...	Box 428 St. Johnsbury, Vt. 05819	Pit.....	Washington.
Calkins Construction, Inc.....	Danville, Vt. 05828.....	Pit.....	Orleans.
J. P. Carrara & Sons, Inc.....	N. Clarendon, Vt. 05759.....	Pit.....	Rutland.
William E. Dailey, Jr.....	N. Bennington, Vt. 05257.....	Pit.....	Bennington.
S. T. Griswold, Inc.....	P.O. Box 8 Williston, Vt. 05495	Pit.....	Chittenden.
Albert S. Nadeau.....	Johnson, Vt. 05656.....	Pit.....	Lamoille.
Lawrence Sangraves, Inc.....	138 Portland St. Johnsbury, Vt. 05819	Pit.....	Essex.
Vermont Sand & Gravel Corp.....	Box 429 Bellows Falls, Vt. 05101	Pit.....	Rutland.
<b>Stone:</b>			
<b>Granite (dimension):</b>			
Rock of Ages Corp.....	Barre, Vt. 05641.....	Quarry.....	Orange, Washington, Windsor.
Wells-Lamson Quarry Co., Inc.....	102 N. Main St. Barre, Vt. 05641	.....do.....	Washington.
<b>Granite (crushed):</b>			
Wells-Lamson Quarry Co., Inc.....	Framingham, Mass. 01701.....	.....do.....	Washington.
<b>Limestone (crushed and broken):</b>			
L. A. Demers Crushed Rock Co.....	Upper Main St. Winooski, Vt. 05404	.....do.....	Chittenden.
Perini Corp.....	Framingham, Mass. 01701.....	Crushing plant, quarry.	Washington.
Swanton Lime Works, Inc.....	Swanton, Vt. 05488.....	Quarry.....	Franklin.
Vermarco Ground Products Division of Vermont Marble Co.	W. Rutland, Vt. 05777.....	.....do.....	Rutland.
White Pigment Corp.....	Proctor, Vt. 05765.....	.....do.....	Do.
<b>Marble (dimension):</b>			
Vermont Marble Co. <sup>3</sup> .....	Proctor, Vt. 05765.....	.....do.....	Rutland, Windsor.
<b>Marble (crushed):</b>			
F. W. Whitecomb Const. Corp.....	Box 429 Bellows Falls, Vt. 05101	.....do.....	Rutland.
<b>Slate (dimension):</b>			
Fair Haven Slate Co., Inc. <sup>4</sup> .....	Fair Haven, Vt. 05743.....	.....do.....	Do.
Green Mountain Slate Corp.....	Granville, N.Y. 12832.....	.....do.....	Do.
John G. Hadeka.....	25 College St. Poultney, Vt. 05764	.....do.....	Do.
Hilltop Slate Co.....	Middle Granville, N.Y. 12849.....	.....do.....	Do.
Rising & Nelson Slate Co., Inc.....	West Pawlet, Vt. 05775.....	.....do.....	Do.
Somich Brothers.....	Granville, N.Y. 12832.....	.....do.....	Do.
Taran Brothers, Inc.....	No. Poultney, Vt. 05764.....	.....do.....	Do.
Tatko Brothers Slate Co.....	Middle Granville, N.Y. 12849.....	.....do.....	Do.
Vermont Structural Slate Co., Inc.	Prospect St. Fair Haven, Vt. 05743	.....do.....	Do.
<b>Talc:</b>			
Eastern Magnesia Talc Co.....	Johnston, Vt. 05656.....	Underground..	Lamoille.
Vermont Talc Co.....	Chester, Vt. 05143.....	.....do.....	Windham.
Windsor Minerals, Inc.....	P.O. Box 680 Windsor, Vt. 05089	.....do.....	Windsor.

<sup>1</sup> Also miscellaneous stone.<sup>2</sup> Also crushed limestone.<sup>3</sup> Also crushed marble.<sup>4</sup> Also crushed slate.





# The Mineral Industry of Virginia

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Virginia Division of Mineral Resources under a cooperative agreement for collecting information on all minerals except fuels.

By Franklin D. Cooper<sup>1</sup>

The value of 1970 mineral production in Virginia rose to a new high of \$374.3 million, 17.9 percent greater than the \$317.5 million value reported for 1969. Value increases of four commodities accounted for 99.7 percent of the \$56.7 million increase in total output value as follows: coal, 94.0 percent; stone, 3.0 percent; cement, 1.9 percent; and lime, 0.8 percent. Although the output of coal declined 1.5 percent, its

value rose 27.7 percent owing to a 29.7 percent increase (\$1.61 per short ton) in the average unit value.

Seven commodities gained in output quantity and 13 gained in output value. Of the total 1970 mineral production value, approximately 66 percent was contributed by fuels, 2 percent by metals, and 32 percent by nonmetals.

<sup>1</sup> Physical scientist, Division of Fossil Fuels.

Table 1.—Mineral production in Virginia<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays.....thousand short tons..	1,677	\$1,504	1,633	\$1,672
Coal (bituminous).....do.....	35,555	192,802	35,016	246,181
Gem stones.....	NA	7	NA	7
Lead (recoverable content of ores, etc.).....short tons..	3,358	1,000	3,356	1,048
Lime.....thousand short tons..	1,072	13,653	1,046	14,090
Natural gas.....million cubic feet..	2,846	845	2,805	864
Petroleum (crude).....thousand 42-gallon barrels..	1	W	1	W
Sand and gravel.....thousand short tons..	12,140	15,954	11,126	15,229
Soapstone.....short tons..	4,600	12	3,760	9
Stone.....thousand short tons..	33,461	58,713	35,415	60,477
Zinc <sup>2</sup> (recoverable content of ores, etc.).....short tons..	18,704	5,462	18,063	5,534
Value of items that cannot be disclosed:				
Aplite, cement (portland and masonry), feldspar, gypsum, iron ore (1969), kyanite, salt, titanium concentrate, and values indicated by symbol W.....	XX	27,575	XX	29,210
Total.....	XX	317,527	XX	374,321
Total 1967 constant dollars.....	XX	299,841	XX	p 338,761

<sup>p</sup> Preliminary. NA Not available. W Withheld to avoid disclosing individual company confidential data. XX Not applicable.

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

<sup>2</sup> Recoverable zinc valued at the yearly average price of prime western slab zinc, East St. Louis market. Value established after transportation, smelting, and manufacturing charges have been added to the value of ore at the mine.

Table 2.—Value of mineral production in Virginia, by counties<sup>1</sup>  
(Thousands)

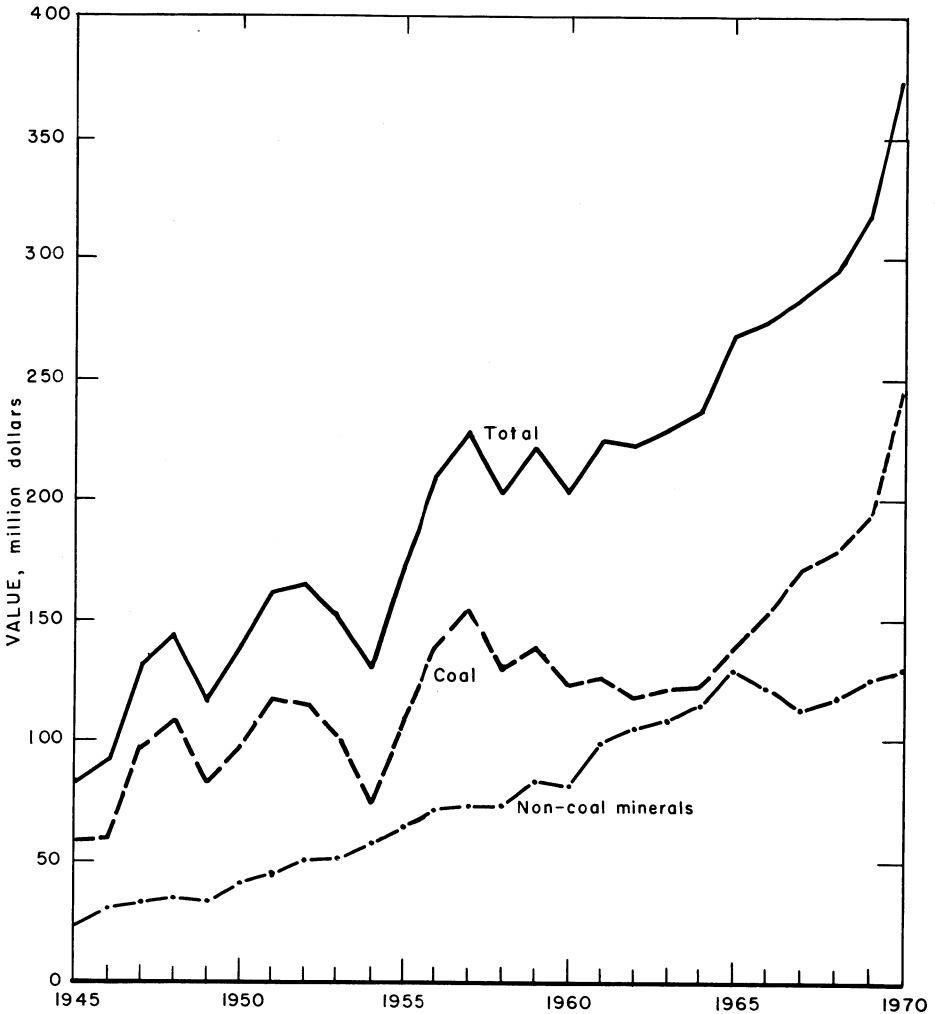
County	1969	1970	Minerals produced in 1970 in order of value
Accomack	\$22	W	Sand and gravel.
Albemarle	W	W	Stone, sand and gravel.
Alleghany	W	W	Do.
Amherst	W	W	Titanium concentrate, sand and gravel.
Appomattox	75	\$30	Stone.
Augusta	952	868	Stone, sand and gravel.
Bath	1	( <sup>2</sup> )	Sand and gravel.
Bedford	W	W	Feldspar.
Bland	W	W	Stone.
Botetourt	W	W	Cement, stone, clays.
Brunswick	W	W	Stone, clays.
Buchanan <sup>3</sup>	83, 180	104, 064	Coal, sand and gravel.
Buckingham	4, 501	W	Kyanite, stone.
Campbell	W	W	Stone.
Caroline	213	W	Sand and gravel.
Carroll	3	W	Stone.
Charles City	W	W	Sand and gravel.
Chesapeake (City)	W	W	Cement.
Chesterfield	3, 162	3, 619	Sand and gravel, stone, clays.
Clarke	W	W	Stone.
Craig	W	W	Do.
Culpeper	W	W	Do.
Dickenson	45, 630	54, 931	Coal.
Dinwiddie	W	W	Stone, clays.
Fairfax	5, 381	W	Stone, sand and gravel.
Fauquier	W	W	Stone.
Floyd	36	-----	-----
Fluvanna	W	-----	-----
Franklin	12	W	Soapstone.
Frederick	5, 537	5, 504	Stone, lime, sand and gravel, clays.
Giles	W	W	Lime, stone.
Goochland	2, 404	1, 767	Stone.
Grayson	W	W	Stone, sand and gravel.
Greensville	W	W	Stone, clays.
Halifax	W	W	Stone, sand and gravel.
Hampton (City)	W	7	Sand and gravel, stone.
Hanover	W	W	Aplite, stone.
Henrico	3, 367	3, 059	Sand and gravel.
Henry	W	W	Stone.
Highland	W	16	Stone, sand and gravel.
Isle of Wight	223	202	Sand and gravel, lime, stone.
King George	W	W	Sand and gravel.
King William	W	W	Sand and gravel.
Lee <sup>4</sup>	3, 695	7, 674	Coal, stone, petroleum.
Loudoun	4, 569	3, 991	Stone.
Louisa	W	W	Do.
Lynchburg (City)	W	-----	-----
Madison	W	W	Stone.
Mecklenburg	W	-----	-----
Middlesex	W	-----	-----
Montgomery	823	W	Sand and gravel.
Nansemond	W	W	Stone, clays, coal.
Nelson	W	W	Stone, clays, sand and gravel.
New Kent	W	W	Stone, apelite.
Newport News (City)	W	W	Sand and gravel.
Norfolk (City)	-----	51	Do.
Northampton	5	W	Do.
Northumberland	3	-----	-----
Nottaway	W	-----	-----
Orange	W	W	Stone.
Page	W	W	Clays.
Patrick	W	W	Stone, sand and gravel.
Pittsylvania	W	( <sup>2</sup> )	Stone.
Prince Edward	W	W	Stone, sand and gravel.
Prince George	W	W	Kyanite, stone.
Prince William	W	W	Sand and gravel.
Pulaski	W	W	Stone, clays.
Rappahannock	W	W	Stone.
Roanoke	W	W	Do.
Rockbridge	901	823	Stone, clays.
Rockingham	1, 529	W	Stone, sand and gravel, clays.
Russell	14, 071	20, 868	Stone, sand and gravel.
Scott	1, 178	1, 356	Coal, stone, clays.
Shenandoah	W	W	Stone, coal.
Smyth	W	W	Lime, stone.
Spotsylvania	W	W	Lime, salt, stone, sand and gravel, clays.
Stafford	W	W	Sand and gravel, stone.
Tazewell <sup>5</sup>	2, 022	460	Sand and gravel.
Virginia Beach (City)	1, 018	8, 425	Coal, stone, clays, lime.
Warren	W	803	Sand and gravel.
Washington	2, 006	W	Cement, stone, sand and gravel.
Westmoreland	W	-----	-----
Wise	45, 456	52, 423	Stone, gypsum.
			Coal, stone.

<sup>1</sup>See footnotes at end of table.

**Table 2.—Value of mineral production in Virginia, by counties <sup>1</sup>—Continued**  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Wythe-----	W	W	Zinc, stone, lead, sand and gravel.
York-----	W	W	Sand and gravel, stone.
Undistributed <sup>2</sup> -----	\$85,552	\$103,383	
Total <sup>7</sup> -----	317,527	374,321	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."  
<sup>1</sup> The following counties are not listed because no production was reported: Amelia, Arlington, Charlotte, Cumberland, Essex, Gloucester, Greene, James City, King and Queen, Lancaster, Lunenburg, Mathews, Powhatan, Richmond, Southampton, Surry, and Sussex.  
<sup>2</sup> Less than 1/2 unit.  
<sup>3</sup> Excludes sand and gravel; included with "Undistributed."  
<sup>4</sup> Excludes petroleum; included with "Undistributed."  
<sup>5</sup> Excludes stone and clays; included with "Undistributed."  
<sup>6</sup> Includes sand and gravel that cannot be assigned to specific counties, gem stones, natural gas, and values indicated by symbol W.  
<sup>7</sup> Data may not add to totals shown because of independent rounding.



**Figure 1.—Value of non-coal minerals, value of coal, and total value of all mineral production in Virginia.**

Table 3.—Indicators of Virginia business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total labor force.....thousands..	1,803.2	1,840.9	+2.1
Unemployment.....do.....	48.8	58.3	+19.5
<b>Employment:</b>			
Manufacturing.....do.....	371.0	364.9	-1.6
Mining.....do.....	14.0	15.3	+9.3
Construction.....do.....	94.7	95.3	+6
Transportation and public utilities.....do.....	95.4	97.4	+2.1
Wholesale and retail trade.....do.....	294.6	303.7	+3.1
Finance, insurance, and real estate.....do.....	65.2	67.7	+3.8
Services.....do.....	210.8	219.8	+4.3
Government <sup>1</sup> .....do.....	237.4	244.2	+2.9
<b>Personal income:</b>			
Total.....millions..	\$15,441	\$16,738	+8.4
Per capita.....	\$3,347	\$3,586	
<b>Construction activity:</b>			
Value of nonresidential construction.....millions..	\$342.0	\$339.9	-6
New housing units authorized.....	38,260	43,114	+12.7
Portland cement shipments to and within Virginia thousand 376-pound barrels..	9,117.0	9,424.0	+3.4
Farm marketing receipts.....millions..	\$576.7	\$603.0	+4.6
Mineral production.....do.....	\$317.5	\$374.3	+17.9

<sup>1</sup> Excludes Federal Government workers in the Virginia portion of the Washington, D.C. metropolitan area.

Sources: Employment and Earnings; Survey of Current Business; Construction Review; Area Trends in Employment and Unemployment; Farm Income Situation; and U.S. Bureau of Mines.

**Employment and Injuries.**—Statistics of employment and injuries in the mineral industry, exclusive of the petroleum industry, are presented in table 4.

Studies of the geology and mineral resources of Virginia include an open-file report issued August 10, 1970, by the Virginia Division of Mineral Resources, which listed the findings of an aeromagnetic survey covering 3,840 square miles of all or portions of 17 central Virginia counties. This survey was performed under a contract awarded March 24, 1970. The Di-

vision also issued reports on the geology of four Virginia quadrangles.<sup>2</sup>

<sup>2</sup> Kozak, Samuel J. Geology of the Elliott Knob, Deerfield, Craigsville, and Augusta Springs Quadrangles, Virginia. Virginia Div. Miner. Res. Rept. of Inv. 21, 1970, 23 pp.

Conely, James F., and William S. Henika. Geology of the Philpott Reservoir Quadrangle, Virginia. Virginia Div. Miner. Res. Rept. of Inv. 22, 1970, 46 pp.

Goodwin, Bruce K. Geology of the Hylas and Midlothian Quadrangles, Virginia. Virginia Div. Miner. Res. Rept. of Inv. 23, 1970, 51 pp.

McGuire, Odell S. Geology of the Eagle Rock, Strom, Oriskany, and Salisbury Quadrangles, Virginia. Virginia Div. Miner. Res. Rept. of Inv. 24, 1970, 39 pp.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Coal.....	10,429	207	2,154	17,177	16	988	58.45	8,374
Metal.....	285	257	73	587	1	45	78.37	11,266
Nonmetal.....	599	267	160	1,273	-----	35	27.49	1,031
Sand and gravel.....	559	250	139	1,275	-----	23	18.04	388
Stone.....	3,742	263	985	8,053	5	190	24.21	4,581
Total.....	15,614	225	3,511	28,365	22	1,281	45.94	6,668
<b>1970:<sup>p</sup></b>								
Coal.....	11,405	206	2,349	18,763	27	945	51.80	10,749
Metal.....	290	259	75	598	-----	37	61.90	1,476
Nonmetal.....	580	272	158	1,263	-----	39	30.88	3,330
Sand and gravel.....	550	234	129	1,190	1	23	20.17	6,935
Stone.....	3,580	262	937	7,758	3	142	18.69	3,448
Total.....	16,405	222	3,648	29,572	31	1,186	41.15	8,176

<sup>p</sup> Preliminary.

A directory of the mineral industry in Virginia is issued annually by the Virginia Division of Mineral Resources.<sup>3</sup> The 1971 edition of this publication lists 223 companies and individuals, exclusive of coal producers, on record as of March 1, 1971. The listing includes portable crushing plants, some captive and intermittent operations, and some processors of out-of-State or imported materials. The names of producers and processors are arranged by county or city under the appropriate raw material or commodity. The locations of the various operations are given with respect to a nearby city or town. An alphabetical listing of the names of companies and individuals is provided as a reference index.

Rutile and ilmenite placer deposits were described in a Geologic Survey Bulletin.<sup>4</sup>

**Government Programs.**—Interstate highways completed during the year cost \$63.2 million. Such highways opened to traffic totaled 79.05 miles bringing the total opened since July 1, 1956, to 3,907.3 miles. At yearend, 90.36 miles were under construction, and 180.42 miles were in the design stage. The Federal-Aid Interstate funds for such projects at yearend totaled \$400.5 million, \$59.1 million more than 1 year earlier.

Primary, secondary, and urban highway extensions completed during 1970 totaled 87.4 miles and cost \$35.6 million. At year-

end, projects underway or authorized for such highways totaled 173.1 miles and \$90.8 million, compared with 174.0 miles and \$75.7 million total cost as of December 13, 1969.<sup>5</sup>

The State Highway Department's contracting budgets for 1971 included the following, in million dollars: Interstate, 101.1; primary, secondary, and urban highway extensions, 46.0; maintenance by contract, 19.0; and maintenance by State forces, 51.0.<sup>6</sup>

One project was completed under the Appalachian program. The Secretary of the Interior approved the Norton School surface mine reclamation project in Wise County on October 15, 1969, and a contribution contract, amended to \$219,100, was signed February 24, 1970. The Federal funding was 75 percent of this contract value and the Norton School Board contributed the remaining 25 percent. Work was started on June 15, 1970, by the Cardinal Construction Co. of Roanoke, Va., and the project was completed in late 1970. The project covered 27 acres, and 182,000 cubic yards of material was handled at \$1.20 per cubic yard. Final inspection was made February 18, 1971. The project's cost was completely paid for in 1970.

No other reclamation projects were completed or started in 1970 in Virginia and nothing is pending under the Appalachian program.

## REVIEW BY MINERAL COMMODITIES

### MINERAL FUELS

**Coal (Bituminous).**—Coal, the State's leading mineral commodity in terms of output value, accounted for 66 percent of Virginia's mineral production in 1970. Mine output declined 1.5 percent in quantity but its value, 27.7 percent more than in 1969, established 1970 as the peak value year. The average f.o.b. value of 1 short ton increased to \$7.03 from \$5.42 in 1969 and \$4.84 in 1968. Open-market sales totaling 34.7 million tons averaged \$7.05 per ton; 0.3 million tons not sold on the open market averaged \$4.80 per ton. Production data include coal produced from deposits within Virginia, whether the mine opening was or was not within the State boundary, and exclude operations producing less than 1,000 tons per year. Regulations for safe working conditions and dust-control limits

of the Federal Coal Mine and Safety Act of 1969 became effective March 30 and June 30, respectively.

Both high- and low-volatile bituminous coals were produced for electric-power generation, industrial uses, coke manufacture, and export. The small quantity of semianthracite coal, mined in Montgomery County, was used for domestic heating.

<sup>3</sup> LeVan, D. C. Directory of the Mineral Industry in Virginia, 1971. Virginia Div. Miner. Res., 1971, 46 pp.

<sup>4</sup> Herz, Norman, L. E. Valentine, and E. R. Iberall. Rutile and Ilmenite Placer Deposits, Roseland District, Nelson and Amherst Counties, Virginia. U.S. Geol. Survey Bull. 1312-F, 1970, 19 pp.

<sup>5</sup> Federal Highway Administration. Quarterly Report on the Federal-Aid Highway Program, Dec. 31, 1969. Press Release RHWA-422, Feb. 10, 1970.

<sup>6</sup> Engineering News Record. V. 186, No. 12, Mar. 25, 1971, p. 12.

The Clinchfield Coal Co. and its Jewell Ridge Division opened three new mines in Buchanan County, and two each in Tazewell and Wise Counties. Island Creek Coal Co.'s Virginia Pocahontas No. 3 mine was completed, and shaft sinking for the Virginia Pocahontas No. 4 mine was started during 1970. Vertical ventilation holes were drilled in the worked-out area of the 1,300-foot-deep Beatrice mine to drain methane from the gob areas. The Stonega Division, Westmoreland Coal Co., opened the new Wentz Marker No. 2 mine near Appalachia.

According to data in Coal Resources of Virginia, Geological Survey Circular 171 (January 1, 1951) and records on coal mined from January 1, 1951, through December 31, 1969, in the Division of Mines Office, the remaining reserves of coal as of January 1, 1970, totaled 10,248 million short tons in Buchanan, Dickenson, Lee, Russell, Scott, Tazewell, and Wise Counties. Buchanan and Dickenson Counties had 6,080 million short tons of the remaining reserves as of January 1, 1970. Approximately 294 million tons of the reserves remaining as of January 1, 1970, in Buchanan, Dickenson, Lee, Russell, Tazewell, and Wise Counties contain less than 0.79 percent average sulfur content. Approximately 64 percent of the remaining reserves having less than 0.79 percent sulfur content were in Buchanan and Dickenson Counties.

The Virginia Electric & Power Co. scheduled an 845-megawatt plant for completion in 1974 near Mineral, Va. This plant was designed to use coal or oil.

The same company had two 780-megawatt nuclear-powered plants under construction at Gravel Neck. These plants will become operable in 1971 and 1972. At yearend two 845-megawatt stations were planned and nuclear reactors were ordered for installation near Mineral. Plant completion is set for 1974 and 1975. This total nuclear-powered generating capacity, if fueled by bituminous coal, would require approximately 7 to 8 million tons per year.

The 1970 annual report of the Virginia Department of Labor and Industry reported 27 fatalities in the coal industry (11 more than in 1969). The number of fatalities were as follows, by cause: 10 by roof falls, eight by machinery, six by haulage, and three by other causes. The re-

port also stated that 25 fatalities resulted from violations of the State Mining Laws in existence since January 1954, and two because the victims were not alert to their surroundings. The fatality rate per million tons of coal produced was 0.77, compared with the alltime low of 0.32 attained in 1968. In 1970, the injury frequency for 1 million man-hours of exposure was 51.8, and the severity rate was 10,749 for 1 million man-hours of exposure. The number of workers directly involved in the industry was 11,405 (437 more than in 1969), including 539 office workers.

Based on preliminary data, productivity for the entire coal industry averaged 14.90 tons per man-day, compared with 16.51 in 1969. The output of cleaned coal from preparation plants decreased to 169.25 tons per man-day from 190.96 in 1969.

Four of the eight counties in which coal was mined accounted for 93 percent of the total output. These counties were Buchanan (42 percent), Wise (24 percent), Dickenson (20 percent), and Russell (7 percent). Of the total coal production 80 percent was from underground mines, 15 percent from strip mines, and 5 percent from auger mines. Buchanan, Dickenson, Wise, and Russell Counties led in underground tonnage; Wise, Buchanan, and Dickenson Counties in strip mine output; and Buchanan, Wise, and Dickenson in auger-mined coal.

There were 803 active mines: 566 were underground, 32 fewer than in 1969; 154 were strip mines, 78 more than in 1969; and 83 were auger mines, one more than in 1969.

Major seams mined included the Blair, Clintwood, Hagy, Imboden, Kennedy, Jewell, Norton, Pocahontas No. 3, Raven, Splash Dam, Taggart, Tiller, and Upper and Lower Banner.

Thirty-three mechanical cleaning plants received 27.25 million tons of raw coal from which 6.27 million tons of impurities were separated and 20.98 million tons salable coal (60 percent of the State's total coal production) were recovered. Ninety-nine percent of the cleaned product came from deep-mined coal. Equal tonnages of the remainder of the clean coal originated from raw coal coming from strip and auger mines.

Wet-washing equipment other than jigs produced 18.2 million tons of clean coal distributed in million tons, by type of

process: 9.31, dense medium; 6.82, tables; and 2.07, froth flotation. Jigs accounted for 2.40 million tons and pneumatic equipment, for 0.38 million tons. Sand was used as the heavy medium in one plant; calcium chloride in four plants; and magnetite in 26 plants.

The annual capacity of bituminous-coal mechanical-cleaning equipment purchased in 1970 by three companies, for use in the Clinchfield, Buchanan County, and Jewell Valley plants, was 1,763,300 net tons. This capacity equals 1,145 tons per operating hour based on a 7-hour day and 220 days per year.

Twenty-three thermal drying units produced 8.59 million tons. Crushed clean and raw coal totaling 16.06 million tons came from 65 plants.

The types of transportation and the quantity of coal moved to market included, in million tons, 33.3 by rail (including 5.9 by unit train) and 1.66 by truck. Coal-fueled utilities in the State received 6,653,000 tons of coal in 1970.

Underground mines produced 28.02 million tons. Production was as follows, in million tons, by method: 1.29, cut by hand and shot from the solid; 15.09, using 441 cutting machines, 702 drills, and blasting; 10.08 by 116 continuous mining machines; and 1.55 by four longwall installations in two mines owned by one company.

The total deep mined production from 556 mines was 2.36 million tons less than that of 1969 from 598 mines. Buchanan County led in deep-mined production with 12.67 million tons (45.2 percent of the total deep-mined production).

Deep mines produced 9.69 million tons by the use of 637 hand held and post mounted drills and 6.95 million tons using 65 mobile drills. Drilling for roof bolting was done by 161 rotary and 120 percussion drills; other rock drilling uses required six rotary drills and 20 percussion drills.

At 141 mines 4,921,000 bolts were installed, all new, as either the sole method of roof support or in conjunction with other support materials. These mines produced 23.5 million tons of coal including 18.8 million tons produced under roof supported only by bolts.

Of the total underground output, 92.6 percent was mechanically loaded, as reported by 369 of the 556 total deep mines;

297 mobile loading machines loaded 7.89 million tons into mine-rail cars or onto conveyors, and 69 other mobile loaders handled 6.44 million tons into shuttle cars or rubber-tired mine cars. Seven continuous miners discharged 212,000 tons onto conveyors, and 109 continuous miners loaded 9.87 million tons into shuttle cars or rubber-tired mine cars. Four plow-type longwall installations cut and loaded nearly 1.56 million tons. Collectively, 486 loading devices were used to load the 25.96 million tons reported.

Haulage in underground mines was performed by rail track systems having 179 trolley and 89 battery locomotives and 2,395 cars of 3.2-ton average capacity operating on 173 miles of track; by rubber-tired equipment comprising 528 tractors, 170 trailers, 1,868 cars averaging 2.3 tons in capacity, 324 cable-reel and 50 battery-powered shuttle cars, and 17 shuttle buggies. Belt conveyors, totaling 308 in number and 128.9 miles in length, averaged 2,209 feet in length. There were 51 personnel carriers and mine-trip cars.

In 1970, shipments of new equipment to the State's deep mines included 10 mobile loaders, 15 continuous miners, nine cutting machines, one longwall unit, 36 shuttle cars, and 51 gathering and haulage conveyors.

The 28.02-million-ton underground production averaged \$7.62 per ton f.o.b. mine, compared with the 30.37-million-ton production at \$5.73 per ton in 1969.

There were 154 strip mines in seven counties, which produced 5.10 million tons (1.54 million tons more than in 1969). The average f.o.b. mine value was \$4.66 per ton, compared with \$3.64 in 1969. Equipment in these strip mines included 65 diesel shovels of which only 21 were larger than 6-cubic-yard capacity, four small-capacity carryall scrapers, 84 bulldozers, seven horizontal drills, 24 vertical drills, 46 front-end loaders, seven motorgraders, and one coal drill.

Eighty-three auger mines in six counties produced 1.89 million tons of coal having an average f.o.b. mine value of \$4.64 per ton, compared to \$3.43 per ton for the 1.62-million-ton production in 1969. Equipment in the 83 auger mines included 85 augers, 73 bulldozers, 14 front-end loaders, three vertical drills, and two motorgraders.



**Table 5.—Virginia: Bituminous coal production in 1970, by type of mine and counties**  
(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines				Production				Value <sup>1</sup> (thousands) dollars
	Under-ground	Strip	Auger	Total	Under-ground	Strip	Auger	Total <sup>2</sup>	
Buchanan.....	388	48	49	485	12,670	1,171	974	14,815	\$104,004
Dickenson.....	58	16	13	87	5,900	983	264	7,147	54,931
Lee.....	31	12	9	52	546	322	258	1,127	6,894
Montgomery....	W	W	-----	W	W	W	-----	W	W
Russell.....	7	9	1	17	2,066	266	2	2,333	19,623
Scott.....	W	W	-----	W	W	W	-----	W	W
Tazewell.....	13	8	3	24	778	328	9	1,115	8,409
Wise.....	67	60	8	135	6,046	2,031	388	8,466	52,177
Undistributed..	2	1	-----	3	11	2	-----	13	83
<b>Total<sup>2</sup>..</b>	<b>566</b>	<b>154</b>	<b>83</b>	<b>803</b>	<b>28,018</b>	<b>5,103</b>	<b>1,895</b>	<b>35,016</b>	<b>246,181</b>

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

<sup>1</sup> Value received or charged f.o.b. mine. Includes a value for coal not sold but used by producers, such as mine fuel and coal coked, as estimated by producers at average prices that might have been received if such coal had been sold commercially.

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

**Coke.**—Three companies operated three coke plants in Buchanan and Wise Counties. The production of coke was discontinued at the Pine Branch plant of the Westmoreland Coal Co. on Feb. 28, 1970. Two of the three plants, including Westmoreland, used non-recovery Mitchell-type ovens.

**Petroleum and Natural Gas.**—Crude petroleum production totaled 917 42-gallon barrels; approximately equal amounts came from one well each in the Ben Hur and Rose Hill fields in Lee County. The American Oil Co. at Yorktown operated a petroleum refinery rated at 52,900-barrel-per-day crude capacity.

Natural gas was produced in Buchanan, Dickenson, Tazewell, and Wise Counties. Tazewell County accounted for 57.0 percent of the total marketed gas, which was 1.4 percent less in volume than that of 1969, but 2.3 percent greater in value because of an average increase of 1.1 cents per thousand cubic feet. About 62 percent of the gas marketed went to the Atlantic Seaboard Corp., 23 percent to the Consolidation Gas Supply Corp., and 15 percent to the Kentucky-West Virginia Gas Co.

Renewed drilling activity occurred in Buchanan, Dickenson, and Tazewell Counties where a total of 73,006 feet (86 percent in the Berea gas-producing formation) was drilled in 17 holes resulting in a combined gas open flow of about 17 million cubic feet from 14 producing wells. Two dry holes were plugged and abandoned.

The proved reserves of natural gas at yearend totaled 32,511 million cubic feet

(1,073 million cubic feet more than at the start of 1970).<sup>7</sup>

#### NONMETALS

**Aplite.**—This commodity, chiefly used in glassmaking, was produced from two operations, one in Hanover County (Feldspar Corp.), and one in Nelson County (International Minerals & Chemical Corp.). A limited quantity was produced in Amherst and Nelson Counties by a third company, Dominion Stone Plant, Inc., for use chiefly as aggregate. Compared with 1969, the output was one-sixth greater and the value was up 21 percent.

**Cement.**—Compared with 1969, portland cement shipments were up 1.2 percent in quantity and 6.9 percent in value; masonry cement shipments were down 7.7 percent in quantity but up 3.1 percent in value. Types I and II, and III portland cement accounted for 82 percent of the total weight of portland and masonry cements shipped and 79 percent of the value of all cement shipments.

Three plants were active, one each in Botetourt and Warren Counties and one in the city of Chesapeake. One plant produced portland cement only, another made colored and natural masonry cement only, and the third made both kinds of cement. Two plants used the dry process and the third used the wet process. The three plants operated eight kilns rated at a total maximum 24-hour capacity of 12,757 bar-

<sup>7</sup> Oil and Gas Journal. Breakout by State of Crude-Oil and Natural-Gas Reserves in the United States. V. 69, No. 14, Apr. 5, 1971, pp. 38-40, 42.

rels (376-pounds). Normal maintenance required the total equivalent of 119 kiln-days.

The quantity of raw materials consumed by the plants in 1,000 short tons comprised the following: limestone, 1,007; domestic clinker, 792; marl, 382; shale, 314; clay, 87; gypsum, 34; sand, 18; iron ore, 7; and fluorspar, 1.

The three plants also used 1,348 million cubic feet of natural gas, 15,000 barrels of fuel oil, 146,000 tons of bituminous coal, and purchased 123.6 million kilowatt-hours of electricity.

Stocks of cement (376-pound-per-barrel basis) totaled 267,298 barrels on January 1 and 380,979 barrels at yearend.

The distribution of shipments, by type of transportation, was, in percent, 70 by rail in bulk, 13 by rail in containers, 15 by truck in bulk, and 2 by truck in containers. Building material dealers, concrete product manufacturers, and ready-mixed concrete producers received 87 percent of the shipments. The remainder of the shipments was used in highway construction.

The 1970 apparent consumption of cement in Virginia was 9.4 million 376-pound barrels of portland and 1.2 million 280-pound barrels of masonry cement.

**Clays.**—Clay production was 2.6 percent less than in 1969, but its value was 11.2 percent greater because the average value increased 12 cents per short ton to \$1.02. Seventy-six percent of the clays produced was classed as shale, 19 percent as common clay, and 5 percent as undifferentiated clay and shale.

Clay production was reported by 13 companies operating 35 open pit mines in 15 counties. None of the production was sold on the open market. Lone Star Cement Corp. and Webster Brick Co. Inc. produced half of the total production and accounted for 56 percent of the total value. In order of output, the chief producing counties were Botetourt, Orange, Russell, Chesterfield, and Nansemond with nearly 77 percent of the State's production and value of output. Twelve brick manufacturing plants were active in 1970.

Nearly 57 percent of the total production was used in manufacturing heavy clay products. Sixty percent of the remainder was used in cement manufacture and the balance went into lightweight aggregates.

**Table 6.—Virginia: Clays sold or used by producers**

(Thousand short tons and thousand dollars)		
Year	Quantity	Value
1965-----	1,415	\$1,657
1966-----	1,486	1,813
1967-----	1,382	1,623
1968-----	1,462	1,714
1969-----	1,677	1,504
1970-----	1,633	1,672

**Feldspar.**—Output and value were both about 45 percent more than in 1969. Northwestern Feldspar Corp. produced feldspar from five mines in Bedford County. Mixed feldspar (soda and potash) was processed at the company's mill in Bedford. The mill output was sold principally to pottery and ceramic enamel manufacturers. Virginia ranked eighth in U.S. feldspar production.

**Gem Stones.**—Amateur lapidarists collected mineral specimens including amethyst, apophyllite, garnet, jasper, moonstone, prehnite, thaumasite, turquoise, quartz, and unakite for sale or as a hobby. The principal finds were made in Amelia, Amherst, Campbell, Fairfax, Madison, and Page Counties.

**Gypsum.**—Compared with 1969, output of crude gypsum increased 22 percent in quantity and 29 percent in value. The raw gypsum, mined at Plasterco, Washington County, was calcined or otherwise processed and manufactured into plasterboard and other gypsum products by United States Gypsum Co. at Plasterco. The company also processed imported gypsum at Norfolk for use in its products.

Virginia's only underground nonmetal mine winner in the 1970 "Sentinels of Safety" competition sponsored by the Department of the Interior, Bureau of Mines, and the American Mining Congress was the Plasterco No. 6 mine of the United States Gypsum Co., Plasterco, Washington County. This mine had 153,456 man-hours without a disabling work injury.

**Kyanite.**—Crude kyanite ore output was up about 8 percent in quantity and 9 percent in value compared with 1969. Shipments were principally to refractory and ceramic product manufacturers. The Kyanite Mining Corp. operated mines and processing plants in adjoining Buckingham and Prince Edward Counties, and a grinding and bagging plant in the latter county.

The bulk of the beneficiated kyanite ( $Al_2SiO_5$ ) was calcined to mullite, one of the most important refractory materials

used in the ceramic industry. Quartzite sand, recovered during kyanite milling, was marketed for industrial and construction uses. Virginia is North America's leading kyanite producer.

**Lime.**—The total lime production (quick and hydrated) decreased 2.4 percent in tonnage and increased 3.2 percent in value compared with 1969. The average value of all production increased from \$12.74 per short ton in 1969 to \$13.46 in 1970. Quicklime accounted for 93 percent of the total production and averaged \$13.38 per ton in value, and hydrated lime, equaling 7 percent of the total production, averaged \$14.60 per short ton. The total output came from eight plants operated by eight companies in six counties. Giles, Shenandoah, and Smyth Counties accounted for 87 percent of the State's total quantity and value. Companies in order of output were National Gypsum Co., Foote Mineral Co., Chemstone Corp., Olin Corp., M. J. Grove Lime Co., W. S. Frey Co., Inc., Battery Park Fish & Oyster Co., and Blue Grass Lime Co.

The principal use for Virginia lime production was in basic oxygen-steel-furnaces. Lime consumption in the State in 1970 totaled 294,000 short tons of quicklime and 31,000 short tons of hydrated lime. Out-of-State sources supplied some of the Virginia consumption.

The destination of Virginia's lime production was as follows, in percent: Virginia, 30; Ohio, 17; Pennsylvania, 15; West Virginia, 13; Kentucky, 10; Maryland, 6; North Carolina, 4; and other States, 5.

Processing equipment used in limemaking included pot, shaft, and rotary kilns

and batch and continuous hydrators. Raw materials included high-calcium limestone (predominately), dolomitic limestone, and oystershell. About 2 million tons of limestone was calcined in the production of lime. Fuels included bituminous coal, coke, and natural gas. Virtually all the lime output was high-calcium products.

**Lithium Compounds.**—The Foote Mineral Co. at Sunbright, Scott County, used limestone mined at Sunbright and spodumene from North Carolina in the preparation of lithium compounds.

**Manganese Ore.**—Imported ore was processed in Lynchburg by C-E Minerals Division of Combustion Engineering, Inc., and in Newport News by the Consumer Products Division of Union Carbide Corp.

**Marl.**—Marl produced in Nansemond County by the Lone Star Cement Corp. was used in the manufacture of cement at the company's plant in Chesapeake. Marl was also produced in the City of Hampton and in York County for fill purposes and in Clarke County for agricultural purposes.

**Mica.**—Mica was processed at two Newport News plants. One plant fabricated mica and the other was listed as a plate-mica plant.

**Nitrogen Compounds.**—Allied Chemical Corp., Nitrogen Division, Hopewell, Prince George County, used reformed natural gas, to produce ammonia, urea, ammonium nitrate, and ammonium sulfate chiefly for use as fertilizer or fertilizer ingredients. The rated annual capacity of the plant at Hopewell is 350,000 short tons of ammonia.

**Salt.**—The production of salt by Olin Corp., Saltville, Smyth County, from cap-

Table 7.—Virginia: Lime sold or used by producers, by uses  
(Short tons)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Steel, BOF	302,638	\$3,989,000	345,002	\$4,493,573
Paper and pulp	129,162	1,702,000	106,458	1,365,700
Steel, electric	104,193	1,373,000	105,418	1,357,000
Water purification	39,123	516,000	37,823	559,200
Sewage	36,764	485,000	36,087	477,340
Steel, open-hearth	49,945	653,000	W	W
Agriculture	28,780	299,524	17,265	209,008
Construction	12,187	172,854	15,056	201,623
Other chemicals <sup>1</sup>	369,597	4,457,746	383,382	5,426,676
Total	1,072,389	13,653,124	1,046,491	14,090,120

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

<sup>1</sup> Includes alkalis, calcium carbide, other metallurgy, open-hearth steel (1970), other chemical, other ore concentration, copper concentration (1969), precipitated calcium carbonate (1969), tanning, food (1969), sand-lime brick (1969), insecticides (1969), and rubber (1969).

tive wells was 1 percent more than in 1969. The brine was used to produce chlorine, liquid and dry caustic soda, soda ash, and other chemicals. In July, the Olin Corp. announced the phasing out of its 375,000 ton-per-year soda ash production facility and the loss of 600 jobs by December 31, 1972, after the Virginia State Water Control Board in June began enforcing a downstream limit of 500 parts per million of chloride. Chlorine and caustic production will not be terminated.<sup>8</sup> Salt shipments into the State in 1970 included 96,000 short tons of evaporated salt and an undisclosed tonnage of rock salt.

**Sand and Gravel.**—Compared with the 1969 situation, the total production was 8.4 percent less and its value was 4.6 percent less despite an average increase in value of 5.5 cents per short ton. Sixty commercial operations using .39 stationary plants, 11 portable plants and four dredges, produced 7.67 million tons of sand and 3.39 million tons of gravel. Government-and-contractor production comprised 57,000 tons of sand and 7,000 tons of gravel. The size of operations ranged from 226,000 total tons from

21 operations to 2.37 million total tons from two operations. The largest producer of sand and gravel was Henrico County followed by Chesterfield, Fairfax, and Charles City Counties. Collectively, these four counties accounted for 52.7 percent of the total production. Sand production in 1970 was 69.5 percent of the total sand and gravel production, compared with 67.9 percent in 1969. Commercial transportation of sand and gravel in million tons, was distributed as follows, in million tons: 6.6 by truck 0.9 by railroad and 3.6 by waterway.

Sand production was 6.2 percent less, but its average value was 2.8 percent more than that of 1969 because of an average increase in value of 7.8 cents per ton. Ground and unground commercial sand for industrial uses, classed as glass, fire or furnace, engine, abrasive, filler and miscellaneous, totaled 494,000 tons and averaged \$3.09 per ton. Construction sand for building, paving and fill purposes totaled 7,027,000 tons and averaged \$1.09 per ton.

<sup>8</sup> Chemical & Engineering News. Danger of Chloride. V. 48, No. 30, July 20, 1970, p. 17.

**Table 8.—Virginia: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	3,852	\$4,762	4,116	\$5,226
Fill.....	571	320	357	173
Paving.....	2,999	2,516	2,497	2,212
Other uses <sup>1</sup> .....	748	1,607	702	1,627
Total <sup>2</sup> .....	8,170	9,206	7,671	9,237
<b>Gravel:</b>				
Building.....	2,501	4,569	2,670	5,009
Paving.....	1,271	1,940	564	758
Other uses <sup>3</sup> .....	119	207	157	203
Total <sup>2</sup> .....	3,892	6,716	3,391	5,970
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Fill.....	42	15	51	18
Paving.....	26	9	6	1
Total <sup>2</sup> .....	68	24	57	19
<b>Gravel:</b>				
Fill.....	7	7	5	2
Paving.....	3	1	3	1
Total <sup>2</sup> .....	10	8	7	3
Total sand and gravel <sup>2</sup> .....	12,140	15,954	11,126	15,229

<sup>1</sup> Includes railroad ballast, glass, fire or furnace, filtration (1970), engine, ground, and other sands.

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

<sup>3</sup> Includes fill, miscellaneous, and other gravel.

Gravel production was 12.9 percent less, and its value was 11.2 percent less than in 1969 despite an average increase in value of 3.5 cents per ton. Only 0.3 percent of the production was used for purposes other than construction.

In the 1970 National Sand and Gravel Association safety contest (covering the period from July 1, 1969 to June 30, 1970), the King George plant of the Solite Corp. in Richmond, reported no accidents.

Operations of the Virginia Glass Sand Corp., and the Shenandoah Silica Co., Inc., near Gore, Frederick County, were consolidated under Unisil Corp., the new owner. The mining and processing of sandstone for glass sand and other industrial uses will be continued.

**Soapstone.**—Crushed and ground soapstone was produced by Blue Ridge Talc Co., Inc., at a plant near Henry, principally for use in insecticides and foundry facings. Raw material came from a company quarry in Franklin County. Output and value of soapstone mined were 18 and 25 percent less respectively, than in 1969. The ground material was sold for about \$15 per short ton.

Dimension soapstone was produced by Alberene Stone, a division of Georgia Marble Co., in Nelson County. This operation employed 175 person a decrease from a normal of 250.

**Stone.**—The total production including dimension stone increased 5.8 percent in tonnage and 3.0 percent in value compared with 1969 despite an average decrease in value of 4.4 cents per short ton.

Dimension stone produced at 11 operations in eight counties was 68 percent less in quantity and 16 percent less in value compared with 1969. Dimension stone accounted for 0.7 percent of the tonnage and 5.7 percent of the State's total stone value. The average value of all dimension stone was \$149.43 per ton, compared with \$56.69 in 1969. Slate accounted for 58 percent of the quantity and 54 percent of the value of all dimension stone. Slate was produced by two operations that also produced limestone, traprock, and other stone. Three operations were active only in slate. The uses of dimension stone, in decreasing order of quantities produced, were structural, flagging, roof slate, irregular shapes and rubble not specified, cut and sawed, and monumental.

Crushed stone, produced at 141 operations in 56 counties, accounted for 99.3 percent of the tonnage and 94.3 percent of the value of all stone produced in the State. The average value of all crushed stone decreased to \$1.61 per ton from \$1.64 in 1969. Major crushed stone producing counties accounting for 52.5 percent of the total crushed stone production were as follows: Albemarle, Botetourt, Campbell, Dinwiddie, Fairfax, Frederick, Giles, Goochland, Loudoun, Roanoke, Shenandoah, and Tazewell.

The number of operations in limestone was 71, 29 in granite, 10 in traprock, 9 in dolomite, six in sandstone, four in marl, three each in quartz and quartzite, two in slate, and one each in marble, shell and other stone.

The percent of quantity and the percent of value of the total crushed stone production were distributed as follows:

	<i>Percent of quantity</i>	<i>Percent of value</i>
Limestone.....	47.7	46.3
Granite.....	30.2	32.1
Traprock.....	9.5	10.6
Dolomite.....	7.2	6.3

Collectively, marble, marl, sandstone, quartz, quartzite, shell, other stone, and slate accounted for 5.4 percent of the quantity and 4.7 percent of the value of all crushed stone.

Crushed limestone for use as aggregate, road-base stone, and lime and cement manufacture accounted for 74.5 percent of the production. The remainder of the production went into 18 minor uses including 120,687 tons for mine rock dusting.

Aggregates consumed 58.6 percent of the crushed dolomite production; agricultural lime took 25.5 percent and 10 other uses consumed the remainder of the production.

Of the crushed granite produced 58.4 percent was used as road-base stone, 30.1 percent went into aggregates, and the remainder was used for other purposes.

All crushed marble was used as terrazzo.

Cement manufacture accounted for 90.4 percent of the crushed marl production. The remainder was used as fill. Of the total crushed sandstone production, 67.6 percent was used for aggregates, 22.7 percent as road-base stone, and the remainder in other minor uses.

Road-base stone accounted for 65.8 per-

cent of the crushed quartzite production; aggregates took the remainder of the production.

All crushed shell was used in cement manufacture.

The uses of crushed traprock production were as follows: 52.3 percent for aggregates; 42.3 percent for road-base stone; and the remainder in other minor applications.

Ninety percent of crushed "other stone" went into concrete aggregates and the remainder into roofing aggregates.

Eighty-five percent of the crushed slate production was used for aggregates.

Shipments of crushed stone were distributed as follows, in million short tons, by method of transportation: 27.0 by truck;

6.3 by railroad; 0.5 by waterway; and 1.6 by other and unspecified methods.

The Riverton Lime and Stone Co., Inc., opened a quarry in May 1970 near Luray, Page County, for producing crushed stone from carbonate rocks. This company worked permanent quarries alternately by the use of portable crushing equipment, screens, and movable loadout bins.

The Appomattox Lime Co. operated a quarry and crushing plant near Oakville for the production of agricultural stone, utilizing the facilities of the former State Lime Grinding Plant No. 2 operated by the Commonwealth of Virginia from 1937 until August 1970.

The Martinsville Stone Corp. transferred

**Table 9.—Virginia: Stone sold or used by producers, by uses**  
(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Dimension stone total.....	72	\$4,082	23	\$3,437
Crushed and broken stone:				
Bituminous aggregate.....	2,332	3,823	2,777	4,643
Concrete aggregate.....	2,367	3,710	2,968	4,614
Dense graded road base stone.....	11,644	19,662	12,319	19,723
Macadam aggregate.....	1,238	2,129	906	1,281
Surface treatment aggregate.....	1,468	2,329	1,483	2,575
Unspecified aggregate and roadstone.....	5,879	9,401	5,779	9,367
Agricultural limestone.....	1,191	2,155	1,145	2,079
Cement.....	1,620	1,811	1,714	1,925
Lime.....	1,980	3,046	1,843	2,993
Railroad ballast.....	566	775	671	933
Riprap and jetty stone.....	194	234	W	W
Stone sand.....	346	668	354	629
Other uses <sup>1</sup> .....	2,613	4,889	3,432	6,278
Crushed total <sup>2</sup> .....	33,388	54,631	35,392	57,040
Grand total <sup>2</sup> .....	33,461	58,713	35,415	60,477

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."  
<sup>1</sup> Includes stone used for mineral food, soil conditioners, filter stone, flux stone, chemical stone, mine dusting, fill, glass, paper, lightweight aggregates, roofing aggregates (1970), and other uses in smaller quantities.  
<sup>2</sup> Data may not add to totals shown because of independent rounding.

**Table 10.—Virginia: Stone sold or used by producers, by kinds**  
(Thousand short tons and thousand dollars)

Kind of stone	1969		1970	
	Quantity	Value	Quantity	Value
Dolomite.....	4,358	\$6,252	2,563	\$3,599
Granite.....	9,193	16,513	10,675	18,290
Limestone.....	13,474	21,128	16,869	26,420
Quartzite.....	W	W	W	239
Sandstone.....	541	869	735	1,305
Slate.....	W	2,403	W	2,322
Traprock.....	4,667	8,653	3,387	6,154
Undistributed <sup>1</sup> .....	1,228	2,894	1,186	2,148
Total <sup>2</sup> .....	33,461	58,713	35,415	60,477

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

<sup>1</sup> Includes marble, marl, quartz, shell, and other stone.

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

quarrying and plant operations in early 1970 from near Collinsville, Henry County, to a new location south of Fieldale in the same county, where crushed stone was produced from gneiss.

**Sulfur.**—Hydrogen sulfide, recovered from fuel gas, was converted to elemental sulfur by the American Oil Co. at its Yorktown refinery. Compared with 1969, sulfur production was down about 30 percent, but the sales value increased 4 percent. Production and sales were approximately equal.

#### METALS

**Iron Ore (Pigment Material).**—Manufactured iron oxides, for use in pigment manufacture were produced at Pulaski, and iron oxides for producing natural pigments were mined near Hiwassee, by the Imperial Color & Chemical Dept. of Hercules, Inc. Natural iron oxide pigments were produced by Blue Ridge Talc Co., Inc., at Henry, Henry County, from hematite obtained from out-of-State sources. The finished iron oxide pigments were used in

cement, printing inks, paint manufacture, and in other products.

**Lead and Zinc.**—Lead and zinc ore were recovered from two mines at Austinville and Ivanhoe in Wytche County, which are operated by the same company. The ratio of zinc recovery to that of lead was about 5.4 to 1. The output value per pound of each metal averaged 0.7 cent higher than in 1969.

**Titanium Concentrates.**—Ilmenite used in the manufacture of titanium dioxide pigments was produced only by the American Cyanamid Co., Piney River, Amherst County. Compared with 1969, production was up 5 percent and the value of shipments that exceeded production by 2 percent was up 6 percent. The Piney River operations were to cease in June 1971, as announced by the company December 8, 1970, reportedly because of the depletion of easily accessible soft ore and ecological problems. The plant, operated by American Cyanamid Co. for 26 years, employs 380 persons, has an annual payroll of \$2 million, and pays \$31,704 in taxes per year to Nelson County.

Table 11.—Virginia: Mine production of recoverable lead and zinc

Year	Lead		Zinc	
	Short tons	Value (thousands)	Short tons	Value <sup>1</sup> (thousands)
1965 .....	3,651	\$1,139	20,491	\$5,942
1966 .....	3,078	930	17,666	5,123
1967 .....	3,430	960	18,846	5,088
1968 .....	3,573	944	19,257	5,199
1969 .....	3,358	1,000	18,704	5,462
1970 .....	3,356	1,048	18,063	5,534

<sup>1</sup> Recoverable zinc valued at the yearly average price of prime western-slab zinc, East St. Louis market. Value established after transportation, smelting, and manufacturing charges have been added to the value of the ore at the mine.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Aplite (crude):</b>			
International Minerals & Chemical Corp., Industrial Minerals Div.	Piney River, Va. 22964	Quarry	Nelson.
<b>Cement:</b>			
Lone Star Cement Corp. <sup>1</sup>	3315 W. Broad St. Richmond, Va. 23230	Plant and quarry	Botetourt.
Lone Star Cement Corp. <sup>2</sup>	do	Plant	Chesapeake (City).
Riverton Lime & Stone Co., Inc. <sup>3</sup>	Riverton, Va. 22651	Quarry and plant	Warren.
<b>Clays (miscellaneous and shale):</b>			
Brick and Tile Corp. of Lawrenceville.	P.O. Box 45 Lawrenceville, Va. 23868	Pit and plant	Brunswick.
Daniels Brick and Tile Co., Inc.	P.O. Box 4237 Richmond, Va. 23224	Pit and plant (City of Richmond).	Chesterfield.
Do	do	Pit	Dinwiddie.
General Shale Prod. Corp.	Box 3547 Johnson City, Tenn. 37601	Pits and plants	Chesterfield, Smyth, Tazewell.
Clinchfield Coal Company Div of The Pittston Co. <sup>4</sup>	Dante, Va. 24237	Plant	Russell.
Locher Brick Co., Inc.	Route 1, Box 1 Glasgow, Va. 24555	Pit and plant	Rockbridge.
Old Virginia Brick Co., Inc	P.O. Box 508 Salem, Va. 24153	do	Roanoke.
Do	do	Pit	Montgomery.
Redford Brick Co.	Box 4096 Richmond, Va. 23224	Pit and plant (City of Richmond).	Chesterfield.
Weblite Corp.	Box 780 Roanoke, Va. 24004	Pit and plant	Botetourt.
Webster Brick Co., Inc.	do	Pits	Botetourt, Nansemond, Orange, Prince William.
Woodbridge Clay Products Co.	Rt. 3, Box 240 Manassas, Va. 22110	Pit	Prince William.
<b>Coal (bituminous):</b>			
Betty B. Coal Co. <sup>5</sup>	Clintwood, Va. 24228	Underground mine	Dickenson.
Clinchfield Coal Co. <sup>6</sup>	Dante, Va. 24237	do	Buchanan.
Clinchfield Coal Co. <sup>7</sup>	do	do	Dickenson.
Clinchfield Coal Co. <sup>8</sup>	do	do	Russell.
Coal Processing Corp.	Box 497 Norton, Va. 24273	do	Wise.
Harman Mining Corp. <sup>6</sup>	Harman, Va. 24618	do	Buchanan.
Island Creek Coal Co. <sup>8</sup>	Box 113 Keen Mountain, Va. 24624	do	Do.
Westmoreland Coal Co. <sup>9</sup>	P.O. Box 229 Big Stone Gap, Va. 24219	do	Wise.
Big Six Corp.	Box 340 Clintwood, Va. 24228	Strip mine	Dickenson.
Contracting Enterprises, Inc.	Clintwood, Va. 24228	do	Do.
Stamach Mining Corp. <sup>8</sup>	P.O. Drawer 389 Appalachia, Va. 24216	do	Wise.
Flat Gap Mining Co., Inc.	Box 387 Norton, Va. 24273	Auger mine	Do.
<b>Coke:</b>			
Christie Coal and Coke Co., Inc.	P.O. Box 409 Norton, Va. 24273	Plant	Do.
Jewell Smokeless Coal Corp.	Jewell Valley, Va. 24623	do	Buchanan.
Westmoreland Coal Co., Stonega Div.	Box 229 Big Stone Gap, Va. 24219	do	Wise.
<b>Feldspar (crude):</b>			
Northwestern Feldspar Corp.	P.O. Box 706 Custer, S.D. 57730	Mine	Bedford.
<b>Gypsum:</b>			
United States Gypsum Company. <sup>10</sup>	101 S. Wacker Drive Chicago, Ill. 60606	Plant	Chesapeake (City).
United States Gypsum Company.	do	Mine and plant	Washington.
<b>Iron-oxide pigments (crude):</b>			
Hercules, Inc., Imperial Color & Chemical Dept. <sup>11</sup>	Hiwassee, Va. 24347	do	Pulaski.
<b>Iron-oxide pigments (finished):</b>			
Blue Ridge Talc Co., Inc.	P.O. Box 7 Henry, Va. 24102	Plant	Franklin.
<b>Kyanite:</b>			
Kyanite Mining Corp. <sup>12</sup>	Dillwyn, Va. 23936	Mine and plants	Buckingham.
Do	do	do	Prince Edward.
<b>Lime:</b>			
Battery Park Fish & Oyster Co. <sup>13</sup>	Battery Park, Va. 23304	Plant	Ilse of Wight.
Blue Grass Lime Co. <sup>14</sup>	Route 3 Tazewell, Va. 24651	do	Tazewell.

See footnotes at end of table.



Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Lime—Continued			
Chemstone Corporation <sup>14</sup> ..	Melo Park Edison, N.J. 08817	Plant.....	Shenandoah.
Foote Mineral Co <sup>14</sup> .....	Rt. 100 Exton, Pa. 19341	.....do.....	Giles.
W. S. Frey Co., Inc <sup>14</sup> .....	257 E. Market St. York, Pa. 17403	.....do.....	Frederick.
M. J. Grove Lime Co., Div. of The Flintkote Co. <sup>14</sup>	Lime Kiln, Md. 21763 .....	.....do.....	Do.
National Gypsum Co. <sup>14</sup> .....	325 Delaware Ave. Buffalo, N.Y. 14202	.....do.....	Giles.
Natural Gas:			
Ashland Oil and Refining Co.	Box 67 Vansant, Va. 24656	Gas wells.....	Buchanan.
Cabot Corp. ....	P.O. Box 1473 Charleston, W. Va. 25325	.....do.....	Do.
Clinchfield Coal Co., Div. of the Pittston Co.	Dante, Va. 24237 .....	.....do.....	Dickenson.
Consol-Ray Corp. ....	Pocahontas, Va. 24635 .....	.....do.....	Tazewell.
P and S Oil and Gas Corp. ....	305 Nelson Bldg. Charleston, W. Va. 25301	.....do.....	Buchanan.
United Fuel Gas Co. ....	P.O. Box 1273 Charleston, W. Va. 25325	.....do.....	Buchanan, Tazewell.
Petroleum refineries:			
American Oil Company <sup>15</sup> ..	Yorktown, Va. 23490 .....	Plant.....	York.
Salt:			
Olin Corp <sup>16</sup> .....	120 Long Ridge Rd. Stamford, Conn. 06905	Brine wells.....	Smyth.
Sand and gravel:			
Commonwealth Sand & Gravel	P.O. Box 7598 Richmond, Va. 23231	Pit.....	Henrico.
Fredericksburg Sand & Gravel Co.	Rt. 4, Box 57 Fredericksburg, Va. 22401	Pit.....	Stafford.
Friend Sand & Gravel Co., Inc.	209 River St. Petersburg, Va. 23801	Pit.....	Prince George.
Locher Silica Corp <sup>17</sup> .....	Glasgow, Va. 24555 .....	Pits.....	Rockbridge, Wythe.
Massaponax Sand & Gravel Corp.	P.O. Box 270 Fredericksburg, Va. 22401	Pit.....	Spotsylvania.
Jobe Newton .....	Box 412 Fredericksburg, Va. 22401	Pit.....	Stafford.
Sadler Materials Corp. ....	P.O. Box 5417 Virginia Beach, Va. 23455	Pit.....	Henrico.
Solite Corp. ....	P.O. Box 883 Fredericksburg, Va. 22401	Pit.....	King George.
Southern Materials Co., Inc.	2125 Kimball Terrace Norfolk, Va. 23504	Pit and dredge....	Chesterfield.
Do .....	.....do.....	Dredge.....	Henrico.
Do .....	.....do.....	Pits.....	Isle of Wight. Prince George. Frederick.
Virginia Glass Sand Corp. <sup>17</sup>	P.O. Box 445 Winchester, Va. 22601	Pit.....	Frederick.
Virginia Concrete Co., Inc.	P.O. Box 666 Springfield, Va. 22150	Pit.....	Fairfax.
West Sand & Gravel Co., Inc.	P.O. Box 6008 Richmond, Va. 23222	Pit.....	Henrico.
E. V. Williams Co., Inc. ....	P.O. Box 938 Norfolk, Va. 23501	Pit.....	Virginia Beach (City).
Williams Paving Co., Inc. ....	.....do.....	Pit.....	Hampton (City).
Soapstone (talc):			
Blue Ridge Talc Co., Inc. <sup>18</sup>	P.O. Box 8 Henry, Va. 24102	Mine and plant....	Franklin.
Stone:			
Granite—crushed and broken:			
Boscobel Granite Corp	Box 1775 Richmond, Va. 23221	Quarry.....	Goochland.
Bull Run Stone Co., Inc.	Box 469 Manassas, Va. 22110	.....do.....	Loudoun.
Burkeville Stone Corp. ....	Box 1775 Richmond, Va. 23221	.....do.....	Nottoway.
The General Crushed Stone Co.	712 Drake Bldg. Easton, Pa. 18042	.....do.....	Hanover.
Martinsville Stone Corp.	Route 2, Box 31 Martinsville, Va. 24113	.....do.....	Henry.
Salem Stone Corp. ....	P.O. Box 1121 Roanoke, Va. 24154	2 quarries.....	Goochland.
Southern Materials Co., Inc.	2125 Kimball Terrace Norfolk, Va. 23501	Quarries.....	Brunswick, Chester- field, Dinwiddie.
Superior Stone Co., Div. Martin	Box 2568 Raleigh, N.C. 27602	.....do.....	Albemarle, Louisa.
Marietta Corp.			

See footnotes at end of table.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Granite—crushed and broken—Continued			
Tidewater Crushed Stone & Asphalt Co., Inc.	Deepwater Terminal Rd. Richmond, Va. 23234	Quarry-----	Chesterfield.
Trego Stone Corp.---	P.O. Box 2459 Roanoke, Va. 24010	-----do-----	Greensville.
Vulcan Materials Co.--	P.O. Box 7506 Winston-Salem, N.C. 27106	Quarries-----	Brunswick, Fairfax, Botetourt, Halifax, Pittsylvania, Prince William.
Limestone—crushed and broken:			
Blue Ridge Stone Corp.	Box 2459 Roanoke, Va. 24010	-----do-----	Botetourt, Campbell.
Foote Mineral Co.---	Duffield, Va. 24244-----	Underground mine..	Scott.
James River Limestone Co.	Box 355 Buchanan, Va. 24066	Quarry-----	Botetourt.
Liberty Limestone Corp.	Box 458 Buchanan, Va. 24066	Quarries-----	Allegheny, Botetourt.
Penn-Dixie Cement Corp.	P.O. Box 152 Nazareth, Pa. 18064	Quarry-----	Scott.
Stuart M. Perry, Inc.--	Box 738 Winchester, Va. 22601	Quarries-----	Clarke,
Pounding Mill Quarry Corp.	Box 2459 Roanoke, Va. 24010	Quarry-----	Frederick.
Radford Stone Corp.--	Route 1, Box 235 Radford, Va. 24141	-----do-----	Tazewell.
Rockydale Stone Service Corp.	Rt. 8, Box 635 Roanoke, Va. 24004	-----do-----	Pulaski.
Rockydale Quarries Corp.	-----do-----	-----do-----	Campbell.
Salem Stone Corp.---	P.O. Box 1121 Roanoke, Va. 24153	Quarries-----	Roanoke.
Vulcan Materials Co.--	Box 7 Knoxville, Tenn. 37901	-----do-----	Montgomery, Roanoke, Washington, Allegheny, Augusta.
Marble—crushed:			
Jamison Black Marble Co.	P.O. Box 1198 Roanoke, Va. 24006	Quarry-----	Rockingham.
Marl, calcareous:			
J.C. Digges & Sons---	White Post, Va. 22663-----	Pit-----	Clarke.
Wm. M. Rice & Son---	29 Harris Creek Rd. Hampton, Va. 23360	Pit-----	Hampton (City).
O. D. Zook-----	Route 238 Yorktown, Va. 23490	Pit-----	York.
Miscellaneous stone—dimension:			
Alberene Stone, Div. of the Georgia Marble Co. <sup>19</sup>	Schuyler, Va. 22969-----	Quarry and plant---	Nelson.
Wade and Griffith---	Route 1 Floyd, Va. 24091	Quarry-----	Patrick.
Miscellaneous stone—crushed:			
Dominion Stone Plant, Inc.	Piney River, Va. 22964-----	-----do-----	Nelson.
Oystershell:			
Battery Park Fish & Oyster Co.	Battery Park, Va. 23304---	Plant-----	Isle of Wight.
Quartz and quartzite—crushed and broken:			
H. D. Crowder & Sons.	Route 1 Austinville, Va. 24312	Quarry-----	Carroll.
The Economy Cast Stone Co.	P.O. Box 3-P Richmond, Va. 23207	-----do-----	Albemarle.
Lone Jack Limestone Co., Inc.	P.O. Box 752 Lynchburg, Va. 24505	-----do-----	Rockbridge.
Quartzite—dimension:			
Leesville Stone Corp.--	Leesville, Va. 24571-----	-----do-----	Campbell.
Lofton Lambert-----	The Plains, Va. 22171-----	-----do-----	Fauquier.
Musselman Bros-----	110 White Oak Rd. Fredericksburg, Va. 22401	-----do-----	Do.
Sandstone—crushed and broken:			
Castle Sands Co.-----	New Castle, Va. 24127-----	-----do-----	Craig.
Culpeper Stone Co., Inc.	Box 650 Culpeper, Va. 22701	-----do-----	Culpeper.
Newman Brothers Quarry, Inc.	Route 3 Hillsville, Va. 24343	-----do-----	Wythe.
Slate—crushed:			
Solite Corp. <sup>20</sup> -----	Box 9138 Richmond, Va. 23227	Plant-----	Buckingham.

See footnotes at end of table.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Slate—dimension:			
Arvonias—Buckingham Slate Co., Inc. <sup>21</sup>	Arvonias, Va. 23004-----	Quarry and plant...	Buckingham.
Le Sueur—Richmond Slate Corp. <sup>21</sup>	-----do-----	-----do-----	Do.
Traprock (diabase)—dimension:			
Buena Black Granite Corp.	Box 74 Rapidan, Va. 22733	Quarry-----	Culpeper.
Virginia Granite Corp.	P.O. Box 250 Elberton, Ga. 30635	-----do-----	Do.
Traprock (diabase)—crushed and broken:			
Arlington Stone Co.---	2633 Shirlington Rd. Arlington, Va. 22206	-----do-----	Loudoun.
Chantilly Crushed Stone, Inc.	Box 112 Chantilly, Va. 22021	-----do-----	Do.
Fairfax Quarries, Inc.--	Box 7155 Richmond, Va. 23211	-----do-----	Fairfax.
Sanders Quarry, Inc.--	335 Waterloo St. Warrenton, Va. 22816	-----do-----	Fauquier.
Virginia Trap Rock, Inc.	Box 705 Leesburg, Va. 22075	-----do-----	Loudoun.
Traprock (basalt)—crushed:			
Charlottesville Stone Corp.	Box 7155 Richmond, Va. 23221	-----do-----	Albemarle.
Titanium concentrate (ilmenite):			
American Cyanamid Co.	Wayne, N.J. 07470-----	Mine and plant....	Amherst, Nelson.

<sup>1</sup> Portland and masonry cement—also captive production of limestone and shale.

<sup>2</sup> Portland cement only—also captive production of marl and clay in Nansemond County.

<sup>3</sup> Masonry cement only—also produce limestone.

<sup>4</sup> Shale obtained from coal preparation plant as a coproduct.

<sup>5</sup> 3 mines.

<sup>6</sup> 2 mines.

<sup>7</sup> 6 mines.

<sup>8</sup> 4 mines.

<sup>9</sup> 11 mines.

<sup>10</sup> Process imported gypsum.

<sup>11</sup> Also finished iron oxide pigments.

<sup>12</sup> Coproduct: quartz sand.

<sup>13</sup> Calcine oystershell.

<sup>14</sup> Also captive production of limestone.

<sup>15</sup> Coproducts: sulfur and coke.

<sup>16</sup> Various chemicals manufactured from salt and lime at plant—captive limestone converted to lime for use in chemical manufacturing.

<sup>17</sup> Mainly industrial silica (crushed sandstone).

<sup>18</sup> Also process out-of-State hematite at plant for pigment manufacture.

<sup>19</sup> Stone variety is soapstone.

<sup>20</sup> Lightweight aggregate.

<sup>21</sup> Also crushed slate produced.

# The Mineral Industry of Washington

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

By Robert A. Whitman <sup>1</sup>

Increases in the production of certain metals raised the value of mineral production in the State of Washington to about \$91 million in 1970. This was nearly a 3-percent increase over the \$88.6 million reported for 1969. In the metals sector increases both in value and tonnage were recorded for gold, silver and zinc, and there was a resurgence of uranium mining, the first appreciable production of the radioactive metal since 1965.

Almost 26 percent of all aluminum produced in the United States came from plants in Washington. Primary aluminum production increased nearly 5 percent in the United States, and aluminum production increased 2 percent in Washington as compared with 1969.

Industrial nonmetallic minerals, such as clay and diatomite, had production increases of around 20 percent in 1970 over 1969. However, production of nonmetallic construction materials such as lime, stone, and sand and gravel decreased between 15 and 25 percent from the previous year. This trend reflects the contraction of public spending and the slowdown in construction resulting from the economic downturn.

**Economic Activity and Employment.**—In the third quarter of 1970, there was a slight slowing in the rate of employment decline. Unemployment fell in September, but this was a normal occurrence for the

<sup>1</sup> Physical scientist, Division of Nonferrous Metals.

Table 1.—Mineral production in Washington <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>Cement:</b>				
Portland.....thousand 376-pound barrels..	6,356	\$22,724	6,495	\$24,882
Masonry.....thousand 280-pound barrels..	58	204	41	158
Clays <sup>2</sup> .....thousand short tons..	230	434	240	436
Coal (bituminous).....do....	58	480	37	470
Copper (recoverable content of ores, etc.).....short tons..	18	17	9	11
Gem stones.....	NA	150	NA	150
Lead (recoverable content of ores, etc.).....short tons..	8,649	2,577	6,784	2,119
Peat.....thousand short tons..	33	134	17	71
Sand and gravel.....do....	34,245	31,046	25,089	27,902
Stone.....do....	15,742	21,069	13,701	19,100
Talc and soapstone.....short tons..	4,228	W	W	W
Zinc (recoverable content of ores, etc.).....do....	9,738	2,843	11,956	3,663
Value of items that cannot be disclosed:				
Bauxite (1970), diatomite, gold, gypsum (1969), lime, mercury (1970), olivine, pumice, silver, uranium (1970), and values indicated by symbol W.....	XX	6,948	XX	12,010
<b>Total</b> .....	XX	88,626	XX	90,922
Total 1967 constant dollars.....	XX	83,690	XX	<sup>p</sup> 82,284

<sup>p</sup> Preliminary. NA Not available. W Withheld to avoid disclosing individual company confidential data. 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; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Washington, by counties  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Adams.....	W	W	Sand and gravel, stone.
Asotin.....	\$3	\$13	Sand and gravel.
Benton.....	W	W	Stone, sand and gravel.
Chelan.....	595	W	Do.
Clallam.....	760	659	Clays, stone, sand and gravel.
Clark.....	1,417	W	Stone, sand and gravel, clays.
Columbia.....	W	W	Stone, sand and gravel.
Cowlitz.....	968	883	Stone, sand and gravel, bauxite, clays.
Douglas.....	W	W	Sand and gravel, clays.
Ferry.....	W	W	Gold, silver, stone, copper, lead, zinc.
Franklin.....	W	W	Sand and gravel, stone.
Garfield.....	1,030	630	Stone, sand and gravel.
Grant.....	2,265	2,702	Diatomite, lime, stone, sand and gravel.
Grays Harbor.....	1,162	1,308	Sand and gravel, stone.
Island.....	271	W	Sand and gravel.
Jefferson.....	W	W	Stone, sand and gravel.
King.....	21,592	24,363	Cement, sand and gravel, stone, coal, clays, peat.
Kitsap.....	460	W	Sand and gravel, stone, peat.
Kittitas.....	1,179	W	Sand and gravel, stone, clays, pumice.
Klickitat.....	428	483	Stone, sand and gravel.
Lewis.....	1,505	W	Sand and gravel, stone, coal, clays.
Lincoln.....	542	143	Stone, sand and gravel.
Mason.....	330	326	Stone, sand and gravel, peat.
Okanogan.....	1,041	489	Stone, sand and gravel.
Pacific.....	308	321	Stone.
Pend Oreille.....	7,815	W	Cement, lead, zinc, stone, sand and gravel, silver, clays, copper, gold.
Pierce.....	6,036	W	Sand and gravel, lime, stone, clays, peat.
San Juan.....	W	W	Sand and gravel, stone.
Skagit.....	2,375	1,432	Olivine, sand and gravel, stone, soapstone.
Skamania.....	303	W	Sand and gravel, stone, pumice.
Snohomish.....	5,191	5,375	Stone, sand and gravel, peat, clays, copper, silver.
Spokane.....	1,917	W	Sand and gravel, stone, clays, peat.
Stevens.....	3,750	W	Uranium, zinc, stone, lead, sand and gravel, clays, silver, copper.
Thurston.....	1,058	W	Sand and gravel, stone, peat.
Wahkiakum.....	W	W	Sand and gravel, stone.
Walla Walla.....	437	453	Do.
Whatcom.....	W	W	Cement, sand and gravel, stone, clays.
Whitman.....	7,459	1,375	Stone, sand and gravel.
Yakima.....	1,798	W	Sand and gravel, lime, stone, mercury.
Undistributed <sup>1</sup> .....	14,631	49,964	
Total.....	88,626	<sup>2</sup> 90,922	

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

<sup>1</sup> Includes value of mineral production that cannot be assigned to specific counties and values indicated by symbol W.

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

month as housewives and students removed themselves from the job market. The seasonally adjusted jobless rate actually increased from 9.6 percent in August to 10.3 percent in September. For the year, the seasonally adjusted unemployment rate nearly doubled. As of September 1970, aerospace industry employment was down about 50 percent, compared with its July 1968 peak of 106,300. The potential cut-backs in this industry more than offset any general improvement in the State's economy.

Spokane was designated one of four U.S. Bureau of Mines field operations centers together with Pittsburgh, Pa., Denver, Colo., and Juneau, Alaska. The Spokane Office of Mineral Resources, established in 1959, has become the Western Field Operations Center. R. N. Appling, Jr., head of

the Spokane office since its inception, was named chief of the Center. The Spokane Center was being expanded through the transfer of a number of Bureau of Mines engineers from other offices. R. N. Appling said the Center would expand its studies of the mineral potential of wilderness areas in the Pacific Northwest to include California and Nevada.

There were no new contracts issued by the Office of Minerals Exploration during 1970.

**Ecology.**—The State Legislature passed an act to provide for the reclamation of surface mining areas. The act does not cover underground mining. The Department of Natural Resources, Division of Mines and Geology, was given the responsibility for administering the law. The law covers land in both private and public

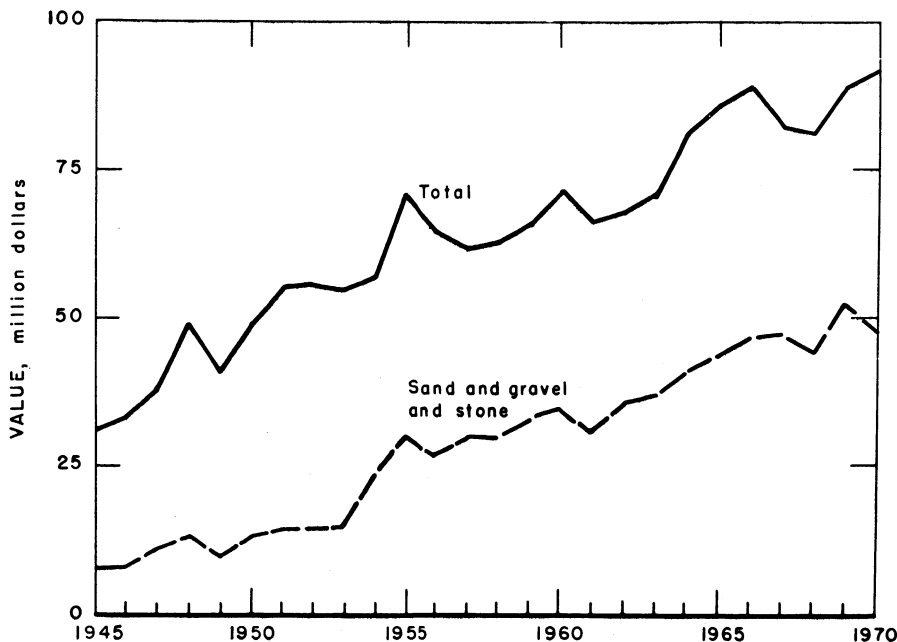


Figure 1.—Value of sand and gravel and stone, and total value of mineral production in Washington.

Table 3.—Indicators of Washington business activity

	1969	1970	Change, percent
Annual average labor force and employment:			
Total labor force..... thousands..	1,404.3	1,405.0	( <sup>1</sup> )
Unemployment..... do.....	66.9	116.9	+74.7
Employment:			
Construction..... do.....	57.6	53.6	-6.9
Aerospace..... do.....	91.1	61.7	-32.3
Lumber and wood products..... do.....	45.2	41.8	-7.5
Food processing..... do.....	29.8	29.5	-1.0
All manufacturing..... do.....	278.6	240.5	-13.7
All industries..... do.....	1,331.0	1,288.1	-3.2
Factory payrolls..... millions.....	\$6,180.4	\$6,049.5	-2.1
Personal income:			
Total..... do.....	\$13,098.0	\$13,679.0	+4.5
Per capita..... do.....	\$3,916.0	\$3,993.0	+2.0
Construction activity:			
Value of nonresidential construction..... millions.....	\$265.6	\$213.7	-19.5
State highway commission:			
Value of contracts awarded..... do.....	\$125.1	\$100.0	-20.0
Cement shipments to and within Washington..... thousand 376-pound barrels.....	6,151.2	6,041.0	-1.8
Farm marketing receipts..... millions.....	\$774.5	\$787.7	+1.7
Mineral production..... do.....	\$88.6	\$90.9	+2.6

<sup>1</sup> Less than ½ of 1 percent.

Sources: State of Washington Economic Review for 1970 and Outlook for 1971, Department of Commerce and Economic Development; Roads and Streets; Survey of Current Business, Construction Review, U.S. Department of Commerce; Farm Income Situation, U.S. Department of Agriculture; Employment and Earnings, U.S. Department of Labor; U.S. Bureau of Mines.

ownership and requires permits to mine, a reclamation plan, standards of inspection, permit fees, and a performance bond. The Mine-land Reclamation Act will become effective January 1, 1971.

The Edmonds City Council unanimously passed a city ordinance to zone land submerged by Puget Sound waters between the north and south city limits and from the shoreline to midpoint in the Sound.

Table 4.—Washington: Annual employment and total wages in the mineral industries

Industry	1969		1970	
	Employment	Wages (thousands)	Employment	Wages (thousands)
Mining.....	1,619	\$14,827	1,683	\$16,379
Stone, clay, and glass products.....	6,134	54,660	5,803	55,550
Smelting, refining, and casting.....	15,098	138,744	14,161	134,522
Petroleum refining and related industries.....	1,078	11,304	1,210	12,592
Chemicals and allied products.....	6,292	61,665	5,927	61,560
Total.....	30,221	281,200	28,784	280,603

Source: Washington Employment Security Department bulletins on industries covered by Washington State Employment Security Act. Industry groups may vary from those in the Bureau of Mines canvass.

Table 5.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1969:								
Coal.....	39	220	9	68	-----	-----	-----	-----
Peat.....	21	140	3	23	-----	-----	-----	-----
Metal.....	220	244	54	429	-----	26	60.67	3,110
Nonmetal.....	85	143	12	98	-----	1	10.18	244
Sand and gravel.....	1,479	207	306	2,462	-----	54	21.93	604
Stone.....	1,127	215	242	1,943	-----	29	14.93	794
Total <sup>1</sup> .....	2,971	211	626	5,022	-----	110	21.90	873
1970: <sup>p</sup>								
Coal.....	45	225	10	76	-----	-----	-----	-----
Peat.....	15	112	2	11	-----	-----	-----	-----
Metal.....	280	263	73	585	3	41	75.16	32,412
Nonmetal.....	55	162	9	72	-----	-----	-----	-----
Sand and gravel.....	1,360	194	265	2,121	1	55	26.40	3,734
Stone.....	1,110	238	264	2,114	-----	28	13.25	979
Total <sup>1</sup> .....	2,865	217	622	4,980	4	124	25.70	5,816

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

The new ordinance establishes a marine-resource district, permits several recreational and commercial uses, but prohibits "submerged-land mining, drilling for petroleum or gas, or excavation in connection therewith." The Council based its action on a 1909 State law extending the jurisdiction of cities and towns over adjacent waters.

Abatement and control of water pollution from mines, mining operations, and

ore concentration plants in the Pacific Northwest were to be studied in a 2-year investigation announced in Portland, Oregon, by James L. Agee, Northwest Director of the Federal Water Quality Administration. The mining wastes study will focus on underground and open pit mining and the concentration of metallic ores, but will not be concerned with placer or dredge mining.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Abrasives.**—Carborundum Co., Vancouver, Clark County, continued to manufacture silicon carbide. Production was at about the same level as in 1969. The company noted that abrasive products are less affected by downturns in the national economy than some other industries.

**Cement.**—Portland cement shipments by four firms operating four plants totaled 6.5

million barrels and were valued at \$24.8 million.

Ideal Basic Industries, Inc., approved in principle a program for bringing its Ideal Cement Co., West Coast Division plants, into conformity with air and water pollution control regulations. Expenditures for the environmental control program were estimated to be about \$10 million in the west coast and Montana areas between

1971 and 1974. Although the program was intended primarily to correct environmental conditions, a parallel objective was to maximize returns by operating the company's most efficient plants at capacity and curtailing production at obsolete operations. The firm's Redwood City, Calif., plant was designated obsolete. Following cement production curtailment, the plant was to continue to function as a cement distribution terminal serving the northern California market by shipping cement supplied from the Seattle plant. Information was published relating to Ideal's Seattle plant<sup>2</sup> and to other company cement plant and distribution terminal locations.<sup>3</sup>

**Clays.**—There was 5 percent more common clay sold or used by producers in 1970 than in 1969. In order of use, the cement industry ranked first, followed by brick and tile makers, and refractory uses. Common clay was produced in 13 counties, but fire clay was produced in only two.

**Diatomite.**—Kenite Corp., a wholly owned subsidiary of the Witco Chemical Corp., increased its production of diatomite in 1970 about 20 percent over that of 1969. The Kenite Corp. has approximately 2,000 acres of high-grade diatomite deposits with about 10 million tons of reserves blocked out. The deposit consists of five separate strata of diatomite with a total thickness of about 45 feet. All the Grant County crude is suitable for the production of calcined and flux-calcined filter aids and related products.

**Gypsum.**—There was no crude gypsum mined in the State in 1970. The amount of gypsum calcined declined by 21 percent. Since there was but one producer, quantities may not be published.

**Lime.**—In 1970, output of lime decreased 15 percent. Two companies, operating in three counties, produced lime for construction, agricultural, and chemical use.

**Sand and Gravel.**—The overall production of sand and gravel decreased 27 percent in 1970, but the value decreased only 10 percent. Sand and gravel was produced in all 37 counties of the State, but 42 percent of total production came from King, Pierce, and Snohomish Counties and another 11 percent from Spokane and Yakima Counties. In the commercial category, sand sold or used decreased 9 percent and

gravel increased 4 percent. Government and contractor operations showed an increase in use of sand but a 63-percent decrease in the use of gravel, mainly for fill and paving.

Distribution of output by use was as follows: paving, 55 percent; building, 25 percent; fill, 15 percent; and other uses, 5 percent.

**Stone.**—Production of stone decreased 13 percent from the 1969 total, but value was down only 9 percent. Quarries produced stone in 36 counties; 82 percent of that stone was transported to market by truck, and 12 percent divided equally between railroad and water transportation. Clark, King, Snohomish, Stevens, and Whitman Counties each had production valued at \$1 million or more. Stone from Clark, King, Snohomish, and Whitman Counties was used largely for construction purposes. Production from Stevens County was principally limestone, marble, and sandstone for industrial uses.

Traprock, commonly a basalt or other dark, fine grained igneous rock, was produced in 35 counties and accounted for 90 percent of the total, or 12.3 million tons. Traprock is used mainly for aggregate, roadwork, riprap, fill, and ballast.

Twelve quarries produced 739,853 tons of limestone, valued at \$999,242, in King, Okanogan, Pend Oreille, San Juan, Stevens, and Whatcom Counties. Most of the limestone was used for cement. Other principal uses were for paper manufacture, flux stone, and lime. It was also used for agricultural lime, riprap, building stone, and terrazzo manufacture.

Granite, produced in King, Okanogan, Skagit, and Yakima Counties, was used mostly in construction as crushed and broken stone.

Almost all marble was used as crushed and broken stone for terrazzo, whiting, roofing aggregate, and stucco.

Washington also produced stone used for industrial silica.

<sup>2</sup> The Ideal Way. Ideal Cement's Seattle Plant One of the Most Modern Facilities in the World. V. 25, No. 3, June-July 1970, pp. 12-13.

<sup>3</sup> The Ideal Way. In the Cement Business, Proximity to Fast Growing Markets Is Essential to Company Growth. V. 25, No. 3, June-July 1970, pp. 19, 22.



**Table 6.—Washington: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	2,681	\$3,332	2,281	\$3,334
Fill.....	718	416	604	342
Paving.....	905	951	1,062	1,238
Other uses <sup>1</sup> .....	174	594	149	715
<b>Total.....</b>	<b>4,478</b>	<b>5,293</b>	<b>4,096</b>	<b>5,629</b>
<b>Gravel:</b>				
Building.....	4,705	5,993	3,990	5,524
Fill.....	1,248	942	1,520	1,225
Paving.....	6,502	7,872	7,680	9,733
Other uses <sup>2</sup> .....	1,097	345	880	1,016
<b>Total.....</b>	<b>13,552</b>	<b>15,452</b>	<b>14,070</b>	<b>17,496</b>
<b>Government-and-contractor operations:</b>				
<b>Sand:</b>				
Building.....	( <sup>4</sup> )	1	13	22
Fill.....	31	15	694	343
Paving.....	229	246	266	266
Other uses.....	125	81	114	67
<b>Total.....</b>	<b>385</b>	<b>343</b>	<b>1,087</b>	<b>703</b>
<b>Gravel:</b>				
Building.....			17	37
Fill.....	9,749	4,888	964	332
Paving.....	6,013	5,028	4,776	3,665
Other uses.....	68	42	79	40
<b>Total.....</b>	<b>15,830</b>	<b>9,958</b>	<b>5,836</b>	<b>4,074</b>
<b>Total sand and gravel.....</b>	<b>34,245</b>	<b>31,046</b>	<b>25,089</b>	<b>27,902</b>

<sup>1</sup> Includes blast, railroad ballast (1969), glass (ground), and other sands.

<sup>2</sup> Includes railroad ballast, miscellaneous (1970), and other gravel.

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

<sup>4</sup> Less than 1/2 unit.

**Table 7.—Washington: Stone sold or used by producers, by uses**

(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Dimension stone total.....	8	\$252	5	\$196
<b>Crushed and broken:</b>				
Bituminous aggregate.....	1,450	2,537	1,423	2,709
Concrete aggregate.....	W	W	W	W
Macadam aggregate.....	562	696	643	892
Dense graded roadbase stone.....	1,191	1,892	1,336	2,054
Surface treatment aggregates.....	3,361	4,418	3,434	4,492
Unspecified aggregate and roadstone.....	1,769	2,173	2,756	2,152
Agricultural limestone <sup>1</sup> .....	17	116	14	77
Metallurgical purposes <sup>2</sup> .....	123	663	137	671
Fill.....	3,562	1,806	1,435	750
Paper manufacturing.....	64	265	53	213
Riprap and jetty stone.....	1,647	3,152	1,227	2,267
Other <sup>3</sup> .....	1,988	3,096	1,239	2,623
<b>Crushed total<sup>4</sup>.....</b>	<b>15,734</b>	<b>20,817</b>	<b>13,696</b>	<b>18,904</b>
<b>Grand total.....</b>	<b>15,742</b>	<b>21,069</b>	<b>13,701</b>	<b>19,100</b>

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

<sup>1</sup> Data includes poultry grit for 1969.

<sup>2</sup> Data includes dead-burned dolomite, ferrosilicon, flux stone and refractory stone.

<sup>3</sup> Data includes stone used in cement and lime manufacture; railroad ballast; stone sand; filter stone (1970); terrazzo and roofing aggregate; abrasives; building products; glass; and other uses in smaller quantities.

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

**Talc and Soapstone.**—Production of soapstone declined in 1970 because one mine in Skagit County was inactive.

#### METALS

**Aluminum.**—The quantity of aluminum produced in 1970 was 2 percent greater than in 1969, and the corresponding value increased 5 percent. Capacity was increased about 1 percent. Washington produced 26 percent of the total national output. This amount was unchanged from 1969.

By the end of 1970, Reynolds Metals Co. had shut down a 24,000-ton-per-year potline at Longview, and Kaiser Aluminum & Chemical Corp. had closed two 26,000-ton-per-year potlines at Mead, one in October and one in December. These three closures represent 5 percent of the rated aluminum capacity for the State.

The fact that the industry produced at rated capacity before completely shutting down a potline to reduce production shows the necessity of 100-percent utilization of power for maximum efficiency. The aluminum industry cannot reduce production by cutting back power to a potline; it must operate the potline at full capacity or not at all.

In Klickitat County, near the John Day Dam, Harvey Aluminum, Inc., continued construction of its 100,000-ton-per-year alumina reduction plant, which is scheduled to start production in late 1971.

Reynolds Metals Co. has substantial reserves of laterites and clays in the United States that may be used in lieu of bauxite as a raw material for aluminum if there is an interruption of overseas bauxite supply. Samples of the laterite reserves in Oregon and Washington were mined in the latter part of 1970 for test refining in existing Reynolds alumina plants.

**Antimony.**—The former Northwest Magnesite Co. flotation mill west of Chewelah in Stevens County was purchased by Pyro-Metric, Inc. The firm also acquired the mill site and tailings ponds and planned to change the mill circuits to process ores containing antimony, silver, lead, zinc, and copper. Principal mill feed was expected to be antimony ores from Fargo Mining Corp. and Cleveland Silver Mines, Inc., but some custom milling was expected. The mill should be able to handle about 300 tons of ore per day.

Fargo Mining Corp. indicated that reserves of about 50,000 tons of zinkenite, a relatively rare lead-antimony mineral, had been developed.

The Lucky Knock mine near Tonasket, Okanogan County, was reopened in May to mine antimony. The mine was leased from E. A. McGill by Hooker Chemical Company, Tacoma, Wash., and is being mined by Lovitt Construction Company, Wenatchee.

**Copper.**—Copper production dropped 50 percent; only 18,000 pounds was produced in 1970. However, with price increases, the value of 1970 production was only 35 percent less than in 1969. There were no primary copper mines operating. There were, however, about 17 companies exploring for copper during 1970 in areas extending from Stevens County in the east through Ferry, Okanogan, Chelan, and Snohomish Counties, to King County in the west, and south to Skamania County.

In January, the Tacoma smelter of the American Smelting & Refining Co. (ASARCO) was shut down as a result of converter flue failure.

**Gold-Silver.**—Production of both gold and silver increased 18 percent and 21 percent, respectively, compared with 1969. However, the value of gold production in-

Table 8.—Primary aluminum plant capacity and production data

Year	Rated primary capacity (thousand short tons)	Primary production			Average U.S. ingot price per pound (cents)
		Thousand short tons	Percent of national total	Value (thousands)	
1966.....	676	598	20	\$294,115	24.5
1967.....	770	746	23	370,287	25.0
1968.....	988	775	24	394,261	25.1
1969.....	1,012	1,003	26	541,834	26.5
1970.....	1,022	1,023	26	569,377	27.8

† Revised.

creased only 4 percent, while the value of silver produced in 1970 was 20 percent greater than 1969.

Nearly all gold and silver production came from the Republic district in Ferry County. However, there were about 12 exploration projects for gold and silver in the five northern counties across the State and in Chelan County.

According to a report from Day Mines, Inc., production through the third quarter came from stopes low in gold content, and the value increased less than production because the average price received on the world market for gold declined from about \$41 per ounce in 1969 to about \$36 per ounce in 1970.

A new \$54,500 exploration project was planned by Silver King Mining and Milling Co. at its properties northwest of Cusick, Pend Oreille County. Underground tunneling and diamond drilling are scheduled. The firm has been exploring the Parker Lake area for 5 years and has found encouraging values in silver. Work has included 1,800 feet of tunneling, 7,000 feet of exploratory drilling, and 1,200 feet of trenching.

**Iron Ore.**—The Copper Chief Mining Co. diamond drilled the Big Iron mine in the Orient district west of Northport in Stevens County. Sparton Exploration Ltd., of Vancouver, British Columbia, carried out geochemical and geophysical work at the Buckhorn mine on Buckhorn Mountain in Okanogan County.

**Lead-Zinc.**—The quantity of zinc produced in 1970 increased about 23 percent and the value increased 29 percent as compared with 1969. However, the shut down in December of the Van Stone mine in Stevens County, will seriously curtail the State's 1971 production. Production of lead declined 22 percent, and the Van Stone closing will mean an even greater decline in the immediate future.

Exploration and development work was under way at four properties in Stevens County. Mercator, Inc., was working at the Deer Trail group, and Giant Minerals Corp. was working on the Silver Star prospect, also in the Deer Trail district. Silver Crown Mining Co. continued its development work at the Casteel mine in the Northport area. An old flotation mill north of Northport has been enlarged

from a 30-ton-per-day to a 100-ton-per-day capacity and placed in operation by Silver Crown. Mill feed is coming from the leased Casteel property 3 miles east of Northport and the company's Hubbard property 15 miles west of Northport. Casteel is an open pit that uses an Allis Chalmers front-end loader and a GMC dual-drive dump truck. Values are in lead, silver, zinc, and cadmium. Long-range plans are for a 300- to 400-ton-per-day mill capacity to accommodate custom ore. Vee-Gee Mining Company, Inc., had development work in progress at the Copper King mine in the Aladdin district.

Silver Consolidated Mining Co. conducted exploration and development work at the Lone Star mine in the Conconully area of Okanogan County. Timberline Mining and Milling Co. was developing the Mohawk property in the same district.

Valuemines, Inc., did exploration and development work in Skagit County on the Diamond claims near Cascade Pass.

An illustrated report on lead-zinc deposits occurring in carbonate rocks in the Kootenay Arc was published. The report covers deposits in northeastern Washington and southeastern British Columbia.<sup>4</sup>

**Magnesium.**—Aluminum Co. of America (Alcoa) announced plans for the construction of a plant to produce 25,000 tons of magnesium per year by the silicothermic process from dolomite, limestone, and quartzite deposits near Addy. The cost is estimated to be between \$25 and \$50 million; completion is scheduled for 1974. Bonneville Power Administration has contracted to furnish power by that date. The plant should employ between 300 and 400 people when on stream.

**Magnesium Compounds.**—Olivine production from the operations in Skagit County of two companies, Northwest International and Olivine Corp., increased by about 2 percent.

**Mercury.**—There was exploration and development work for mercury in the Morton area of Lewis County by the Fern Hill Cinnabar of Morton. In the Wildcat Creek area of Yakima County, limited exploration on the Red Spur claims was carried out by Tony Feist, a local miner.

<sup>4</sup> Society of Economic Geologists. Lead-Zinc Deposits in the Kootenay Arc, Northeastern Washington and Adjacent British Columbia. Wash. State Div. of Mines and Geol. Bull. No. 61, 1970.

**Molybdenum.**—Several of the properties under exploration for copper contain molybdenum as a by-product metal, but there are a few in which molybdenum is the principal mineral. The Starr mine of the Bear Creek Mining Co. in Okanogan County was one. Another was the Dead Goat prospect in the Sulphide Creek area of Whatcom County, being explored by the Inspiration Development Co. Natural Resources Development Corp. was developing the Condor (Clipper) property in King County, and Northwood Inc. was doing geochemical and diamond drill exploration at the Copper Find group west of Northport in Stevens County, both properties carrying molybdenum as a co-product.

**Uranium.**—Production of uranium ore continued; shipments of ore from the Midnite mine were initiated in 1970. Dawn Mining Co. estimated that ore reserves at the beginning of the year were 429,000 tons averaging 0.23 percent  $U_3O_8$ . The Dawn mill at Ford was rehabilitated after a 3½-year shutdown and started shipping yellow cake (83.1 percent uranium oxide) in February. The operating capacity was 500 tons per day.

Exploratory drilling for uranium on the Nickell property northeast of Davenport and south of the Spokane Indian Reservation was started by Uranium Corp. of Washington, Inc.

Solar Nuclear Corp. started exploration on Indian Agency leases in the Wellpinit Mountain areas in Stevens County. Trojan Exploration Development Co., Inc., had development underway at the Curtain property in the Mt. Spokane area of Spokane County.

#### MINERAL FUELS

**Coal.**—A total of 36,695 tons of coal was produced from two underground mines in King County and a strip mine in Lewis County. This production was valued at \$469,919, or \$12.81 per ton.

The Skookumchuck River dam for the Centralia Steam-Electric project was completed in October. The 165-foot-high structure is earthfilled and has a consolidated clay core extending to bedrock along the long axis of the dam. This dam will assure the water supply for the power generating plant, which is projected to supply 1.4 X 10<sup>6</sup> kilowatts from both units. The plant

will use 10 tons per minute of powdered coal that has been washed and ground, eliminating some of the ash and other contaminants. Annual consumption of washed coal is expected to be 4.8 million tons with 8100 Btu per ton.

Coal reserves for this project are estimated to be 0.5 billion tons and are expected to last for 35 years.

**Peat.**—Production of peat dropped 48 percent in 1970 from nine operations in King, Kitsap, Mason, Pierce, Snohomish, Spokane, and Thurston Counties.

**Petroleum and Natural Gas.**—Exploration activity increased from the very low level of 1969. Fourteen shallow wells, or coreholes, were drilled by a single operator in the onshore area adjacent to Gray's Harbor. Estimated total exploratory footage was from 35,000 to 40,000 feet.

Geophysical surveys were conducted in the area of Gray's Harbor, Strait of Juan de Fuca, and Puget Sound, with its bordering counties of Kitsap, Island, Snohomish, and Kings. These surveys included 1.0 crew-months of gravity and 11.7 crew-months of seismic surveys. Of the seismic surveys, 7.1 months were onshore and 4.6 were offshore.

In November the State Land Commissioner rejected applications for exploratory leases for gas and oil in Puget Sound. The order did not affect drilling on private lands in the Puget Sound Basin, away from the water and the shoreline.

An estimated 150,000 acres, extending from north of Everett to south of Tacoma and west of Bremerton, was nominated for leasing in the Puget Sound area.<sup>5</sup>

Transportation options for shipping Alaskan North Slope crude petroleum to the Puget Sound area were the subjects of several reports.<sup>6</sup>

El Paso Natural Gas Co. renegotiated its purchase contract for Canadian gas to provide for a price increase, larger volumes, and an extension of deliveries. Upon approval, El Paso expected to purchase a maximum of 281 billion cubic feet of natural gas annually to augment the supply for its Pacific Northwest market.

<sup>5</sup> Oil and Gas Journal. Washington State Oil Search Reviving. V. 68, No. 5, June 22, 1970, p. 50.

<sup>6</sup> Chemical Engineering. Alaska Oil Still Awaits Its Path to the Market. V. 77, No. 14, June 29, 1970, pp. 20-22.

Resources for the Future. Oil on the Alaskan North Slope. No. 33, January 1970, pp. 17-19.

Geologic structure, surface features, stratigraphic sequence of rock units, and other features related to mining and petroleum exploration and production were subjects of reports.<sup>7</sup>

<sup>7</sup> Beverage, J. P., and M. N. Swecker. Estuarine Studies in Upper Grays Harbor, Washington. U.S. Geol. Survey, Water Supply Paper 1173-B, 1969, 90 pp.

Livingston, Vaughn E., Jr. Geologic History and Rocks and Minerals of Washington. Wash. Dept. of Nat. Res., Div. of Mines and Geol., Inf. Circ. No. 45, 1969.

Newcomb, R. C. Effect of Tectonic Structure on the Occurrence of Ground Water in the Basalt of the Columbia River Group of the Dalles Area, Oregon and Washington. U.S. Geol. Survey, Prof. Paper 383-C, 1969, 33 pp.

Weissenborn, A. E. Geologic Map of Washington. U.S. Geol. Survey, Misc. Geol. Inv. map 1-583, 1969, scale 1:2,000,000.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
NONMETALS			
<b>Cement:</b>			
Columbia Cement Co.....	Marietta Road, P.O. Box 37 Bellingham, Washington 98225	Plant.....	Whatcom.
Ideal Cement Co., Div. of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colorado 80202	....do.....	King.
Lehigh Portland Cement Co. <sup>1</sup> .....	713 Hamilton St. Allentown, Pennsylvania 18105	....do.....	Pend Oreille.
Lone Star Cement Corp.....	P.O. Box 2047 Seattle, Washington 98111	....do.....	King.
<b>Clays:</b>			
Chehalis Brick & Tile Co.....	P.O. Box 868 Chehalis, Washington 98532	Pit and plant...	Lewis.
Cle Elum Cement Products, Inc.....	P.O. Box 336 Cle Elum, Washington 98922	....do.....	Kittitas.
R. L. Fleshman.....	2804 Spirit Lake Highway Castle Rock, Washington 98611	Pit.....	Cowlitz.
Hidden Brick Co.....	2610 Kauffman Ave. Vancouver, Washington 98660	Pit and plant...	Clark.
Jim Hoy Co.....	1757 W. Bakerview Road Bellingham, Washington 98225	Pit.....	Whatcom.
Ideal Cement Co., Div. of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colorado 80202	Pit and plant...	Clallam.
International Pipe & Ceramics Corp.	2901 Los Feliz Blvd. Los Angeles, California 90039	3 pits and plants.	King.
		2 pits and plants.	Spokane.
		Pit and plant...	Stevens.
		Pit.....	Whatcom.
Lind Gravel Co.....	1530 State St. Bellingham, Washington 98225		
Lowell Brick Co.....	Box 3005 Everett, Washington 98201	Pit and plant...	Snohomish.
Mutual Materials Co.....	P.O. Box 3547 Seattle, Washington 98124	....do.....	King, Pierce.
Wenatchee Silica Sand.....	Box 1668 Wenatchee, Washington 98801	Pit.....	Douglas.
<b>Diatomite:</b>			
Kenite Corp.....	2 Overhill Road, Overhill Bldg. Scarsdale, New York 10583	Mine and plant.	Grant.
<b>Gypsum:</b>			
Kaiser Gypsum Co., Inc.....	300 Lakeside Drive Oakland, California 94612	Plant.....	King.
<b>Lime:</b>			
Domtar Chemical, Inc.....	Tacoma, Washington 98421	....do.....	Pierce.
<b>Olivine:</b>			
Northwest International.....	329 Kincaid Mount Vernon, Washington 98273	Mine and plant.	Skagit.
Olivine Corp.....	1015 Hilton Bellingham, Washington 98225	....do.....	Do.
<b>Pumice and pumicite:</b>			
W. L. Marenakos Co.....	Rt. 1, Box 921 Issaquah, Washington 98027	Plant.....	Kittitas.
Weyerhaeuser Co.....	Longview, Washington 98632	....do.....	Skamania.
<b>Roofing granules:</b>			
Northwest Talc & Magnesium Co.	P.O. Box 324 Clear Lake, Washington 98235	....do.....	Skagit.
<b>Sand and gravel:</b>			
Ace Concrete Co.....	N. 302 Park Road Dishman, Washington 99206	Pit and plant...	Spokane.
Associated Sand & Gravel Co.....	6300 Glenwood Ave. Everett, Washington 98202	....do.....	Snohomish.
Cadman Gravel Co.....	Redmond, Washington 98052	....do.....	King.
Central Pre-Mix Concrete.....	805 N. Division St. Spokane, Washington 99202	....do.....	Spokane.
DeAtley Corp. <sup>2</sup> .....	Box 648 Lewiston, Idaho 83501	....do.....	Okanogan, Pend Oreille, Spokane.

See footnotes at end of table.

Table 9.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
NONMETALS—Continued			
Sand and gravel—Continued			
Friday Harbor Sand & Gravel	Box 8 Bellingham, Washington 98225	Pit and plant	San Juan.
Glacier Sand & Gravel Co.	5975 E. Marginal Way Seattle, Washington 98134	do	King, Pierce.
W. F. Herrett Co.	1619 E. Linn St. Seattle, Washington 98102	do	King.
Holroyd Land Co., Inc.	7216 Custer Road West Tacoma, Washington 98467	do	Pierce.
Klineline Sand & Gravel Co.	1112 N.E. Hazel Dell St. Vancouver, Washington 98665	do	Clark.
Lakeside Gravel Co., Inc.	Box 7, Bellevue, Washington 98004	do	King.
Marine Asphalt Co.	Rt. 3, Box 735 Anacortes, Washington 98221	do	Various.
Miles Sand & Gravel	Box 130, Auburn, Washington 98002	do	King.
North Kitsap Gravel Asphalt Co. <sup>2</sup>	Rt. 2, Box 305 Poulsbo, Washington 98370	do	Kitsap.
North Star Sand & Gravel Corp.	Box 398, Everett, Washington 98036	do	Snohomish.
Olympia Oil & Wood	State and Washington Streets Olympia, Washington 98501	do	Thurston.
Pacific Sand & Gravel Co.	Box 699 Centralia, Washington 98531	do	Lewis.
Pioneer Sand & Gravel	Box 1881 Steilacoom, Washington 98111	do	Pierce.
Quigg Bros. McDonald, Inc.	1500 Riverside Ave. Hoquiam, Washington 98550	do	Grays Harbor.
Reid Sand & Gravel Co.	Box 922 Bellevue, Washington 98004	do	King.
Stoneway Concrete, Inc.	Box 509, Renton, Washington 98005	do	Do.
D. A. Sullivan Co. <sup>2</sup>	Parkwater Station, Box 37 Spokane, Washington 99211	do	Various.
S & S Sand & Gravel Co. <sup>2</sup>	Box 938 Ephrata, Washington 98823	do	Do.
Ray Weist Construction Co. <sup>1</sup>	Box 191, Yakima, Washington 98901	do	Yakima.
Western Sand & Gravel Co.	Rt. 2, Box 1205 Maple Valley, Washington 98088	do	King.
Woodworth & Co., Inc.	1200 East D St. Tacoma, Washington 98421	do	Pierce.
Yakima Cement Products Co.	1202 S. First St. Yakima, Washington 98901	do	Yakima.
Silicon carbide:			
The Carborundum Co.	P.O. Box 423 Niagara Falls, New York 14302	Plant	Clark.
Stone:			
Associated Sand & Gravel Co., Inc.	6300 Glenwood Ave. Everett, Washington 98202	Quarry and plant.	Skagit, Snohomish.
Carl Carbon, Inc.	Box 5153 N. Central Station Spokane, Washington 99205	do	Spokane, Whitman.
Cascade Asphalt Paving Co. <sup>3</sup>	6328 S. Tacoma Way Tacoma, Washington 98409	do	Pierce.
Columbia Cement Co.	Marietta Road Bellingham, Washington 98225	do	Whatcom.
Crow Rock Products	1384 Walela Drive Moscow, Idaho 83843	do	Whitman.
Erickson Paving Co.	14446 Sunset Blvd. Bellevue, Washington 98004	do	Garfield.
General Construction Co.	Box 3845 Seattle, Washington 98124	do	Jefferson.
Roy L. Houck Sons	1158 Chemeketa N.E. Salem, Oregon 97301	do	Lewis, Various.
Lehigh Portland Cement Co.	718 Hamilton St. Allentown, Pennsylvania 18105	do	Pend Oreille.
Lockheed Shipbuilding & Construction.	12020 E. Marshall Way Seattle, Washington 98168	do	King.
Materne Bros.	Box 0—Rosewood Station Spokane, Washington 99208	do	Various.
Murphy Bros., Inc.	E. 3812 Broadway Spokane, Washington 99202	do	Grant, Whitman.
Sather & Sons, Inc.	Box 326, Parkwater Station Spokane, Washington 99211	do	Benton, Columbia, Garfield.
Steelman-Duff, Inc.	1411 N.E. Columbia Blvd. Portland, Oregon 97217	do	Garfield, Whitman.

See footnotes at end of table.

Table 9.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
NONMETALS—Continued			
Stone—Continued			
Stoen Construction Co.....	2210 E. 95th St. Seattle, Washington 98115	Quarry and plant.	Snohomish.
Umpqua River Navigation Co....	2280 Oakmont Way Eugene, Oregon 97401	.....do.....	Clark.
Vinnell-Mannix-Fuller- Dillingham.	Star Route Pomeroy, Washington 99347	.....do.....	Whitman.
R. Wamberg Construction Co....	7404 S. Tacoma Way Tacoma, Washington 98408	.....do.....	Grays Harbor.
Weyerhaeuser Co.....	Longview, Washington 98632	.....do.....	Clark, Cowlitz, Lewis, Pacific.
Sulfuric acid:			
American Smelting & Refining Co.	Box 1605 Tacoma, Washington 98401	Smelter.....	Pierce.
Talc and soapstone:			
Northwest Talc & Magnesium Co.	Clearlake, Washington 98235	Quarry.....	Skagit.
Herman Smith.....	Marblemount, Washington 98267	.....do.....	Do.
Vermiculite (exfoliated):			
Vermiculite-Northwest, Inc.....	P.O. Box A Auburn, Washington 98002	Plant.....	Spokane.
METALS			
Aluminum:			
Aluminum Company of America..	Vancouver, Washington 98600	.....do.....	Clark.
	Wenatchee, Washington 98301	.....do.....	Chelan.
Intalco Aluminum Corp.....	Bellingham, Washington 98225	.....do.....	Whatcom.
Kaiser Aluminum & Chemical Corp.	Spokane, Washington 99200	.....do.....	Spokane.
Reynolds Metals Co.....	Tacoma, Washington 98400	.....do.....	Pierce.
	Longview, Washington 98632	.....do.....	Cowlitz.
Copper:			
American Smelting & Refining Co.	Box 1605 Tacoma, Washington 98401	Smelter.....	Pierce.
Pend Oreille Mines & Metals Co..	923 Old National Bank Bldg. Spokane, Washington 99201	Mine and mill...	Pend Oreille.
Ferroalloys:			
Footo Mineral Co.....	Wenatchee, Washington 98801	Plant.....	Douglas.
Ohio Ferro-Alloys Corp.....	Tacoma, Washington 98400	.....do.....	Pierce.
Gold:			
Knob Hill Mines, Inc.....	160 Sansome St. San Francisco, California 94104	Mine and mill...	Ferry.
Lead-zinc:			
Pend Oreille Mines & Metals Co..	923 Old National Bank Bldg. Spokane, Washington 99201	.....do.....	Pend Oreille.
Steel:			
Bethlehem Steel Co., Pacific Coast Division.	Seattle, Washington 98134	Plant.....	King.
Northwest Steel Rolling Mills, Inc.	Seattle, Washington 98134	.....do.....	Do
Zinc:			
American Smelting and Refining Co.	Wallace, Idaho 83873	Mine and mill...	Stevens.
MINERAL FUELS			
Coal:			
Black Prince Coal Co.....	Rt. 2, Box 59 Centralia, Washington 98531	Mine.....	Lewis.
Palmer Coking Coal Co., Inc....	P.O. Box 8 Black Diamond, Washington 98010	.....do.....	King.
Peat:			
Cunningham Sand & Gravel Co., Inc.	N. 6315 Cedar St. Spokane, Washington 99208	Bog.....	Spokane.
Harbor Heights Humus Co.....	Gig Harbor, Washington 98335	.....do.....	Pierce.
Maple Valley Humus.....	Renton, Washington 98055	.....do.....	King.
Plant Food Co.....	Bothell, Washington 98011	.....do.....	Snohomish.
Petroleum refining:			
Mobil Oil Corp.....	Ferndale, Washington 98248	Refinery.....	Whatcom.
Shell Oil Co.....	Anacortes, Washington 98221	.....do.....	Skagit.
Sound Refining, Inc.....	Tacoma, Washington 98400	.....do.....	Pierce.
Texaco, Inc.....	Anacortes, Washington 98221	.....do.....	Skagit.
Union Oil Co. of California.....	Edmonds, Washington 98020	.....do.....	Snohomish.
U.S. Oil & Refining Co.....	Tacoma, Washington 98400	.....do.....	Pierce.

<sup>1</sup> Also clay.<sup>2</sup> Also traprock.<sup>3</sup> Also sand and gravel.

# The Mineral Industry of West Virginia

By H. L. Riley <sup>1</sup>

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

In 1970 West Virginia was the leading producer of bituminous coal in the Nation. Coal production totaled 144 million tons in 1970, compared with 141 million tons in 1969 and provided 89 percent of the State's mineral output value. The average value of the coal increased from \$5.73 per ton in 1969 to \$7.93 per ton in 1970.

The value of total mineral output in the State increased by \$338 million, a gain of 37 percent.

**Legislation and Government Programs.**—The West Virginia Geological and Economic Survey continued to cooperate with the

U.S. Geological Survey on a topographic mapping program and a Ground-Water Resources Survey. An additional 20 new 7.5-minute quadrangle topographic maps were published. At yearend 1970, 65-percent of the State had been topographically mapped.

A long-term reappraisal of the quantity and quality of coal reserves of the State was begun with special emphasis on low-sulfur coal reserves by the State Geological and Economic Survey.

Several publications pertinent to the min-

<sup>1</sup> Mining engineer, Division of Fossil Fuels.

Table 1.—Mineral production in West Virginia <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays <sup>2</sup> ..... thousand short tons..	247	\$348	191	\$238
Coal (bituminous)..... do.....	141,011	807,811	144,072	1,142,245
Lime..... do.....	269	3,648	262	3,757
Natural gas..... million cubic feet..	231,759	62,575	242,452	61,583
Petroleum (crude)..... thousand 42-gallon barrels..	3,104	11,888	3,124	11,871
Salt..... thousand short tons.....	1,309	4,978	1,190	5,171
Sand and gravel..... do.....	r 5,021	r 11,475	4,896	11,473
Stone <sup>3</sup> ..... do.....	9,031	15,801	9,740	16,722
Value of items that cannot be disclosed:				
Cement (portland and masonry), fire clay, gem stones, natural gas liquids, and stone (dimension sandstone).....	XX	28,715	XX	32,304
Total.....	XX	r 947,239	XX	1,285,364
Total 1967 constant dollars.....	XX	894,478	XX	r 1,163,254

<sup>2</sup> Preliminary. <sup>r</sup> Revised. XX Not applicable.

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

<sup>3</sup> Excludes fire clay; included with "Value of items that cannot be disclosed."

<sup>4</sup> Excludes certain stone; included with "Value of items that cannot be disclosed."



Table 2.—Value of mineral production in West Virginia, by counties <sup>1</sup>  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Barbour.....	\$16,971	\$27,839	Coal.
Berkeley.....	W	W	Cement, stone, lime, clays.
Boone.....	W	W	Coal, stone.
Braxton.....	W	W	Stone.
Brooke.....	W	W	Coal, sand and gravel.
Cabell.....	W	W	Clay, stone, sand and gravel.
Clay.....	W	W	Coal.
Fayette.....	W	W	Coal, stone.
Gilmer.....	255	498	Coal.
Grant.....	11,706	W	Coal, stone.
Greenbrier.....	4,368	5,244	Do.
Hancock.....	W	5,173	Clays, sand and gravel, coal.
Hardy.....	35	43	Stone.
Harrison.....	W	W	Coal, stone.
Jackson.....	-----	W	Stone.
Jefferson.....	W	W	Stone, lime.
Kanawha.....	W	W	Coal, stone.
Lewis.....	W	2,272	Coal.
Lincoln.....	W	W	Clays.
Logan.....	84,699	118,303	Coal.
McDowell.....	118,837	191,149	Do.
Marion.....	55,651	61,428	Do.
Marshall.....	W	W	Coal, salt.
Mason.....	W	W	Coal, sand and gravel.
Mercer.....	W	W	Coal, clays.
Mineral.....	W	W	Coal, stone.
Mingo.....	22,628	16,823	Coal.
Monongalia.....	W	W	Coal, stone.
Monroe.....	-----	-----	-----
Morgan.....	W	W	Sand and gravel.
Nicholas.....	W	W	Coal, stone, sand and gravel.
Ohio.....	W	W	Coal, sand and gravel.
Pendleton.....	W	W	Stone, lime.
Pleasants.....	W	W	Sand and gravel.
Pocahontas.....	394	W	Coal, stone.
Preston.....	10,087	W	Do.
Raleigh.....	W	W	Coal, stone, sand and gravel.
Randolph.....	3,344	W	Coal, stone.
Roane.....	-----	W	Stone.
Summers.....	-----	209	Coal.
Taylor.....	W	1,329	Do.
Tucker.....	W	W	Coal, stone.
Tyler.....	W	W	Salt, sand and gravel.
Upshur.....	1,820	4,884	Coal.
Wayne.....	W	W	Stone, coal.
Webster.....	679	2,448	Coal.
Wetzel.....	W	W	Sand and gravel.
Wirt.....	W	-----	-----
Wood.....	W	W	Sand and gravel, stone.
Wyoming.....	W	110,569	Coal, sand and gravel.
Undistributed <sup>2</sup> .....	r 615,765	737,150	-----
Total.....	r 947,239	1,285,364	-----

<sup>r</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

<sup>1</sup> Calhoun, Doddridge, Hampshire, Putnam, and Ritchie Counties are not listed because no production was reported.

<sup>2</sup> Includes gem stones, natural gas, natural gas liquids, and petroleum that cannot be assigned to specific counties, and values indicated by symbol W.

erals industry were published by the State Geological and Economic Survey.<sup>2</sup>

At the Bureau of Mines Morgantown Energy Research Center, producer gas, a fuel gas with a relatively low calorific value, was successfully produced in an experimental fixed-bed gasifier by passing steam and air continuously through a deep bed of incandescent coal. In this country, most of the coals mined east of the Mississippi River agglomerate when heated into a mass impermeable to air flow. The main objective of these tests was to successfully gasify all grades of coal by

providing mechanical stirring of the fuel bed.

<sup>2</sup> Bain, George L. Salty Ground-Water in the Pocatillo Basin. W. Va. Geol. Survey, C11, 1970, 31 pp.

Cardwell, D. H., D. G. Patchen, and L. D. Woodfork. Oil and Gas Fields Map of West Virginia. W. Va. Geol. Survey, 1970.

Donaldson, A. C. Some Appalachian Coals and Carbonates: Models of Ancient Shallow-Water Depositions. W. Va. Geol. Survey, 1970, 385 pp.

Hidalgo, Robert V., and John J. Renton. The Use of Pelletized Samples for X-ray Diffraction of Clay Minerals in Shale. W. Va. Geol. Survey, C12, 1970, 25 pp.

Lotz, Charles W. Probable Original Mineral Extent of the Bituminous Coal Seams of West Virginia. W. Va. Geol. Survey, 1970.

In a cooperative effort between Federal and State agencies, the utilization of fly ash as a soil conditioner on abandoned coal strip mine sites was investigated. Fly ash was spread at a rate of 150 tons per acre over the mine bench and disturbed

slope. A good growth of rye grass and Kentucky 31 fescue was obtained.

By the use of radioisotopes, methods were developed to determine by continuous analysis the moisture and sulfur contents of coal.

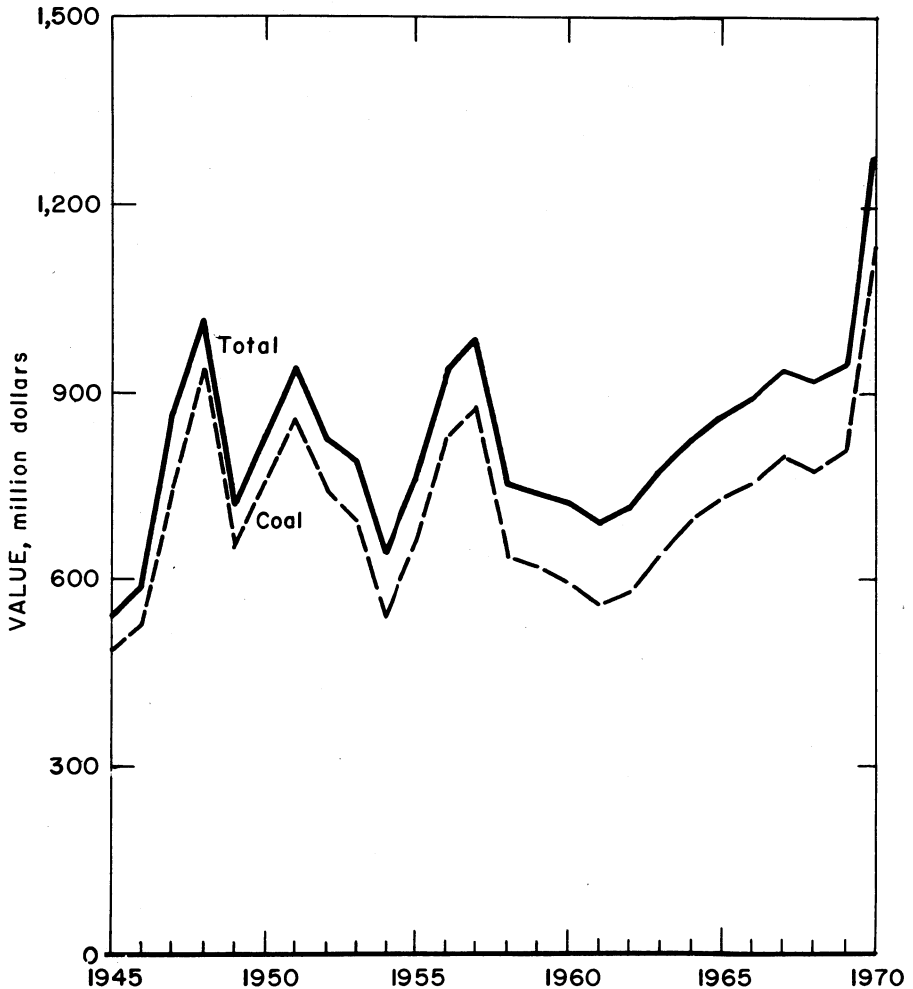


Figure 1.—Value of coal and total value of mineral production in West Virginia.

Table 3.—Indicators of West Virginia business activity

	1969	1970	Change, percent
Employment and labor force, annual average: <sup>1 2</sup>			
Total labor force.....thousands..	623.8	629.4	+ .9
Unemployment.....percent of work force..	5.5	6.4	+16.4
Employment:			
Manufacturing.....thousands..	131.0	126.4	-3.5
Transportation and public utilities.....do..	41.1	41.6	+1.2
Wholesale and retail trade.....do..	91.5	91.1	-.4
Finance, insurance and real estate.....do..	15.1	15.7	+4.0
Mining.....do..	47.1	48.9	+3.8
Services.....do..	64.7	67.1	+3.7
Contract construction.....do..	26.8	27.5	+2.6
Government.....do..	95.0	95.6	+ .6
Payroll average weekly earnings: <sup>2</sup>			
Manufacturing.....	\$128.64	\$136.12	+5.8
Personal income: <sup>3</sup>			
Total.....millions..	\$4,735	\$5,103	+7.8
Per capita.....	\$2,712	\$2,929	+8.0
Construction activity:			
Cement shipments to and within West Virginia <sup>4</sup>			
thousand 376-pound barrels..	2,512	2,496	-.6
Mineral production <sup>4</sup> .....thousands..	\$947,239	\$1,285,364	+35.7

<sup>1</sup> Revised.<sup>2</sup> Source: Area Trends in Employment and Unemployment, U.S. Department of Labor.<sup>3</sup> Source: Employment and Earnings, v. 17, No. 11, May 1971, U.S. Department of Labor.<sup>4</sup> Source: Survey of Current Business, U.S. Department of Commerce.<sup>4</sup> Source: U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours		
					Fatal	Non-fatal	Frequency	Severity	
1969:									
Coal.....	42,501	214	9,081	71,929	70	3,904	55.25	8,423	
Nonmetal.....	243	235	57	457	-----	10	21.86	490	
Sand and gravel.....	182	254	46	416	-----	17	40.85	1,322	
Stone.....	1,126	266	299	2,330	-----	40	17.16	291	
Total <sup>1</sup> .....	44,052	215	9,484	75,133	70	3,971	53.78	8,083	
1970: <sup>2</sup>									
Coal.....	44,400	221	9,801	77,738	66	4,380	57.20	7,686	
Nonmetal.....	185	231	43	340	-----	7	20.58	121	
Sand and gravel.....	215	209	45	431	-----	13	30.16	278	
Stone.....	1,175	259	305	2,471	1	50	20.64	3,179	
Total <sup>1</sup> .....	45,930	222	10,194	80,981	67	4,450	55.79	7,478	

<sup>2</sup> Preliminary.<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### MINERAL FUELS

**Coal (Bituminous).**—West Virginia continued to be the leading coal-producing State in the Nation. The 1970 production increased 2 percent to 144 million tons, compared with 141 million tons in 1969. The value of coal produced increased by 41 percent to \$1,142 million. The production of open-market coal totaled 125 million tons valued at \$958 million, an increase of 3 percent in quantity and an

increase of 43 percent in value. Captive coal production was 18.8 million tons and was valued at \$183.9 million, a decrease of 5 percent in quantity and a 34 percent increase in value.

The average value per ton of coal rose to \$7.93 from \$5.73 in 1969. There were 1,319 active mines with production in excess of 1,000 tons; these included 748 underground mines, 418 strip mines, and 153 auger mines. Of the total output, 81 percent was mined underground; 15 percent

by strip mining; 4 percent by auger mining. The value of coal produced was \$940 million from underground operations, an increase of 31 percent; \$155 million from strip mining, an increase of 124 percent; \$48 million from auger mining, an increase of 112 percent.

Equipment reported used at underground mines included 774 cutting machines, 105 less than in 1969; 709 hand-held and post mounted drills, a decrease of 133; 311 mobile drills, an increase of 61 drills; 716 rotary drills; and 176 percussion drills.

Of the total underground production, more than 98 percent was mechanically loaded. Continuous miners produced 64 million tons; of this, 6 percent was loaded onto conveyors or mine cars, 55 percent onto shuttle cars, and 39 percent directly onto the mine floor to later be loaded by mobile loaders. The continuous miners were reportedly used as follows: 356 loaded onto shuttle cars, 83 onto conveyors or mine cars, and 156 directly onto the mine

bottom. Mobile loaders were reportedly used as follows: 609 loaded onto shuttle cars or rubber-tired mine cars, 36 onto mine cars or conveyors, and 204 were used in conjunction with continuous miners. Two percent of the tonnage mechanically loaded was produced by the longwall mining method. Less than 1 percent was loaded by duckbill loaders or scraper loaders.

Strip coal mining equipment included 316 power shovels, 37 drag lines, 20 carryall scrapers, 452 bulldozers, 39 horizontal drills, and 95 vertical drills. Equipment at auger mines included 154 augers, two power shovels, and 151 bulldozers.

Of the total production, 45 percent was crushed. In 1970, 136 cleaning plants cleaned 71 percent of the total production. Of this quantity, 29 percent was cleaned by jigs, 66 percent by wet washing other than jigs, and 5 percent by air cleaning. Of the total coal cleaned, 28 percent was dried in 53 thermal drying plants.

Of the total production, 21 percent was shipped by unit train.

Table 5.—West Virginia: Bituminous coal production, by type of mine and counties  
(Excludes mines producing less than 1,000 short tons per year)

County	Number of mines				Production (thousand short tons)				Value (thousands)
	Under-ground	Strip	Auger	Total	Under-ground	Strip	Auger	Total	
Barbour.....	23	29	1	53	1,633	1,942	38	3,613	\$27,856
Boone.....	44	31	29	104	8,337	2,595	1,280	12,212	91,712
Brooke.....	3	9		12	679	316		995	4,876
Clay.....	3			3	W			W	W
Fayette.....	39	16	4	59	3,470	1,013	217	4,700	38,258
Gilmer.....	2	3		5	38	55		93	498
Grant.....	3	8		11	1,865	556		2,421	14,889
Greenbrier.....	16	3		19	384	94		478	2,815
Hancock.....		1		1	W			W	W
Harrison.....	13	44	2	59	5,443	1,720	27	7,190	44,362
Kanawha.....	48	13	21	82	8,867	1,833	1,024	11,724	83,006
Lewis.....	1	8	3	12	3	259	71	333	2,271
Logan.....	44	13	28	85	10,435	704	1,494	12,633	118,371
Marion.....	8	5	1	14	8,901	359	35	9,295	61,254
Marshall.....	5			5	5,162			5,162	26,842
Mason.....	3			3	646			646	5,278
McDowell.....	149	39	8	196	15,662	1,394	89	17,145	191,167
Mercer.....	9	8		17	1,060	99		1,159	12,193
Mineral.....	3	9	1	13	51	304	8	363	1,205
Mingo.....	33	13	12	58	1,547	457	220	2,224	16,813
Monongalia.....	21	17		38	12,331	497		12,828	71,837
Nicholas.....	60	26	4	90	6,192	946	139	7,277	62,218
Ohio.....	2			2	W			W	W
Pocahontas.....	3			3	40			40	400
Preston.....	30	39		69	867	2,152		3,019	15,699
Raleigh.....	52	31	17	100	7,663	2,184	581	10,428	105,323
Randolph.....	13	5		18	489	161		650	4,849
Summers.....		2		2		21		21	205
Taylor.....	3	6		9	6	219		225	1,330
Tucker.....		4		4		300		300	1,299
Upshur.....	6	14		20	299	571		870	4,881
Wayne.....	4	1		5	98	8		106	795
Webster.....	11	3	2	16	129	118	8	255	2,458
Wyoming.....	94	18	20	132	11,451	977	540	12,968	110,487
Undistributed.....					2,668	32		2,700	17,631
Total <sup>1</sup> .....	748	418	153	1,319	116,414	21,885	5,772	144,072	1,142,488

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

<sup>1</sup> Data may not add to totals shown because of independent rounding.

**Natural Gas Liquids.**—Reserves of natural gas liquids at yearend were 81.5 million 42-gallon barrels, 300,000 barrels less than that of 1969.<sup>3</sup>

**Petroleum and Natural Gas.**—Crude oil production in 1970 was 3.1 million barrels, the same as that of the previous year. The price paid in West Virginia was \$3.75 per barrel. Effective in October, the price paid at the wellhead for interstate gas was raised to \$0.32 per thousand cubic feet. Natural gas production was 242,452 million cubic feet, 5 percent greater than in 1969.

The total number of oil and gas wells drilled declined 4 percent from 1969. Well completions were reported in 14 counties. The Oil and Gas Division of the West Virginia Department of Mines issued 866 permits to drill new wells and/or deepen old wells.

Seventy-six exploratory wells were reported by the West Virginia Geological and Economic Survey in 1970. This included 25 wildcat wells, of which 11 were successful; 19 deeper pool test wells, of which four were successful; and 27 outpost wells, three of which were new pool discoveries. Shallow pools were discovered in two development wells.

The deepest exploratory well located in Marshall County was drilled to a depth of 16,512 feet. No shows were reported. The well bottomed in the Upper Cambrian Copper Ridge Dolomite.

According to the Oil and Gas Journal, estimated proved crude oil reserves at yearend were 53.2 million barrels. Proved reserves of natural gas at the end of 1969 were estimated at 2,447 billion cubic feet.

At midyear, the West Virginia Geological and Economic Survey reported a total of 2.9 million underdeveloped acres in West Virginia that were under lease by 14 large companies. Additional acreage was under lease by independent operators and lease brokers.

The Big Injun Waterflood in the Granny-Stockly field, Clay County, was the only full-scale waterflood operation. Two pilot waterflood projects were abandoned in Mason and Marion Counties.

#### NONMETALS

**Cement.**—Shipments of portland and masonry cement decreased 6 and 16 percent,

respectively. The average price per barrel increased slightly, however, Capital Cement Co. Division of Martin-Marietta Corp. at Martinsburg, Berkeley County, is the only producer. Three coal-fired rotary kilns were operated. Most of the cement was used in ready-mixed concrete and in the construction of buildings and highways.

**Clays.**—Production of miscellaneous clay decreased 23 percent. Miscellaneous clay was used primarily in the production of cement and building brick. The largest production of miscellaneous clay was in Berkeley County. Fire clay was used mostly for the manufacture of fire bricks and block. Two underground mines were in operation.

**Lime.**—Lime production was 262,000 tons in 1970, compared with 269,000 tons in 1969. Chief uses were steel production, construction, agriculture, refractories, and chemicals. Eighty percent of the shipments went to Pennsylvania. Three lime plants were in production, one each in Berkeley, Jefferson, and Pendleton Counties.

**Salt.**—Production of salt was 9 percent less than in 1969; production was from brines, which resulted from solution mining in Marshall and Tyler Counties. The salt was used by the producers in the manufacture of chlorine and caustic soda.

**Sand and Gravel.**—The quantity produced decreased 12 percent, and the total value remained substantially the same.

The average price increased from \$2.29 to \$2.61 per ton. Of the total production, 67 percent was sand, and 33 percent was gravel. Sixty-one percent was barged, and the balance was shipped by railroad or truck.

Production was reported in 13 counties; heading the list were Hancock, Morgan, and Brooke. Production was from six stationary plants, one portable plant, and 11 dredges.

**Slag.**—Weirton Steel Division, National Steel Corp., crushed air-cooled blast furnace slag for aggregate use.

**Stone.**—Crushed limestone and sandstone production increased 8 percent. Major uses were for the limestone manufacture of cement, construction aggregate, railroad ballast, lime production, mine dusting, and

<sup>3</sup> Oil and Gas Journal, V. 69, No. 14, Apr. 5, 1971, p. 40.

**Table 6.—West Virginia: Sand and gravel sold or used by producers, by classes of operations and use**

(Thousand short tons and thousand dollars)

Class of operation and use	1969 <sup>r</sup>		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
<b>Sand:</b>				
Building.....	1,529	\$2,083	1,233	\$1,775
Paving.....	351	582	343	568
Other uses <sup>1</sup> .....	1,295	6,241	1,378	6,912
<b>Total <sup>2</sup>.....</b>	<b>3,175</b>	<b>8,907</b>	<b>2,954</b>	<b>9,255</b>
<b>Gravel:</b>				
Building.....	1,300	1,723	978	1,520
Fill <sup>3</sup> .....	33	47	38	56
Paving.....	512	798	425	641
<b>Total <sup>2</sup>.....</b>	<b>1,845</b>	<b>2,570</b>	<b>1,442</b>	<b>2,218</b>
<b>Total sand and gravel <sup>2</sup>.....</b>	<b>5,021</b>	<b>11,475</b>	<b>4,396</b>	<b>11,473</b>

<sup>r</sup> Revised.<sup>1</sup> Includes oil (hydrafrac) (1969), glass, molding, grinding and polishing, blast, fire or furnace, engine, filtration, abrasives, chemical, enamel, fill, foundry, glass, pottery, and other sands.<sup>2</sup> Data may not add to totals shown because of independent rounding.<sup>3</sup> Includes railroad ballast.**Table 7.—West Virginia: Crushed and broken stone sold or used by producers, by uses**

(Thousand short tons and thousand dollars)

Use	1969		1970	
	Quantity	Value	Quantity	Value
Bituminous aggregate.....	W	W	755	\$1,228
Concrete aggregate.....	81	\$166	982	1,608
Dense graded road base stone.....	973	1,739	1,525	2,483
Macadam aggregate.....	W	W	15	W
Surface treatment aggregate.....	427	740	411	588
Unspecified aggregate and roadstone.....	1,112	1,894	608	1,109
Agricultural purposes.....	118	290	87	201
Mine dusting.....	213	954	231	1,036
Railroad ballast.....	703	884	696	784
Other uses <sup>1</sup> .....	5,404	9,136	4,433	7,683
<b>Total <sup>2</sup>.....</b>	<b>9,031</b>	<b>15,801</b>	<b>9,740</b>	<b>16,722</b>

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

<sup>1</sup> Includes stone sand, stone used in cement and lime manufacture, riprap, flux, dead burned dolomite, refractory materials, glass (1970), and other miscellaneous stone in smaller quantities.<sup>2</sup> Data may not add to totals shown because of independent rounding.

aglimestone. The leading counties producing limestone were Berkeley, Monongalia, Jefferson, and Greenbrier. Crushed limestone production was 7.3 million tons.

#### METALS

**Aluminum.**—Kaiser Aluminum & Chemical Corp. smelted alumina at Ravenswood, Jackson County. Production of aluminum was approximately the same as that of the previous year. Imported bauxite was processed into alumina at Baton Rouge and Gramercy, La.

**Ferroalloys.**—Union Carbide Corp. operated its ferroalloy plant near Alloy, Fayette County. Smelting was accomplished

in electric furnaces. Most mineral raw materials were obtained from other States or were imported. Foote Mineral Co., Inc. produced ferroalloys in electric furnaces at Graham Station, Mason County. Chemicals Div., Diamond-Shamrock Corp. produced ferromanganese in electric furnaces at Kingwood, Preston County.

**Nickel.**—Huntington Alloy Products Division, International Nickel Products Co., Inc., rolled various types of high-nickel alloys at its operation in Huntington (Cabell and Wayne Counties). Principal products include nickel and high-nickel alloys in mill forms such as strip, sheet, plate, tube, wire rod, and bars.

**Zinc.**—Matthiessen & Hegeler Zinc Co. refined zinc in 20 vertical zinc retorts at its plant in Meadowbrook, Harrison County. The smelter feed included precalcined zinc concentrates imported from Canada and zinc dross from galvanizing plants. The plant produced slab zinc, dust, and ball anodes.

**Zirconium and Hafnium.**—Amax Special-

ty Metals Division of American Metal Climax, Inc., produced zirconium sponge metal from zircon sands at its plant near Parkersburg, Wood County. The firm also manufactured hafnium oxide at this plant. Union Carbide Corp. made zirconium alloys at their plant at Alloy. Corhart Refractories Co. made zircon refractories at Buckhannon, Upshur County.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement (portland and masonry):</b>			
Capitol Cement Co., Div. of Martin-Marietta Corp. <sup>1</sup>	Box 5618 Baltimore, Md. 21210	Plant.....	Berkeley.
<b>Clays:</b>			
<b>Fire clay:</b>			
Crescent Brick Co., Inc.	Box 368 New Cumberland, W. Va. 26047	Underground.....	Hancock.
Globe Refractories, Inc.	Box D Newell, W. Va. 26050	.....do.....	Do.
<b>Common clay and shale:</b>			
Barboursville Clay Manufacturing Co.	Box 1048 Charleston, W. Va. 25324	Pit.....	Cabell.
Continental Clay Products Co.	931 Investment Bldg. 1511 K St. N.W. Washington, D.C. 20005	Pit.....	Berkeley.
Lincoln Clay Product Co.	West Hamlin, W. Va. 25571	Pit.....	Lincoln.
Sanders Dummy Co.	Midkiff, W. Va. 25540	Pit.....	Do.
United Clay Products Co.	931 Investment Bldg. Washington, D.C. 20005	Pit.....	Berkeley.
Virginia Brick & Tile Co.	Box 983 Princeton, W. Va. 24740	Pit.....	Mercer.
<b>Coal (bituminous):</b>			
Amherst Coal Co. <sup>2</sup> .....	Lundale, W. Va. 25631.....	Underground and auger.	Logan.
Amherst Coal Co.....	do.....	Auger.....	Wyoming.
Arco Steel Corp. <sup>3</sup> .....	Montcoal, W. Va. 25135.....	Underground.....	Boone and Raleigh.
Bethlehem Mines Corp.....	701 East 3d St. Bethlehem, Pa. 18015	.....do.....	Kanawha and Marion.
Bethlehem Mines Corp. <sup>4</sup> .....	do.....	Underground, strip, and auger.	Raleigh.
Bishop Coal Co.....	Pocahontas, Va. 24635	Underground.....	McDowell.
Cannelton Coal Co. <sup>2</sup> .....	Cannelton, W. Va. 25036.....	Underground and strip.	McDowell and Kanawha.
Carbon Fuel Co.....	1310 Kanawha Valley Bldg. Charleston, W. Va. 25301	Underground.....	Boone.
Do. <sup>5</sup> .....	do.....	Underground and auger.	Kanawha.
Carbon Fuel Co.....	do.....	Auger.....	Raleigh.
Christopher Coal Co., Div. of Consolidation Coal Co. <sup>6</sup>	Box 100 Osage, W. Va. 26543	Underground.....	Monongalia.
Clinchfield Coal Co. <sup>3</sup> .....	Box 472 Clarksburg, W. Va. 26301	.....do.....	Harrison.
Eastern Associated Coal Corp. <sup>6</sup>	Koppers Bldg. Pittsburgh, Pa. 15219	.....do.....	Boone and McDowell.
Island Creek Coal Co. <sup>7</sup> .....	Holden, W. Va. 25625.....	do.....	Grant, Logan, Marion, Monongalia, Nicholas, Raleigh, Wyoming.
Mountaineer Coal Co., Div. of Consolidation Coal Co. <sup>8</sup>	Box 1632 Fairmont, W. Va. 26555	.....do.....	Harrison.
Mountaineer Coal Co., Div. of Consolidation Coal Co.	do.....	Underground and strip.	Marion.
National Coal Mining Co..	Drawer L Holden, W. Va. 25625	Underground.....	Mingo.
Ohio Valley Div. Consolidation Coal Co. <sup>8</sup>	Moundsville, W. Va. 26041	.....do.....	Marshall.
Olga Coal Co.....	Box 900 Youngstown, Ohio 44500	.....do.....	McDowell.

See footnotes at end of table.

Table 8.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Coal (bituminous)—Continued			
Pocahontas Fuel Co., Div. of Consolidation Coal Co. <sup>9</sup>	Pocahontas, Va. 24635	Underground	Mercer and Wyoming.
Pocahontas Fuel Co., Div. of Consolidation Coal Co. <sup>4</sup>	-----do-----	Underground and strip.	McDowell.
Powellton Co. <sup>5</sup>	Mallory, W. Va. 25634	Underground	Logan.
Ranger Fuel Corp. <sup>4</sup>	Drawer V Beckley, W. Va. 25801	Strip and auger	Boone.
Ranger Fuel Corp. <sup>5</sup>	-----do-----	Underground and strip.	Raleigh and Wyoming.
Semet-Solvay, Div. Allied Chemical Corp. <sup>3</sup>	40 Rector St. New York, N.Y. 10006	Underground	Fayette, McDowell, Wyoming.
Slab Fork Coal Co.	Slab Fork, W. Va. 25920	-----do-----	Raleigh.
The Valley Camp Coal Co. <sup>2</sup>	Shrewsbury, W. Va. 25184	Underground and strip.	Kanawha.
The Valley Camp Coal Co. <sup>8</sup>	Box 218 Triadelphia, W. Va. 26059	Underground	Ohio and Marshall.
Union Carbide Corp., Ferroalloys.	Box 38 Mammoth, W. Va. 25132	-----do-----	Kanawha and Mason.
United States Steel Corp. <sup>10</sup>	525 William Penn Place Pittsburgh, Pa. 15219	Underground and strip.	McDowell.
Westmoreland Coal Co. <sup>3</sup>	123 South Broad St. Philadelphia, Pa. 19109	Underground	Boone.
Winding Gulf Coals, Inc. <sup>11</sup>	Tams, W. Va. 25933	-----do-----	Fayette, Raleigh, Wyoming.
Lime:			
Germany Valley Limestone Co., Div. of Greer Limestone Co. <sup>12</sup>	Riverton, W. Va. 26814	Plant	Pendleton.
Jones & Laughlin Steel Corp., Blair Limestone Div. <sup>12</sup>	R.D. 3 Martinsburg, W. Va. 25401	-----do-----	Berkeley.
Standard Lime & Refractories Co., Div. Martin-Marietta Corp. <sup>13</sup>	2000 First National Bank Bldg. Baltimore, Md. 21203	-----do-----	Jefferson.
Magnesium Compounds:			
Amax Specialty Metals, Inc.	Box 1728 Parkersburg, W. Va. 26101	-----do-----	Wood.
Petroleum refineries:			
Elk Refining Co.	Falling Rock, W. Va. 25079	-----do-----	Kanawha.
Quaker State Oil Refining Corp.	St. Marys, W. Va. 26170	-----do-----	Pleasants.
Salt:			
Industrial Chemicals Div. Allied Chemical Corp.	Box 70 Morristown, N. J. 07960	-----do-----	Marshall.
Inorganic Chemical Div. FMC Corp.	Box 8127 South Charleston, W. Va. 25303	Mine	Tyler.
PPG Industries, Inc., Chemical Div.	1 Gateway Center Pittsburgh, Pa. 15222	Plant	Marshall.
Sand and gravel:			
Delta Concrete Co.	41st and Noble St. Bellaire, Ohio 43906	Pit	Ohio.
Dravo Corp., Keystone Div.	5th and Liberty Ave. Pittsburgh, Pa. 15222	Dredge	Hancock.
Duquesne Sand Co.	East Beaver St. Glenfield, Pa. 15115	-----do-----	Brooke.
Iron City Sand & Gravel Corp., Div. of McDonough Co.	Box 538 Parkersburg, W. Va. 26100	Pit	Hancock and Wood.
Ohio River Sand & Gravel, Div. of McDonough Co.	-----do-----	Dredges	Tyler and Wood.
Ohio Valley Sand Co., Inc.	Box 99 New Martinsville, W. Va. 26155	Pit	Wetzel.
Pennsylvania Glass Sand Corp.	Berkeley Springs, W. Va. 25411	Pit	Morgan.
Pfaff & Smith Builders Supply Co.	Box 2508 Charleston, W. Va. 25329	Dredge	Wood.
Smelters:			
Kaiser Aluminum & Chemical Corp.	300 Lakeside Dr. Oakland, Calif. 94626	Plant	Jackson.
Matthiessen & Hegeler Zinc Co.	9th and Sterling St. LaSalle, Ill. 61301	-----do-----	Harrison.

See footnotes at end of table.



Table 8.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Stone:</b>			
Limestone (crushed and broken):			
Acme Limestone Co....	Fort Spring, W. Va. 24936	Mine and quarry	Greenbrier.
Aurora Stone Co., Inc.	Route 3 Keyser, W. Va. 26726	Quarry	Mineral.
Appalachian Stone Div., Martin-Marietta Corp.	Box 120 Mercersburg, Pa. 17236	do	Berkeley.
Elkins Limestone Co..	Elkins, W. Va. 26241	Mine	Randolph and Tucker.
The H. Frazier Co., Inc.	Box 1377 Richmond, Va. 23211	Quarry	Greenbrier.
Green Bag Cement Co., Div. of Marquette Cement Manufacturing Co.	20 North Wacker Dr. Chicago, Ill. 60606	Mine	Monongalia.
Greer Limestone Co. <sup>14</sup>	Greer Building Morgantown, W. Va. 26505	Mine and quarry	Do.
Paul Harrold	Route 1 Wolf Summit, W. Va. 26462	Quarry	Harrison.
Jones & Laughlin Steel Corp., Blair Limestone Div.	R.D. 3 Martinsburg, W. Va. 25401	do	Jefferson.
Terra Alta Limestone Co.	Aurora, W. Va. 26705	do	Preston.
United States Steel Corp.	Millville, W. Va. 25432	do	Jefferson.
Sandstone (dimension):			
Rhine Creek Stone Co.	Box 265 Egdon, W. Va. 26716	do	Preston.
Sandstone (crushed):			
Fairfax Sand & Crushed Stone Co.	Thomas, W. Va. 26292	do	Tucker.
Basil R. Heavner	French Creek, W. Va. 26218	do	Lewis.
Manheim Quarries, Inc.	P.O. Box 2187 Morgantown, W. Va. 26505	do	Preston.
Mazzella Quarries, Inc	2087 Oakridge Dr. Charleston, W. Va. 25311	do	Kanawha.
Meadows Stone & Paving, Inc.	Box 518 Gassaway, W. Va. 26624	do	Braxton.
Do	do	do	Nicholas.
Raleigh Stone Co. of Beckley, W. Va.	Box 1387 Roanoke, Va. 24001	do	Raleigh.
Salerno Brothers, Inc.	Shinnston, W. Va. 26431	do	Harrison.
Stone Co. Inc.	5347 Route 60E Huntington, W. Va. 25705	do	Boone, Cabell, Fayette, Wayne.
Tony Pacifico Stone Quarry, Inc.	1417 Camden Drive Charleston, W. Va. 25302	do	Kanawha.

<sup>1</sup> Also limestone and shale.

<sup>2</sup> 9 mines.

<sup>3</sup> 3 mines.

<sup>4</sup> 4 mines.

<sup>5</sup> 6 mines.

<sup>6</sup> 14 mines.

<sup>7</sup> 22 mines.

<sup>8</sup> 2 mines.

<sup>9</sup> 8 mines.

<sup>10</sup> 7 mines.

<sup>11</sup> 13 mines.

<sup>12</sup> Also limestone.

<sup>13</sup> Also dolomite.

<sup>14</sup> Also quartzite.

# The Mineral Industry of Wisconsin

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

By Grace N. Broderick <sup>1</sup>

Wisconsin mineral production in 1970 was valued at \$87.7 million, an increase of nearly 10 percent over that of 1969. The gain in value was due to a large increase in output of iron ore pellets, production of which began in December 1969, and a lesser increase in lime production. All

other mineral commodities (except vermiculite which is exfoliated in Wisconsin from crude material mined outside the State) decreased in both quantity and value.

<sup>1</sup> Physical scientist, Division of Ferrous Metals.

Table 1.—Mineral production in Wisconsin <sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays..... thousand short tons	12	\$24	8	\$14
Iron ore (usable)..... thousand long tons, gross weight	36	W	806	W
Lead (recoverable content of ores, etc.)..... short tons	1,102	323	761	238
Lime..... thousand short tons	244	4,080	247	4,503
Peat..... do	2	155	2	W
Sand and gravel..... do	42,815	35,414	41,103	35,107
Stone..... do	18,954	27,571	17,577	25,167
Zinc (recoverable content of ores, etc.)..... short tons	22,901	6,687	20,634	6,322
Value of items that cannot be disclosed:				
Abrasive stone (grinding pebbles), cement, gem stones, and values indicated by symbol W.....	XX	r 5,533	XX	16,319
Total.....	XX	r 79,792	XX	87,670
Total 1967 constant dollars.....	XX	75,349	XX	p 79,341

<sup>p</sup> Preliminary. <sup>r</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

Table 2.—Value of mineral production in Wisconsin, by counties <sup>1</sup>

(Thousands)

County	1969	1970	Minerals produced in 1970, in order of value
Adams.....	W	W	Sand and gravel.
Ashland.....	\$126	\$292	Sand and gravel, stone.
Barron.....	285	485	Sand and gravel.
Bayfield.....	197	257	Do.
Brown.....	1,705	W	Stone, lime, sand and gravel.
Buffalo.....	260	W	Stone, sand and gravel.
Burnett.....	157	W	Sand and gravel.
Calumet.....	234	W	Stone, sand and gravel.
Chippewa.....	230	545	Sand and gravel.
Clark.....	W	757	Do.

See footnotes at end of table.

Table 2.—Value of mineral production in Wisconsin, by counties <sup>1</sup>—Continued  
(Thousands)

County	1969	1970	Minerals produced in 1970, in order of value
Columbia	\$2,271	\$2,226	Sand and gravel, stone.
Crawford	406	W	Stone, sand and gravel.
Dane	3,978	3,974	Sand and gravel, stone.
Dodge	1,706	W	Sand and gravel, lime, stone.
Door	330	W	Sand and gravel, stone.
Douglas	W	W	Lime, sand and gravel, stone.
Dunn	168	W	Sand and gravel, stone.
Eau Claire	W	W	Sand and gravel.
Florence	34	W	Do.
Fond du Lac	1,278	W	Stone, sand and gravel, lime, clays.
Forest	89	209	Sand and gravel.
Grant	2,778	3,169	Zinc, stone, lead, sand and gravel.
Green	696	W	Stone, sand and gravel.
Green Lake	603	554	Sand and gravel, stone.
Iowa	592	W	Stone, zinc.
Iron	16	W	Sand and gravel.
Jackson	W	W	Iron ore, sand and gravel.
Jefferson	206	W	Sand and gravel, stone.
Juneau	W	W	Stone, sand and gravel.
Kenosha	124	388	Sand and gravel.
Kewaunee	589	637	Sand and gravel, stone.
La Crosse	332	197	Stone, sand and gravel.
Lafayette	5,239	4,556	Zinc, stone, lead.
Langlade	544	W	Sand and gravel.
Lincoln	457	W	Sand and gravel, peat.
Manitowoc	1,939	2,295	Cement, sand and gravel, lime, stone.
Marathon	3,682	2,407	Stone, sand and gravel.
Marinette	W	1,194	Do.
Marquette	W	W	Stone.
Milwaukee	W	W	Cement, stone, sand and gravel.
Monroe	1,079	304	Stone, sand and gravel.
Oconto	583	W	Sand and gravel, stone.
Oneida	197	255	Sand and gravel.
Outagamie	811	1,243	Stone, sand and gravel.
Ozaukee	623	578	Sand and gravel.
Pepin	75	W	Stone, sand and gravel.
Pierce	446	W	Do.
Polk	1,094	W	Do.
Portage	792	W	Sand and gravel, stone.
Price	72	148	Sand and gravel.
Racine	2,216	W	Stone, sand and gravel, clays.
Richland	240	443	Stone, sand and gravel.
Rock	2,115	2,039	Sand and gravel, stone.
Rusk	255	W	Sand and gravel.
St. Croix	586	W	Stone, sand and gravel.
Sauk	1,460	W	Stone, sand and gravel, abrasives.
Sawyer	98	149	Sand and gravel.
Shawano	279	W	Sand and gravel, stone.
Sheboygan	699	626	Do.
Taylor	487	595	Sand and gravel.
Trempealeau	242	W	Stone, sand and gravel.
Vernon	489	W	Do.
Vilas	202	228	Sand and gravel.
Walworth	1,128	W	Sand and gravel, stone.
Washburn	180	W	Sand and gravel.
Washington	2,062	1,766	Do.
Waukesha	8,032	W	Sand and gravel, stone, peat.
Waupaca	398	W	Sand and gravel, stone.
Waushara	185	128	Sand and gravel.
Winnebago	2,432	W	Stone, sand and gravel.
Wood	275	454	Sand and gravel, stone.
Undistributed <sup>2</sup>	18,710	54,572	
Total <sup>3</sup>	79,792	87,670	

<sup>r</sup> Revised.

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

<sup>1</sup> No production reported for Menominee County.

<sup>2</sup> Includes gem stones, some sand and gravel, and stone that cannot be assigned to specific counties, and values indicated by symbol W.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Wisconsin business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total labor force..... thousands..	1,908.4	1,939.5	+1.9
Unemployment..... do.....	63.7	89.7	+40.8
<b>Employment:</b>			
Manufacturing..... do.....	520.9	500.8	-3.9
Construction..... do.....	66.6	61.9	-7.1
Mining..... do.....	2.6	2.6	-
Transportation and public utilities..... do.....	79.6	80.8	+1.5
Wholesale and retail trade..... do.....	321.6	331.4	+3.0
Finance, insurance, and real estate..... do.....	58.8	61.1	+3.9
Services..... do.....	219.7	230.8	+5.1
Government..... do.....	255.3	265.4	+4.0
<b>Personal income:</b>			
Total..... millions..	\$15,376	\$16,491	+7.3
Per capita..... do.....	\$3,512	\$3,722	+6.0
<b>Construction activity:</b>			
Valuation of authorized nonresidential construction..... millions..	\$217.1	\$208.0	-4.2
Number of private and public residential units authorized..... do.....	22,950	21,790	-5.1
State highway commission contracts awarded..... millions..	\$86.6	\$104.7	+20.9
Portland cement shipments to and within Wisconsin..... thousand 376-pound barrels..	9,611	8,137	-15.3
Farm marketing receipts..... millions..	\$1,524.8	\$1,597.3	+4.8
Mineral production..... do.....	\$79.8	\$87.7	+9.9
<b>International trade:<sup>1</sup></b>			
Value of exports through Wisconsin..... do.....	\$154.7	\$156.2	+1.0
Value of imports through Wisconsin..... do.....	\$128.5	\$136.0	+5.8

<sup>1</sup> Includes Milwaukee Customs District.

Sources: Survey of Current Business; Farm Income Situation; Employment and Earnings; Construction Review; Roads and Streets; Area Trends in Employment and Unemployment; Highlights of U.S. Export and Import Trade; U.S. Bureau of Mines.

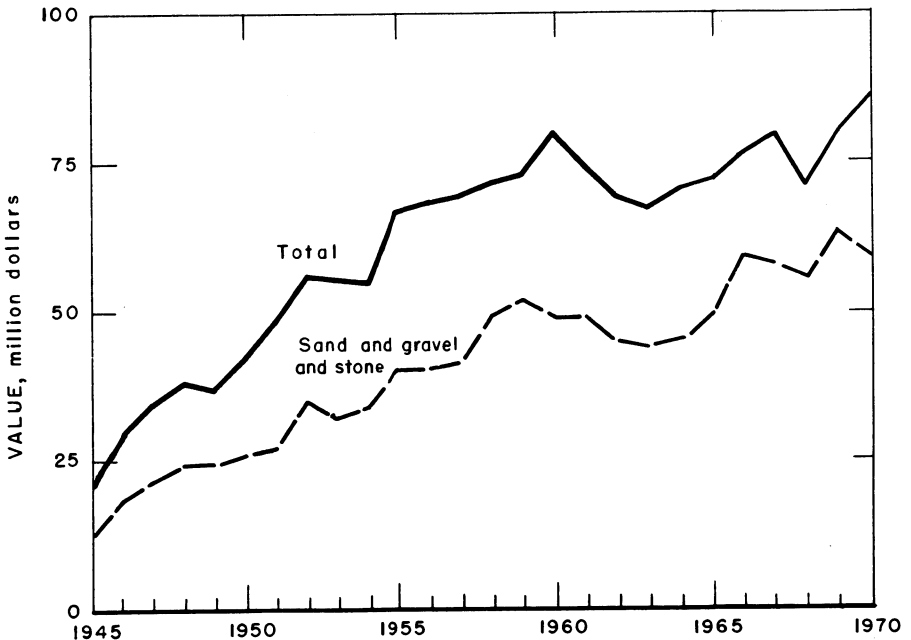


Figure 1.—Value of sand and gravel, stone, and total value of mineral production in Wisconsin.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
<b>1969:</b>								
Peat.....	8	170	1	11	--	--	--	--
Metal.....	217	276	60	482	2	21	47.73	26,426
Nonmetal.....	22	186	4	36	--	--	--	--
Sand and gravel.....	1,850	200	370	3,281	1	70	21.64	3,357
Stone.....	1,775	224	397	3,379	2	81	24.56	4,215
Total <sup>1</sup> .....	3,872	215	833	7,188	5	172	24.62	5,285
<b>1970: <sup>p</sup></b>								
Peat.....	9	212	2	15	--	--	--	--
Metal.....	325	278	90	726	--	37	50.97	1,991
Nonmetal.....	25	175	4	35	--	--	--	--
Sand and gravel.....	1,870	188	352	3,051	1	62	20.65	3,076
Stone.....	1,675	217	364	3,046	2	91	30.53	4,715
Total <sup>1</sup> .....	3,895	208	811	6,874	3	190	28.08	3,665

<sup>p</sup> Preliminary.<sup>1</sup> Data may not add to totals shown because of independent rounding.

## REVIEW BY MINERAL COMMODITIES

### NONMETALS

**Abrasive Stone.**—Baraboo Quartzite Co., Inc., produced grinding pebbles from a quartzite deposit in Sauk County. Quantity and value of production decreased from those of 1969.

**Cement.**—Medusa Portland Cement Co. produced white cement at its Manitowoc plant. Raw materials used in this production included clay from Kentucky, limestone from Michigan, and silica sand from Wisconsin. Marquette Cement Manufacturing Co. operated the State's other cement plant at Milwaukee, producing types I and II (general use and moderate heat) and type III (high-early-strength) portland and masonry cement. Shipments of portland cement decreased in both quantity and value in 1970. Most of the cement shipments were by truck in bulk form; lesser amounts were shipped by truck in packaged form and by rail in both bulk and packaged forms. Shipments of masonry cement declined over 13 percent in quantity and over 6 percent in value.

Most of the cement shipments were to points in Wisconsin, and lesser amounts were shipped to other States. Building material dealers, concrete product manufacturers, and ready-mix concrete manufacturers were the major users.

**Clays.**—Clay and shale produced in Wisconsin by two companies, one less than in 1969, decreased substantially in quantity

and value. Production came from Fond du Lac and Racine Counties, and the material was used for making building brick and drain tile. The Red Wing Sewer Pipe Corp. ceased operations.

**Lime.**—Wisconsin's lime output increased 1 percent in quantity and 10 percent in value. Lime production in Wisconsin has increased in quantity and value each year for the past 9 years. Companies producing lime were the Cutler-LaLiberte-McDougall Corp. in Douglas County, the Western Lime & Cement Co., with plants in Brown, Dodge, and Fond du Lac Counties, Mayville White Lime Works in Dodge County, and the Rockwell Lime Co. in Manitowoc County. The principal use was for paper and pulp. Other uses included construction, agriculture, and chemicals.

**Perlite.**—Expanded perlite was produced at Milwaukee and Appleton from crude material mined outside the State. Material was used for lightweight aggregate in concrete, tile, and building plaster, for loose fill insulation, for soil conditioning, and other uses. Production decreased in quantity and value from that of 1969.

**Sand and Gravel.**—Wisconsin contributed 4 percent of the total sand and gravel production in the United States and ranked sixth nationally in quantity and ninth in value of sand and gravel produced. Production, which declined 4 percent in quantity and about 1 percent in value, was reported from 68 counties.

Table 5.—Wisconsin: Sand and gravel sold or used by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Blast.....	68	\$236	73	\$253
Building.....	3,944	3,751	3,640	3,439
Fill.....	2,030	1,043	1,945	1,090
Molding.....	916	2,516	782	2,190
Paving.....	2,443	2,023	2,451	1,947
Other uses <sup>1</sup> .....	145	349	240	588
Total <sup>2</sup> .....	9,546	9,917	9,131	9,506
Gravel:				
Building.....	4,236	4,145	4,292	4,402
Fill.....	1,693	981	1,443	799
Paving.....	16,123	13,355	15,488	13,401
Railroad ballast.....	157	107	158	99
Other uses <sup>3</sup> .....	15	15	18	22
Total <sup>2</sup> .....	22,224	18,603	21,399	18,722
<b>Government-and-contractor operations:</b>				
Sand:				
Fill.....	156	70	142	62
Paving.....	2,072	1,127	2,359	1,274
Other uses.....	238	119	177	102
Total <sup>2</sup> .....	2,466	1,316	2,678	1,438
Gravel:				
Fill.....	538	253	459	229
Paving.....	8,035	5,319	7,437	5,213
Other uses.....	7	5	--	--
Total <sup>2</sup> .....	8,579	5,577	7,896	5,443
Total sand and gravel <sup>2</sup> .....	42,815	35,414	41,108	35,107

<sup>1</sup> Includes foundry (1970), engine, filtration, glass, oil (hydrafrac), and other sands.<sup>2</sup> Data may not add to totals shown because of independent rounding.<sup>3</sup> Includes miscellaneous (1970), and other gravel.

Sand and gravel constituted 40 percent of the State's total mineral value and ranked number one in production among the commodities produced in the State. Counties with production of more than 1 million tons of sand and gravel, in descending order of quantity, were Waukesha, Washington, Dane, Rock, and Walworth. These five southeastern counties accounted for more than 32 percent of the sand and gravel tonnage produced in 1970.

**Stone.**—Wisconsin, with a production of over 17 million tons, ranked eighteenth in the Nation's output of stone. Among all mineral commodities produced in Wisconsin, stone ranked second, representing nearly 29 percent of the State's mineral output value. Quantity and value of the State's stone production decreased 7.3 percent and 8.7 percent, respectively, from 1969. Table 7 shows the quantity and value of limestone and dolomite sold or

used by producers, by uses, and table 8 shows the quantity and value, by counties, of stone sold or used by producers.

**Vermiculite.**—Exfoliated vermiculite was produced by Zonolite Division, W. R. Grace & Co., at Milwaukee from crude material mined outside the State. The exfoliated material was used for loose fill insulation, lightweight aggregate in concrete and plaster, for agricultural purposes, and as a fire base. Output increased in quantity and value over that of 1969.

#### METALS

**Copper.**—Great Lakes Exploration Co., a wholly owned subsidiary of Kennecott Copper Corp., completed an 18-month program of exploratory drilling on a copper prospect near Ladysmith in Rusk County. At yearend, the company was evaluating the results of the drilling and studying the feasibility of developing a mining opera-

Table 6.—Wisconsin: Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Ashland.....	2	160	W	3	W	W
Barron.....	9	385	\$285	11	657	\$485
Bayfield.....	4	180	197	6	248	257
Brown.....	10	561	W	12	629	538
Buffalo.....	1	59	24	1	65	27
Burnett.....	2	258	157	2	W	W
Chippewa.....	4	236	230	6	625	545
Clark.....	11	W	W	10	749	757
Columbia.....	5	1,002	2,151	3	W	W
Crawford.....	3	242	W	3	W	W
Dane.....	30	2,356	2,395	33	2,339	2,480
Dodge.....	15	658	W	16	845	666
Door.....	4	309	W	5	302	263
Douglas.....	17	728	531	14	581	418
Florence.....	1	39	34	1	W	W
Fond du Lac.....	8	312	W	7	343	250
Forest.....	3	163	89	4	257	209
Grant.....	3	59	47	2	W	W
Green.....	3	49	31	3	W	W
Green Lake.....	9	393	585	9	312	524
Iron.....	2	27	16	2	W	W
Jackson.....	4	146	123	4	132	113
Jefferson.....	6	266	178	7	266	174
Juneau.....	1	41	18	1	W	W
Kenosha.....	8	176	124	10	420	388
Kewaunee.....	4	571	W	4	674	W
La Crosse.....	2	73	W	2	W	W
Langlade.....	2	820	544	2	W	W
Lincoln.....	5	569	457	6	589	480
Manitowoc.....	8	934	629	10	960	687
Marathon.....	11	538	520	10	342	352
Marquette.....	4	323	289	3	W	W
Marquette.....	1	12	7	?	?	?
Milwaukee.....	2	74	27	3	W	W
Monroe.....	1	185	96	1	W	77
Oconto.....	6	760	W	7	743	600
Oneida.....	8	259	197	9	345	255
Outagamie.....	2	94	125	4	W	415
Ozaukee.....	10	702	623	8	631	578
Pepin.....	1	7	3	1	W	W
Pierce.....	6	123	W	5	130	145
Polk.....	7	738	W	5	465	300
Portage.....	9	854	790	6	804	783
Price.....	2	118	72	2	113	143
Racine.....	12	1,053	W	10	936	797
Richland.....	2	77	W	2	W	W
Rock.....	10	2,048	1,769	8	1,932	1,706
Rusk.....	3	384	255	3	W	W
St. Croix.....	3	421	275	2	W	W
Sauk.....	8	534	W	8	249	313
Sawyer.....	3	155	98	4	207	149
Shawano.....	7	314	248	7	392	320
Sheboygan.....	9	950	673	9	854	595
Taylor.....	6	662	487	9	770	595
Trempealeau.....	1	28	14	1	W	37
Vernon.....	1	49	23	2	53	31
Vilas.....	4	231	202	4	237	223
Walworth.....	20	1,339	W	18	1,050	833
Washburn.....	2	261	180	2	W	W
Washington.....	19	2,861	2,062	18	2,437	1,766
Waukesha.....	39	6,748	4,939	38	5,532	4,053
Waupaca.....	7	508	359	7	W	381
Waushara.....	4	273	185	5	184	123
Winnebago.....	2	780	691	3	W	W
Wood.....	2	356	178	4	W	W
Undistributed <sup>1</sup> .....	14	6,235	11,234	13	11,597	10,251
Total <sup>2</sup> .....	434	42,815	35,414	440	41,103	35,107

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

<sup>1</sup> Includes Adams, Calumet, Dunn and Eau Claire Counties, and some sand and gravel that cannot be assigned to specific counties, and data indicated by symbol W.<sup>2</sup> Data may not add to totals shown because of independent rounding.

Table 7.—Wisconsin: Limestone and dolomite sold or used by producers, by uses

(Thousand short tons and thousand dollars unless otherwise specified)

Use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Dimension:</b>				
Rough architectural.....thousand cubic feet..	55	\$45	59	\$44
Irregular-shaped stone.....	5	( <sup>1</sup> )	7	97
Rubble.....	21	<sup>1</sup> 294	19	179
Cut stone.....thousand cubic feet..	39	143	27	104
House stone veneer.....do.....	249	667	217	543
Sawed stone.....do.....	10	37	21	65
Construction.....do.....	93	121	99	128
Flagging.....do.....	97	115	85	103
Total (approximate thousand short tons).....	71	<sup>2</sup> 1,421	67	1,263
<b>Crushed and broken:</b>				
Bituminous aggregate.....	1,080	1,459	734	930
Concrete aggregate.....	741	990	962	1,216
Dense graded road base stone.....	5,033	5,577	6,184	7,103
Macadam aggregate.....	1,082	1,455	984	1,407
Surface treatment aggregate.....	4,740	5,308	2,908	3,510
Unspecified aggregate and roadstone.....	1,996	2,174	2,087	2,349
Agricultural limestone.....	866	1,242	797	1,436
Flux.....	36	54	28	36
Riprap and jetty stone.....	156	234	90	259
Other <sup>3</sup> .....	207	614	548	813
Total <sup>2</sup> .....	15,937	19,108	15,321	19,060
Grand total <sup>2</sup> .....	16,008	20,530	15,388	20,323

<sup>1</sup> Value of irregular-shaped stone combined with rubble to avoid disclosing individual company confidential data.

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

<sup>3</sup> Includes stone used for asphalt filler and other fillers or extenders; filter stone; lime; railroad ballast; stone sand; and other unspecified uses.

tion. The company is continuing to explore other prospects in Rusk County and elsewhere in Wisconsin.

**Iron Ore.**—In 1970, its first complete year of operation, Jackson County Iron Co., a wholly owned subsidiary of Inland Steel Co., produced taconite pellets and exceeded the capacity of its 750,000-ton-per-year plant near Black River Falls. Pellets were shipped by rail to Inland Steel Co.'s Indiana Harbor Works in East Chicago, Ind.

The U.S. Forest Service has begun a multiple-use impact survey to determine the availability of lands in the Chequamegon National Forest for possible taconite development. The study will explore the possible effects of taconite mining upon the total forest environment. Some 8,400 acres of land are involved in the survey. The Hanna Mining Co. is presently studying the feasibility of future taconite operations in the area.

**Lead and Zinc.**—Wisconsin contributed

nearly 4 percent of the Nation's mine production of zinc. Output of zinc, in terms of recoverable metal content, decreased almost 10 percent in quantity and over 5 percent in value. Lead production decreased almost 31 percent in quantity and over 27 percent in value. Average annual weighted prices, used in calculating 1970 values in table 1, were 15.62 cents per pound for lead and 15.32 cents per pound for zinc, compared with 1969 average prices of 14.90 cents per pound for lead and 14.60 cents per pound for zinc.

In September, the American Zinc Co. terminated production at its Wisconsin operations. The Bear Hole, Champion, and Crawhall (which had only begun operation 6-months earlier) mines were closed, as well as the Vinegar Hill mill.

The New Jersey Zinc Co. operated its Elmo mill and two mines south of Platteville; Ivey Construction Co. operated a mine and mill near Mineral Point; and Eagle-Picher Industries, Inc., operated its Shullsburg mine and mill.



Table 8.—Wisconsin: Stone sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1969			1970			Kind of stone produced in 1970 <sup>1</sup>
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value	
Ashland.....	1	( <sup>2</sup> )	W	1	W	W	Granite.
Brown.....	10	743	\$766	10	554	\$754	Limestone.
Buffalo.....	7	217	236	11	W	W	Do.
Calumet.....	6	121	W	5	106	170	Do.
Columbia.....	4	106	120	5	W	W	Do.
Crawford.....	15	211	W	16	356	383	Do.
Dane.....	31	1,303	1,583	33	1,341	1,494	Do.
Dodge.....	6	459	621	4	281	494	Do.
Door.....	3	25	W	2	W	W	Do.
Douglas.....	1	249	249	1	249	249	Traprock.
Dunn.....	3	58	W	4	68	83	Limestone.
Fond du Lac.....	12	422	985	13	480	1,085	Do.
Grant.....	27	773	789	23	735	868	Do.
Green.....	24	613	665	26	705	798	Do.
Green Lake.....	1	13	18	1	23	30	Do.
Iowa.....	24	376	374	20	334	338	Do.
Jefferson.....	2	31	28	1	W	W	Do.
Kewaunee.....	1	W	W	1	32	W	Do.
La Crosse.....	3	221	W	3	W	W	Do.
Lafayette.....	20	517	383	24	532	494	Do.
Manitowoc.....	2	140	W	2	W	W	Do.
Marathon.....	17	1,605	3,162	14	848	2,055	Granite, quartzite, sandstone.
Marquette.....	2	26	W	2	W	W	Granite, limestone.
Milwaukee.....	2	W	W	2	W	W	Limestone.
Monroe.....	10	755	983	6	173	227	Do.
Outagamie.....	9	539	686	9	596	828	Do.
Pepin.....	4	72	72	4	W	392	Do.
Pierce.....	10	311	300	10	W	W	Do.
Polk.....	2	354	W	2	W	W	Limestone, traprock.
Portage.....	1	( <sup>2</sup> )	2	1	W	W	Limestone.
Rock.....	14	345	346	14	298	333	Do.
St. Croix.....	8	289	311	7	256	290	Do.
Sauk.....	21	648	845	23	W	W	Limestone, quartzite.
Shawano.....	2	18	31	3	93	W	Limestone.
Sheboygan.....	1	4	26	1	13	31	Do.
Trempealeau.....	4	174	228	5	W	W	Do.
Vernon.....	29	398	466	27	W	W	Do.
Waukesha.....	25	1,690	2,938	21	1,535	2,592	Do.
Waupaca.....	2	26	39	2	W	W	Do.
Winnebago.....	13	1,276	1,741	14	1,021	1,407	Do.
Wood.....	2	126	97	3	W	W	Granite, limestone, sandstone.
Undistributed <sup>3</sup> ...	52	3,701	8,480	60	6,948	9,773	
Total <sup>4</sup> .....	433	18,954	27,571	436	17,577	25,167	

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

<sup>1</sup> "Limestone" used generally to include dolomite.<sup>2</sup> Less than ½ unit.<sup>3</sup> Includes production for Jackson (1969), Juneau, Marinette, Oconto, Racine, Richland, and Walworth Counties, and production for which no county breakdown is available, and data indicated by symbol W.<sup>4</sup> Data may not add to totals shown because of independent rounding.

## MINERAL FUELS

**Peat.**—Although peat is classed as a mineral fuel, it is not used for that purpose in the United States; its main use is for agricultural purposes. Total production in Wisconsin in 1970 was reported as 1,581 short tons, a decrease of 404 short tons from that of 1969. Two companies were active during the year, Demilco, Inc., which produced humus peat in Waukesha County, and Superior Brand Peats, which

produced moss and humus peat in Lincoln County.

Sales totaled 1,650 short tons, representing a decrease of more than 6 percent from the 1969 figure of 1,761 short tons. Decreases in sales were due to a lesser output of seed inoculant, which comprised 95 percent of the State's 1970 output, and material for general soil improvement, which comprised the remainder. Most of the peat was sold in packaged form.

Table 9.—Wisconsin: Mine production (recoverable) of lead and zinc

	1968	1969	1970
Mines producing:			
Lode.....	11	9	8
Material sold or treated:			
Zinc ore..... thousand short tons..	923	846	749
Production (recoverable):			
Quantity:			
Lead..... short tons..	1,126	1,102	761
Zinc..... do..	25,711	22,901	20,634
Value:			
Lead..... thousands..	\$298	\$328	\$238
Zinc..... do..	6,942	6,687	6,322
Total <sup>1</sup> ..... do..	7,239	7,015	6,559

<sup>1</sup> Data may not add to totals shown because of independent rounding.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasive stone—Grinding pebbles:			
Baraboo Quartzite Co., Inc.....	Box 123 Baraboo, Wis. 53913	Quarry; stationary plant.	Sauk.
Cement:			
Marquette Cement Mfg. Co.....	20 N. Wacker Dr. Chicago, Ill. 60606	Portland and ma- sonry, dry process.	Milwaukee.
Medusa Portland Cement Co.....	Box 5688 Cleveland, Ohio 44101	White, dry process...	Manitowoc.
Clays and shale:			
Oakfield Shale Brick & Tile Co.....	Oakfield, Wis. 53065.....	Pit and plant.....	Fond du Lac.
Union Grove Drain Tile Co.....	Box 348 Union Grove, Wis. 53182	do.....	Racine.
Coke:			
Milwaukee Solvay Coke Div., Pickands Mather & Co.	311 E. Greenfield Ave. Milwaukee, Wis. 53204	Coke ovens.....	Milwaukee.
Iron ore:			
Jackson County Iron Co.....	30 W. Monroe St. Chicago, Ill. 60603	Mine, concentrator, agglomerator.	Jackson.
Inland Steel Co.: Black River Falls.			
Lead and zinc: <sup>1</sup>			
American Zinc Co.:			
Bear Hole.....	20 S. 4th St. St. Louis, Mo. 63101	Mine; ore treated at Vinegar Hill mill.	Lafayette.
Champion.....		do.....	Do.
Crawhall.....		do.....	Do.
Vinegar Hill mill.....		Mill.....	Do.
Eagle-Picher Industries, Inc.:			
Shullsburg.....	Box 1040 Galena, Ill. 61036	Mine and mill.....	Do.
Ivey Construction Co.:	128 High St. Mineral Point, Wis. 53565	Mine and mill. Closed in Septem- ber.	Iowa.
The New Jersey Zinc Co.:			
Elmo No. 1.....	160 Front St. New York, N.Y. 10038	Mine and mill.....	Grant.
Kopp No. 3.....		Mine; ore treated at Elmo mill.	Do.
Lime:			
Cutler-LaLiberte-McDougall Corp.	12th Ave. & Waterfront Duluth, Minn. 55802	Quick and hydrated, two rotary kilns, one continuous hy- drator.	Douglas.
Mayville White Lime Works.....	Box 25 Mayville, Wis. 53050	Quicklime, one shaft kiln.	Dodge.
Rockwell Lime Co.....	228 N. LaSalle St. Chicago, Ill. 60601	Quick and hydrated, one rotary kiln, one continuous hy- drator.	Manitowoc.

See footnote at end of table.

Table 10.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Lime—Continued			
The Western Lime & Cement Co.:			
Green Bay plant.....	Box 2076 Milwaukee, Wis. 53201	Quick and hydrated, five shaft kilns, one batch hydrator.	Brown.
Knowles plant.....		Hydrated, five shaft kilns, one continuous hydrator.	Dodge.
Eden plant.....		Quick and hydrated, five shaft kilns, one batch hydrator.	Fond du Lac.
Peat: Demilco, Inc.....	3101 W. Custer Ave. Milwaukee, Wis. 53209	Bog, processing plant.	Waukesha.
Expanded perlite:			
Midwest Perlite Co.....	912 College Ave. Appleton, Wis. 54911	Processing plant.....	Outagamie.
Zonolite Division, W. R. Grace & Co.	72 Whittemore Ave. Cambridge, Mass. 02140	---do-----	Milwaukee.
Sand and gravel:			
Eau Claire Sand & Gravel Co....	104 Gibson St. Eau Claire, Wis. 54701	Pits; portable and stationary plants.	Chippewa, Dunn, Eau Claire.
Genessee Sand & Gravel Co., Inc.	8532 W. Schlinger Ave. Milwaukee, Wis. 53214	Pit; portable and stationary plants.	Waukesha.
Jaeger Sand & Gravel Co., Inc.	1110 Harding St.	Pit; stationary plant.	Rock.
Janesville Sand & Gravel Co.....	Janesville, Wis. 53545		
Johnson Sand & Gravel, Inc.....	22750 W. Bluemound Rd. Waukesha, Wis. 53186	Pits; portable plants.	Waukesha.
Edward Kraemer & Sons, Inc....	Plain, Wis. 53577.....	---do-----	Brown, Barron, Chippewa, Eau Claire, Forest, Oconto, Ozaukee, Polk, Portage, Racine, Sauk, Sawyer, Sheboygan, Walworth, Washington, Waukesha.
C. C. Linck, Inc.....	1226 N. Center St. Beaver Dam, Wis. 53916	---do-----	Calumet, Columbia, Dane, Dodge, Fond du Lac, Green Lake, Racine, Waushara.
Manley Sand Division, Martin Marietta Corp.	Rockton, Ill. 61072.....	Pit; stationary plant; industrial sand.	Columbia.
Plautz Brothers, Inc.....	Route 1 Willard, Wis. 54493	Pits; portable plants.	Chippewa, Clark.
Rein, Schultz & Dahl, Inc.....	6217 Nesbitt Rd. Madison, Wis. 53711	---do-----	Dane, Jackson, Jefferson, Waukesha.
State Sand & Gravel Co.....	10833 W. Watertown Plank Rd. Milwaukee, Wis. 53326	Pits; stationary plants.	Waukesha.
Wissota Sand & Gravel Co.....	313 One Half Eau Claire Eau Claire, Wis. 54701	---do-----	Barron, Bayfield, Eau Claire, Washington.
Stone:			
Granite:			
Anderson Bros. & Johnson Co.	Box 26 E. Manson St. Wausau, Wis. 54401	Quarries; stationary plant.	Marathon, Marinette.

See footnote at end of table.

Table 10.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Granite—Continued			
Lawrence Ladick, Inc.....	Route 1 Vesper, Wis. 54489	Quarry.....	Marathon.
Lake Wausau Granite Co.....	2d St., Box 397 Wausau, Wis. 54401	Quarry; stationary plant.	Do.
Montello Granite Co.....	Montello, Wis. 53949	.....do.....	Marquette.
Prehn Granite Quarries, Inc..	1108 Hamilton Wausau, Wis. 54401	.....do.....	Marathon.
Limestone and dolomite:			
Courtney & Plummer, Inc....	Box 351 Neenah, Wis. 54956	Quarries; stationary and portable plants.	Calumet, Waupaca, Winnebago.
Daanen & Janssen.....	214 S. Huron St. De Pere, Wis. 54115	Quarries; portable plants.	Brown.
Franklin Stone Products, Inc..	7220 S. 68th St. Hales Corners, Wis. 53130	Quarry; stationary plant.	Milwaukee.
Halquist Lannon Stone Co....	Sussex, Wis. 53089.....	Quarries; stationary plant.	Waukesha.
Edward Kraemer & Sons, Inc.	Plain, Wis. 53577.....	Quarries; portable plants.	Buffalo, Columbia, Crawford, Dunn, Green, La Crosse, Marquette, Monroe, Pierce, Portage, Racine, Richland, Sauk, Trempealeau, Vernon, Waukesha, Wood.
Arthur Overgaard, Inc.....	Box 87 Elroy, Wis. 53929	Quarries; stationary and portable plants.	Juneau, Various counties.
Vulcan Materials Co., Mid- west Division.	29 N. Wacker Dr. Chicago, Ill. 60606	Quarries; stationary plants.	Milwaukee, Racine, Waukesha, Winnebago.
Waukesha Lime & Stone Co.	Box 708 Waukesha, Wis. 53186	Quarry; stationary and portable plants.	Waukesha.
Wingra Stone Co., Inc., Stewart Watson Con- struction Co.	Route 2, Box 4284 Madison, Wis. 53711	Portable plants.....	Dane.
Quartzite:			
Foley Bros., Inc.....	450 Endicott Bldg. on 4th St. Paul, Minn. 55101	Quarry; stationary plant.	Sauk.
Minnesota Mining & Mfg. Co.	2501 Hudson Rd. St. Paul, Minn. 55119	Quarries; stationary plant.	Marathon.
Sandstone:			
Ellis Quarries, Inc.....	Stevens Point, Wis. 55481	.....do.....	Marathon, Wood.
Traprock (basalt):			
Bryan Rock Products Inc....	Box 215 Shakopee, Minn. 55379	Quarry; stationary and portable plants.	Polk.
GAF Corp.....	Pembine, Wis. 54156.....	Quarry; stationary plant.	Marinette.
McLean Construction Co....	314 Ogden Ave. Superior, Wis. 54880	Quarry; portable plant.	Douglas.
Vermiculite, exfoliated:			
Zonolite Div., W. R. Grace & Co..	62 Whittemore Ave. Cambridge, Mass. 02140	Processing plant.....	Milwaukee.

<sup>1</sup> All lead-zinc mining was by underground methods.



# The Mineral Industry of Wyoming

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

By Richard F. Zaffarano <sup>1</sup>

Mineral production in Wyoming continued to expand and total mineral value rose to a record high of \$705 million, an increase of \$58 million over that of 1969. Wyoming ranked 10th nationally in value of mineral production. Overall growth in mineral value was attributed to increased output of the major commodities and higher unit values. The two leading revenue-producing minerals were petroleum and natural gas. These commodities accounted for 74 percent of total mineral value. Distribution of mineral value by groups was energy minerals (mineral fuels and uranium), 84.6 percent; nonmetals, 12.3 percent; and metals, 3.1 percent.

The minerals industry set a rapid growth pace for Wyoming in 1970. Petroleum activities centered mainly in the Powder River Basin. As in recent years, Campbell County led the State in field discoveries. Operations in the Hilight field provided a strong development effort, which in turn was responsible for the Powder River Basin emergence as a natural gas area. The Wyoming Oil and Gas Conservation Commission held 168 hearings, 30 more than in 1969. The Commission was particularly concerned with flaring of casinghead gas, and restrictions were ordered on many fields in the Powder River Basin to conserve natural gas until processing facilities could be constructed.

Coal production rose 5½ percent in response to utilities' rising demand for low-sulfur coal for blending to cope with a wave of stringent air pollution regulations. Wyoming's coal production is projected to increase primarily to fuel industrial complexes that will supply electric power, and

to provide feedstock for synthetic gaseous fuels and petrochemicals.

Uranium exploration continued at a high level. During the year, a number of new discoveries were added which will help provide the uranium reserves needed for future nuclear power.

A project, believed to be the only current intensive research on beryllium compounds in the world, was initiated in an agreement between the University of Wyoming and the University of Oslo, Norway. The joint project involves the exchange of American and Norwegian students.

**Government Programs.**—The Bureau of Mines Laramie Energy Research Center received approximately \$2 million during 1970 for research on oil shale and shale oil. Projects of particular interest included an investigation of in-situ retorting at a site near Rock Springs to produce crude shale oil directly from an underground formation; evaluation of core samples taken at various locations including the Washakie Basin in southeastern Wyoming; and studies of the effects of retorting conditions on the properties and refinability of shale oil. In addition, a Grant was made by the Bureau to the University of Wyoming for research on the reactions involved in hydrogenation of shale oil, an important step in modern refining procedures.

Rock Springs was the site of a practical pilot project to reduce subsidence. The project was to determine the feasibility of filling abandoned water-filled mine tunnels with slurried solids pumped in at high pressure to prevent surface cave-ins. The

<sup>1</sup> Physical scientist, Division of Fossil Fuels.

Table 1.—Mineral production in Wyoming<sup>1</sup>

Mineral	1969		1970	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays..... thousand short tons.....	1,992	\$18,970	1,950	\$18,829
Coal (bituminous)..... do.....	4,602	15,443	7,222	24,423
Gem stones.....	NA	129	NA	130
Gypsum..... thousand short tons.....	W	W	216	868
Iron ore (usable)..... thousand long tons, gross weight.....	2,043	20,751	W	W
Lime..... thousand short tons.....	27	W	22	W
Natural gas (marketed)..... million cubic feet.....	303,517	44,617	338,520	49,762
Natural gas liquids:				
LP gases..... thousand 42-gallon barrels.....	4,423	7,085	4,556	7,472
Natural gasoline and cycle products..... do.....	2,523	7,051	2,597	7,085
Petroleum (crude)..... do.....	154,945	433,846	160,345	469,811
Sand and gravel..... thousand short tons.....	7,568	7,288	9,447	9,298
Stone..... do.....	1,584	3,012	1,266	2,758
Uranium <sup>2</sup> (recoverable content U <sub>3</sub> O <sub>8</sub> )..... thousand pounds.....	6,716	40,318	6,346	38,768
Value of items that cannot be disclosed: Cement, copper (1969), feldspar (1970), gold (1969), gypsum, phosphate rock, pumice (1969), sodium carbonate, sodium sulfate, and values indicated by symbol W.....	XX	r 48,933	XX	76,329
Total.....	XX	r 647,443	XX	705,533
Total 1967 constant dollars.....	XX	585,936	XX	p 638,507

<sup>p</sup> Preliminary. <sup>r</sup> Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

<sup>2</sup> Value estimated based on \$5.86 (1969) per pound for sale to the Atomic Energy Commission and an assumed price of \$6.10 (1969) per pound for commercial sales.

block selected to be backfilled was the most critical of nearly 200 acres of surface area where earth slippage had occurred. The Rock Springs project was financed through a \$275,500 grant, \$170,000 of which was from the Department of Housing and Urban Development. Other funds included Bureau of Mines, \$55,000; State of Wyoming, \$20,500; Dowell Division of The Dow Chemical Co., \$20,000; and Union Pacific Railroad Co., \$10,000.

Through a 5-year U.S. Office of Coal Research contract, the University of Wyoming's Natural Resources Research Institute continued research on converting coal to gas and petroleum products.

Wyoming continued in 1970 to lead the Nation in the amount of Federal land under oil and gas and mining leases. Some 21.6 million acres were held under 40,500

oil and gas leases and 707,500 acres under 306 mining leases.

Under the year's highway budget, contracts awarded for construction of 436.9 miles of highway totaled \$38.3 million; of this amount, \$18.0 million was for the Interstate Highway system, \$11.3 million for primary and secondary roads in the Federal-aid program (ABC contracts), and \$9.0 million for State-financed roads.<sup>2</sup> Highway expenditures in 1970 were 13 percent below the 1969 level.

Total designated mileage of the federally authorized Interstate system for 1970 was adjusted to 913.7 miles. Of this mileage 765.8 were open to traffic, 34.2 were under construction, 58.3 were being designed or right-of-way had been acquired, and 55.4 were under preliminary consideration.

<sup>2</sup> Wyoming Highway Department. Progress Report, December 1970, 3 pp.

Table 2.—Value of mineral production in Wyoming, by counties  
(Thousands)

County	1969	1970	Minerals produced in 1970 in order of value
Albany.....	\$6,787	\$7,317	Cement, sand and gravel, petroleum, stone, gypsum, iron ore.
Big Horn.....	27,409	23,346	Petroleum, clays, gypsum, sand and gravel, lime, stone, natural gas, uranium.
Campbell.....	99,738	142,193	Petroleum, natural gas, natural gas liquids, coal, sand and gravel, stone.
Carbon.....	21,402	26,397	Uranium, coal, petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Converse.....	15,435	20,704	Petroleum, coal, natural gas liquids, natural gas, sand and gravel.
Crook.....	24,097	22,954	Petroleum, clays, natural gas liquids, sand and gravel, natural gas, stone.
Fremont.....	86,803	82,688	Petroleum, uranium, iron ore, natural gas liquids, sand and gravel, feldspar, stone.
Goshen.....	W	588	Sand and gravel, lime, petroleum, stone.
Hot Springs.....	44,207	36,932	Petroleum, natural gas, coal, sand and gravel.
Johnson.....	17,395	17,804	Petroleum, clays, sand and gravel, natural gas, natural gas liquids, stone.
Laramie.....	3,023	3,104	Petroleum, stone, sand and gravel, natural gas.
Lincoln.....	10,518	12,122	Coal, natural gas liquids, phosphate rock, petroleum, sand and gravel, stone, natural gas.
Natrona.....	53,143	51,222	Petroleum, uranium, natural gas, natural gas liquids, sand and gravel, clays, sodium sulfate, stone.
Niobrara.....	1,820	W	Petroleum, sand and gravel, natural gas, natural gas liquids.
Park.....	103,242	112,090	Petroleum, natural gas, natural gas liquids, gypsum, sand and gravel, stone.
Platte.....	4,445	4,820	Iron ore, stone, sand and gravel.
Sheridan.....	3,379	6,685	Coal, petroleum, sand and gravel, stone, natural gas.
Sublette.....	24,565	22,047	Petroleum, natural gas, sand and gravel, natural gas liquids, stone.
Sweetwater.....	79,226	86,457	Sodium carbonate, petroleum, natural gas, coal, natural gas liquids.
Teton.....	W	W	Sand and gravel, stone.
Uinta.....	1,267	2,435	Natural gas, natural gas liquids, petroleum, clays, sand and gravel, stone.
Washakie.....	9,914	10,046	Petroleum, natural gas, natural gas liquids, sand and gravel, lime, stone.
Weston.....	8,697	11,334	Petroleum, clays, sand and gravel, natural gas, natural gas liquids, stone.
Yellowstone National Park.....	151	W	Sand and gravel.
Undistributed <sup>1</sup> .....	828	2,250	
Total <sup>2</sup> .....	r 647,443	705,533	

<sup>r</sup> Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

<sup>1</sup> Includes gem stones, some stone, and some sand and gravel that cannot be assigned to specific counties and values indicated by symbol W.

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



Table 3.—Indicators of Wyoming business activity

	1969	1970	Change, percent
<b>Employment and labor force, annual average:</b>			
Total labor force.....thousands..	141.8	142.9	+ .8
Employment.....do.....	136.1	136.6	+ .4
Unemployment.....do.....	5.7	6.3	+10.5
<b>Nonagricultural employment:</b>			
Mining.....do.....	11.8	11.4	-3.4
Contract construction.....do.....	6.6	6.5	-1.5
Manufacturing.....do.....	7.3	7.2	-1.4
Government.....do.....	28.3	29.1	+2.8
Services.....do.....	15.8	16.1	+1.9
Wholesale and retail trade.....do.....	23.5	22.6	-3.8
Transportation and public utilities.....do.....	10.7	10.8	+ .9
Finance, insurance, and real estate.....do.....	3.6	3.7	+2.8
<b>Personal income:</b>			
Total.....millions..	\$1,073	\$1,136	+5.9
Per capita.....do.....	\$3,261	\$3,420	+4.9
<b>Construction activity:</b>			
Number of new residential units authorized.....	567.0	1,056.0	+86.2
Value of authorized nonresidential construction.....millions..	\$8.1	\$6.7	-17.3
Highway construction contracts awarded.....do.....	\$47.7	\$44.3	-7.1
Cement shipments to and within the State thousand 376-pound barrels..	1,253.0	989.0	-21.1
Farm marketing receipts.....millions..	\$224.6	\$226.5	+ .8
Mineral production.....do.....	\$647.4	\$705.5	+9.0

Sources: Survey of Current Business; Employment and Earnings and Annual Report on the Labor Force; Area Trends in Employment and Unemployment; Construction Review; Roads And Streets Magazine; Farm Income Situation; and U.S. Bureau of Mines.

Table 4.—Worktime and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man- days worked (thou- sands)	Man- hours worked (thou- sands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non- fatal	Fre- quency	Severity
<b>1969:</b>								
Coal.....	391	239	94	715	3	11	19.59	25,850
Metal.....	1,845	239	441	3,740	--	85	22.73	486
Nonmetal.....	1,496	300	448	3,618	1	36	10.23	1,861
Sand and gravel.....	777	168	131	1,141	--	24	21.04	2,111
Stone.....	224	234	52	420	--	11	26.18	483
Total <sup>1</sup> .....	4,733	246	1,166	9,633	4	167	17.75	3,077
<b>1970: <sup>p</sup></b>								
Coal.....	435	243	106	802	--	16	19.95	858
Metal.....	1,715	267	458	4,034	1	78	19.58	2,132
Nonmetal.....	1,485	299	443	3,595	--	35	9.74	335
Sand and gravel.....	790	164	129	1,034	--	3	2.90	3
Stone.....	215	242	52	426	1	4	11.74	14,341
Total <sup>1</sup> .....	4,640	256	1,189	9,890	2	136	13.95	1,679

<sup>p</sup> Preliminary.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

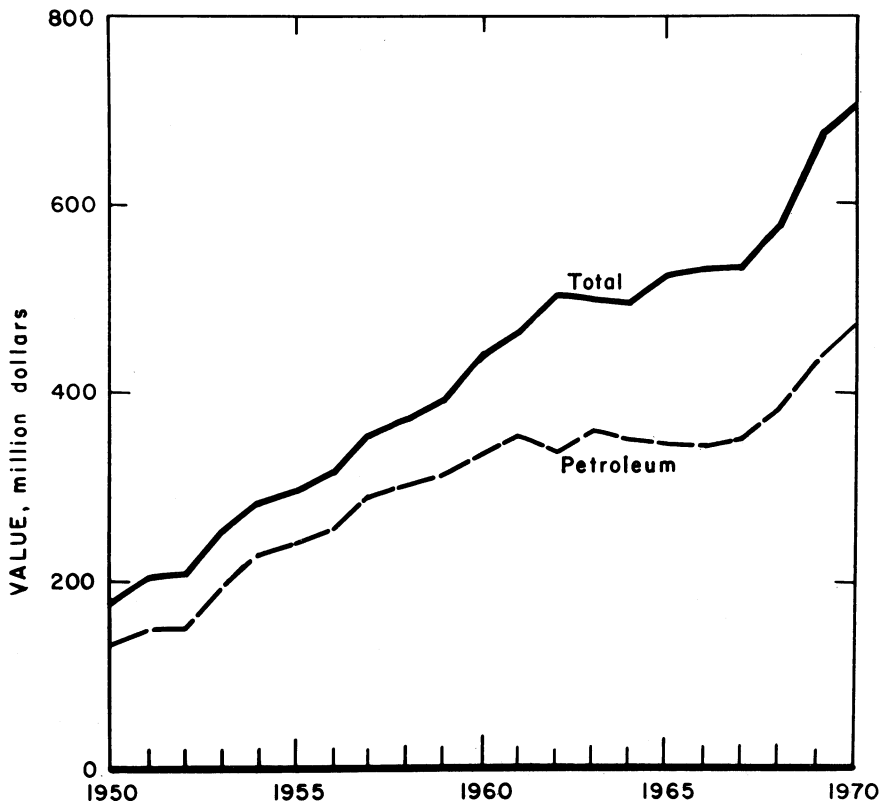


Figure 1.—Value of petroleum, and total value of mineral production in Wyoming.

Reports on Wyoming mineral resources were published by the U.S. Bureau of

Mines, U.S. Geological Survey, and the Wyoming Geological Survey.<sup>3</sup>

<sup>3</sup> Averitt, Paul. Stripping-Coal Resources of the United States. U.S. Geol. Survey Bull. 1322, 1970, 34 pp.

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## REVIEW BY MINERAL COMMODITIES

## MINERAL FUELS

**Coal (Bituminous).**—Production in 1970 increased 57 percent in tonnage, and value increased to \$24.4 million, up \$15.4 million over that of 1969. The 7.2 million ton production was from 13 mines, 9 strip and 4 underground. Strip mines in Campbell, Carbon, Converse, Lincoln, Sheridan, and Sweetwater Counties provided approximately 98 percent of the output.

Routh Construction Co. of Rock Springs was awarded a 2-year contract by Wisconsin Power and Light Co. to load a 90-car train north of Rock Springs each 5 days for the next 2 years. Coal will be mined from strip mines and used to power steam-electric utility plants.

Pacific Power & Light Co. (PP&L) exercised its option to purchase 35,000 acre-feet of State-owned municipal and industrial water for use in a \$300 million powerplant to be built in southwest Wyoming. This project was the largest single construction project announced in 1970 and will be the second largest coal-fired electric powerplant west of the Mississippi, generating 1.5 million kilowatts. Union Pacific Corp. commenced negotiations with five electric utilities to deliver 150 million tons of coal containing less than 1 percent sulfur during a 30-year contract period. This tonnage represents 1.5 percent of the company's Wyoming coal reserves. A Union Pacific Railroad subsidiary filed a new tariff rate based on 6,000-ton trainload lots of coal from Wyoming to Commonwealth Edison Co., Chicago, Ill.

Record high bids were received for coal leases on two deposits on Federal land near Hanna, Wyo. Arch Land Company of

St. Louis, Mo. bid \$257 per acre on about 7,600 acres of land lying 8 to 16 miles west of Hanna. Belco Petroleum Corp. bid \$240 per acre on 640 acres south of U.S. 30 at Hanna Junction.

Chemical Construction Corp. received a \$4 million contract to design and install a pollution control system for a new subbituminous-coal-fired generating unit of PP&L. The control system is scheduled to become operational in March 1972 as an integral part of a new 360,000-kilowatt unit of the Dave Johnston plant near Glenrock, Wyo.

At Lake De Smet, Reynolds Mining Co. continued work on a project that involves water storage and diversion on Piney Creek. The water diversion tunnel runs through a coal seam with an overall thickness of 175 feet. A 40-foot dam at the north end of the lake will raise the level of the lake 10 feet.

A "boom" hit Kleenburn, Wyo., a tiny town 10 miles northwest of Sheridan, named for the clean-burning coal that is mined there by Big Horn Coal Mining Co. The company has been forced to work double shifts to meet large orders for its coal from utilities in Chicago and Kansas City. Two 60- to 65-car unit trains weekly travel the 920 miles. To handle the mine's output, an additional unit train and regular freight haulage were used during the year.

**Natural Gas.**—Marketed natural gas increased 11.5 percent in quantity and in value; 35 billion cubic feet and \$5.1 million, respectively. Natural gas production in 1970 set a new high of 362.8 billion cubic feet, a 3-percent increase over 1969.

Table 5.—Wyoming: Bituminous coal production in 1970, by type of mine and counties

(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines			Production (thousand short tons)			Value (thousands)
	Underground	Strip	Total	Underground	Strip	Total	
Campbell.....	--	1	1	--	W	W	W
Carbon.....	--	1	1	--	W	W	W
Converse.....	--	2	2	--	W	W	W
Hot Springs.....	3	--	3	W	--	W	W
Lincoln.....	--	2	2	--	W	W	W
Sheridan.....	--	2	2	--	W	W	W
Sweetwater.....	1	1	2	W	W	W	W
Total.....	4	9	13	118	7,105	7,222	24,423

W Withheld to avoid disclosing individual company confidential data.

The Big Piney-LaBarge complex of gasfields in Lincoln and Sublette Counties retained its leadership as the largest gas-producing area. The leading gasfield within the area was Hogsback in Sublette County with a production of 19.2 billion cubic feet. The remaining five leading gasfields in order of rank and their production (in billion cubic feet) were Beaver Creek, Fremont County (18.0), Elk Basin, Park County (17.9), Hilight, Campbell County (15.7), and Desert Springs, Sweetwater County (14.8).

Estimates by the American Gas Association, Inc. (AGA) indicate Wyoming's proved natural gas reserves increased from 3.9 to 4.2 trillion cubic feet at yearend. New fields and new pools added 24.8 billion cubic feet; extensions and revisions added 620.7 billion cubic feet.

Of the seven gas discoveries during the year, the Davis Oil Co.'s Antelope field discovery in Sweetwater County possibly generated the most interest. This discovery well, No. 1—Federal, flowed 8.3 million cubic feet of gas and 25 barrels of condensate per day upon initial test from Almond Formation perforations at 6,743 to 6,814 feet. Based upon a four-point potential test, calculated absolute open flow potential was 32 million cubic feet of gas daily.

Another significant discovery was the True Oil Co. Deep Creek No. 31—31 well in Carbon County. This well was a triple completion in the Cherokee Creek, Deep Creek, and Muddy Formations with initial daily productive potentials of 1.5, 2.7, and 4.0 million cubic feet of gas, respectively. This discovery marks the first production from the Muddy Formation in this portion of Carbon County.

Also significant was the Glasner field discovery by Travis Oil Co., in Fremont County. The discovery well, No. 2 State, was completed to produce from the Shannon Formation with perforations at 1,902 to 1,912 feet. Total depth was 1,946 feet. Initial daily flow gage was 1.5 million cubic feet of gas. Inexco Oil Co. found Fort Union gas production at the No. 1 Government-Polly well in Sweetwater County. The well discovered the Powder Springs field and was completed to flow at a rate of 2.3 million cubic feet daily from the interval 5,387 to 5,404 feet.

El Paso Natural Gas Co. completed a

19,000-foot wildcat 20 miles southeast of Pinedale in the Pinedale gasfield. The experimental well was drilled in conjunction with Project Wagon Wheel, an industry-Government venture in the use of nuclear energy to stimulate production of natural gas. Detonation was scheduled for October 1972.

McCulloch Interstate Gas Co. and Colorado Interstate Gas Co. completed approximately 212 miles of 16-inch gas transmission pipeline from the Hilight field to the Colorado Interstate Gas Co. main line near Laramie. Estimated cost of the line was \$10 million. Panhandle Eastern Pipe Line Co. installed 75 miles of 16-inch gasline from the Hilight field to the Phillips Petroleum Co.'s new processing plant at Douglas. Estimated cost of the line was \$8 million.

**Natural Gas Liquids.**—Output of natural gas liquids increased 202,000 barrels; output value increased 3.0 percent to \$14.5 million. Production of LP gases increased 128,000 barrels, and natural gasoline output increased 74,000 barrels. Wyoming did not have underground storage capacity for LP and LR gases, nor aboveground storage of 50,000 barrels or more. Daily average output of natural gas liquids increased 23,000 gallons above that of the previous year. AGA and American Petroleum Institute (API) reserve estimates of natural gas liquids at yearend 1970 was 111 million barrels, an increase of 11 million barrels from the previous year.

According to the annual Oil and Gas Journal survey of gas processing plants, 32 plants in Wyoming at yearend 1970 had a gas capacity of 1,147 million cubic feet per day. Gas processed in 1970 averaged 75 percent of capacity. Restrictions placed on natural gas flaring to prevent waste in the Hilight field, pending the completion of natural gas processing plants, curtailed natural gas production in 1970.

Phillips Petroleum Co.'s Hilight natural gas processing plant went on stream late in 1970 with 45 million cubic feet per day capacity. Plant throughput capacity was expected to be increased to 110 million cubic feet per day by mid-1971.

McCulloch Oil Corp.'s fourth natural gas processing plant in the Hilight field went on stream in midyear with an initial capacity of 35 million cubic feet per day. A second unit was added in September

raising the plant's total capacity to 65 million cubic feet per day at an estimated cost of \$5 million. At yearend, McCulloch planned to construct a 5-million cubic feet per day plant in the North Kitty field at an estimated cost of \$600,000.

Work was initiated on two other natural gas processing plants during the year. The Phillip Petroleum Co. initiated building a plant in Converse County near Douglas to process 60 million cubic feet per day from wells producing from the Muddy Formation in Campbell County. Natural gas from this plant will be sold to the Panhandle Eastern Pipe Line Co. Union Texas Petroleum Co. was building a 100-million cubic feet per day natural gas processing plant in Douglas. Feed for the plant will be collected from the Hilight field.

**Oil Shale.**—At the Laramie Energy Research Center, test runs were conducted on mine-run, ungraded oil shale ranging in size from fines to pieces weighing 5 tons obtained from the Bureau of Mines Rifle, Colo., facility. Test runs on the 10-ton retort provided extraction efficiencies up to 80 percent; 150-ton retort efficiencies of 40 to 60 percent were recorded. These above-ground experiments are providing engineering data to support field in-situ work. These data also would be applicable to the retorting phase of a proposed experiment in which oil shale would be fragmented by a nuclear explosion and retorted underground.

Results of an in-situ combustion experiment by the Bureau of Mines, conducted in a 20-foot-thick section of oil shale 68 to 88 feet below ground near Rock Springs, Wyo., demonstrated that shale oil of pipeline quality could be produced by underground retorting a fractured body of oil shale. Combustion was established using air injection and a propane burner and subsequently was sustained by supplying only air to the combustion zone. During the 6-week period that combustion was maintained, approximately 190 barrels of shale oil were produced.

A second and more comprehensive experiment was initiated at the site in September 1970 at a depth of 130 feet. This test was programed to continue through 1972.

**Petroleum.**—Wyoming accounted for 55 percent of the Rocky Mountain Region's crude oil production. Output of crude oil,

160.3 million barrels, was 3.5 percent over the 154.9 million barrels produced in 1969. Increased crude oil production was attributed to continued activity in the Hilight and other new Powder River Basin fields in Campbell County. Cumulative crude oil production to the end of 1970 reached 3.5 billion barrels. Petroleum remained the most valuable mineral commodity, accounting for 67 percent of the total State mineral production value.

The State had 16 oilfields which produced more than 2 million barrels of oil each during 1970; these fields accounted for 91.1 million barrels, 57 percent of the total production. The leading four oilfields were Oregon Basin, Elk Basin, Hilight, and Salt Creek. First-ranked Oregon Basin field in Park County produced 13.3 million barrels of oil. Rising production in this old field was attributed to a successful well stimulation program initiated in recent years. Elk Basin, Park County, produced 12.8 million barrels of oil, and the 2-year-old Hilight field in Campbell County accounted for 12.7 million barrels of oil. Hilight easily could have been the leading field had it not been for gas flaring restrictions and mechanical problems at the McCulloch gas plant. Salt Creek field, Natrona County, held fourth place with 11.9 million barrels of oil production.

Nine operating refineries had a combined calendar-day throughput capacity of 138,850 barrels.<sup>4</sup> They processed 47.7 million barrels of crude oil; 45.6 million barrels were received at refineries from Wyoming sources, 1.1 million were from out of State, and the remainder was foreign crude. Crude oil shipped out of State totaled 118.8 million barrels as follows: Indiana, 29.1 million; Kansas, 19.0 million; Utah, 15.9 million; Montana, 15.0 million; Illinois, 10.7 million; Colorado, 8.9 million; Michigan, 8.1 million; Ohio, 6.1 million; Missouri-Nebraska, 5.7 million; and Kentucky-Tennessee, 0.3 million.

Annual API proved crude oil reserve estimate for Wyoming as of January 1, 1971, was 1.0 billion barrels, a net increase of 20.8 million barrels. Wyoming was the only Rocky Mountain State to post a net gain in crude oil reserves. Much of the increase was attributed to the successful exploratory programs throughout the

<sup>4</sup> Oil and Gas Journal. V. 68, No. 14, Apr. 6, 1971, p. 116.

Powder River Basin area. New fields and pools added oil reserves of 5.0 million barrels; revisions and extensions added 171.1 million barrels.

Drilling activity was below the 1969 level. Total completions numbered 1,399, a decline of 10 percent from the previous year. Combined footage drilled was 9.9 million feet for the 1,399 wells. Average oil and gas well depth was 7,090 feet as compared with a U.S. average of 4,950 feet. The State's exploratory well total of 569 was 17 less than 1969. Developmental drill-

ing declined from 1,010 to 830 wells—a decrease of 18 percent from the previous year. New field wildcat wells numbered 453 and resulted in 34 new oilfields and six new gasfields.

At midyear, Atlantic Richfield Co. announced plans for a major waterflood project in the north half of the Recluse field. A total of 28 injection wells, with water supplied from the Fox Hills or Lance Formation, will be used to flood the 6,110-acre field. Recovery of an additional 9.7 million barrels of oil is anticipated.

Table 6.—Wyoming: Oil and gas well drilling completions in 1970, by counties

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Number of wells	Footage
Albany.....	--	--	1	--	--	7	8	37,450
Big Horn.....	15	1	14	2	--	9	41	190,882
Campbell.....	366	2	131	42	--	174	715	6,168,937
Carbon.....	3	2	1	2	2	11	21	139,004
Converse.....	13	2	4	6	--	24	49	338,804
Crook.....	6	--	4	2	--	24	36	194,792
Fremont.....	31	10	18	2	2	24	87	873,738
Goshen.....	--	--	--	--	--	21	21	128,376
Hot Springs.....	5	--	2	--	--	9	16	60,539
Johnson.....	6	--	2	--	--	4	12	93,663
Laramie.....	1	--	--	--	--	11	12	103,957
Lincoln.....	1	3	4	2	--	7	17	92,566
Natrona.....	15	--	12	1	--	25	53	211,364
Niobrara.....	2	--	2	--	--	27	31	164,802
Park.....	39	--	1	1	--	11	52	246,470
Platte.....	--	--	--	--	--	11	11	23,885
Sheridan.....	1	--	1	1	--	11	14	124,297
Sublette.....	8	8	3	2	--	23	44	263,246
Sweetwater.....	6	10	8	1	3	34	62	409,578
Teton.....	--	--	--	--	--	2	2	6,256
Uinta.....	--	--	1	--	--	1	2	2,182
Washakie.....	15	--	7	1	--	6	29	246,913
Weston.....	28	--	15	1	--	20	64	296,133
Total.....	561	38	231	66	7	496	1,399	9,917,834

Source: American Petroleum Institute.

### NONMETALS

**Cement.**—Monolith Portland Midwest Co. in Laramie constructed structures to support an electrostatic precipitator scheduled for installation in late 1971. The \$1.1 million project consists of a complete dust collection system to reduce air pollution.

**Clays.**—Black Hills Bentonite Co. produced a dry crushed bentonitic product which will be used in Canada, Europe, and Australia. This product is 99.8 percent dust free, can be dried to any percent moisture without creating any measurable amount of dust, and competes with bentonites invading the world market from Greece.

Much high-swelling bentonite, vital to the oil industry, went to the taconite industry in 1970.

**Feldspar.**—The Northwestern Feldspar Corp.'s potash feldspar mill, 3 miles north of Shoshoni at Bonneville in Fremont County, was completed in 1970. The \$400,000 mill has a capacity of 100 tons of finished products a day. Northwestern Feldspar Corp. made its first shipment from its Wyospar Division plant in the first quarter of 1970. Feldspar ore is refined and processed in the mill by dry grinding. Two grades of feldspar are produced, 20-mesh feldspar used in manufacture of ordinary glass products and 250-

**Table 7.—Wyoming: Crude petroleum production, by counties**  
(Thousand 42-gallon barrels)

County	1969 <sup>1</sup>	1970 <sup>2</sup>	Principal fields in 1970 in order of production
Albany.....	847	300	Quealy Dome.
Big Horn.....	7,426	5,698	Byron, Garland, Torchlight, Bonanza, Sage Creek.
Campbell.....	34,541	42,390	Hilght, Recluse, Kitty, Gas Draw, Spring Creek, Ute, Collums, Rocky Point.
Carbon.....	2,377	1,576	Wertz, Rock River, Cooper Cove.
Converse.....	3,635	4,677	Glenrock South, Cole Creek South, Big Muddy, Kaye, Cole Creek.
Crook.....	4,139	4,183	Wood, Coyote Creek, Mellot Ranch, Kummerfield, Donkey Creek, Semelk.
Fremont.....	10,511	10,936	Winklemen, Steamboat Butte, Beaver Creek, Big Sand Draw.
Goshen.....	7	7	Torrington.
Hot Springs.....	15,668	12,532	Hamilton Dome, Grass Creek, Murphy Dome, Little Buffalo Basin, Black Mountain.
Johnson.....	5,195	5,149	Sussex, Meadow Creek, North Fork, Sussex West-Dug-out, Reno East.
Laramie.....	463	445	Horse Creek, Golden Prairie, Pine Bluff South.
Lincoln.....	17,147	293	Hogsback, Labarge Unit, Green River Bend.
Natrona.....	595	15,448	Salt Creek, Poison Spider, West, Cole Creek, Grieve Unit.
Niobrara.....	34,598	532	Lance Creek, Mule Creek, Lightning Creek.
Park.....	554	36,392	Oregon Basin, Elk Basin, Little Buffalo Basin, Frannie, Pitchfork.
Sheridan.....	4,640	572	Ash Creek South, Fence Creek, Ash Creek.
Sublette.....	7,934	4,323	Hogsback, Big Piney Shallow, McDonald Draw, Birch Creek, Tip Top, Dry Piney.
Sweetwater.....	50	9,117	Lost Soldier, Patrick Draw, Wertz, Arch Unit, Desert Springs.
Uinta.....	2,396	50	Church Buttes.
Washakie.....	2,722	2,325	Cottonwood Creek, Rattlesnake, No Water Creek, Hidden Dome.
Weston.....		3,400	Osage, Fiddler Creek, Coyote Creek South, Skull Creek, Mush Creek.
Total.....	154,945	160,345	

<sup>1</sup> Wyoming Ad Valorem Tax Division, State Board of Equalization.

<sup>2</sup> Based on data from the Wyoming Ad Valorem Tax Division, State Board of Equalization, and the Wyoming Oil and Gas Conservation Commission.

mesh used in exotic glass and ceramic work. Output of feldspar ranked seventh in the United States.

**Gypsum.**—Gypsum was mined by Big Horn Gypsum Co. in Park County, Georgia-Pacific Corp. in Big Horn County, Monolith Portland Midwest Co. in Albany County, and Wyo-Ben Products Co. in Big Horn County. Production declined slightly, whereas value increased. Calcined gypsum was utilized by Georgia-Pacific Corp. and Big Horn Gypsum Co. for the manufacture of building material (wallboard). Calcined production decreased 6 percent, and unit value was 7 percent above the 1969 level. Uncalcined gypsum was principally used as a retarder for portland cement; however, a significant amount was consumed for agricultural purposes. Average unit value for uncalcined gypsum increased 3 percent.

**Lime.**—Production of lime declined 19 percent; value declined 17 percent from the previous year. Output of lime was 21,665 short tons. Quicklime was produced and used at beet sugar refineries at Lovell, Torrington, and Worland. The Great

Western Sugar Co., a subsidiary of Great Western United Corp., owns the Lovell plant; the other two are owned by Holly Sugar Corp.

**Phosphate Rock.**—Output of phosphate rock by the State's only producer, Stauffer Chemical Co., increased 74 percent in quantity and 79 percent in value, ending a 3-year downtrend. Much of the production, mainly in the form of phosphoric acid and ordinary superphosphates, was exported.

**Sand and Gravel.**—Among nonmetals, sand and gravel production ranked third in value. Output quantity increased 25 percent and value increased 28 percent. The value of production from 181 mines was up from \$7,288,000 to \$9,298,000, and the quantity increased from 7,568,000 tons to 9,447,000 tons. Average unit price increased to 98 cents per ton, up 2 cents from the 1969 level. The leading producing counties in descending order of value were Albany, Carbon, Johnson, Sweetwater, Laramie, Natrona, and Lincoln. Commercial operations accounted for 57 percent of sand and gravel production.

Table 8.—Principal oil and gas discoveries in 1970

County and field	Well	Operator	Location			Producing formation	Total depth (feet)	Initial production		Remarks
			Section	Township	Range			Barrels of oil per day	Thousand cubic feet of gas per day	
Big Horn:										
Flashlight	No. 1-29 Serio Exploration-Federal.	Stoltz & Co.	29	51 N	92 W	{ Phosphoria Tensleep Madison	4,502	451 (Com-ming-led)	--	Pumping.
Campbell:										
Big Hand	No. 48-14-Federal.	Maepet.	14	47 N	71 W	Dakota.	10,467	27	--	Do.
Bracken	No. 1 Bracken-Federal.	Davis Oil Co.	12	52 N	69 W	Muddy.	5,600	57	--	Do.
Buif	No. 1 Ohman Unit.	Felmont Oil Corp.	30	46 N	72 W	--do--	10,265	366	--	Flowing.
Cutler	No. 1 Cutler.	C. B. Mansfield.	9	57 N	74 W	--do--	7,142	--	--	Do.
Gibbs	No. 42-8 Thompson-Federal.	True Oil Co.	8	52 N	69 W	Minnelusa.	7,478	288	--	Pumping.
Hensley Draw	No. 1 Hensley Oil & Gas-Government.	Southland Royalty Co.	20	53 N	73 W	Muddy.	8,100	80	--	Do.
Iberlin	No. 1 United Western.	Texaco, Inc.	9	46 N	76 W	--do--	13,485	16	--	Do.
Interstate	No. 32-1 Barlow-Powers.	Anschutz Corp.	32	50 N	73 W	--do--	9,640	380	--	Do.
Jayson	No. 1 Reserve-Federal.	Colorado Oil & Gas Co.- Baum Gartner Oil Co.	31	47 N	69 W	--do--	8,450	187	--	Flowing.
Joe Creek	No. 1 Gilmore-Federal.	Davis Oil Co.-Fred Goodstein-Apache Corp.	4	56 N	75 W	--do--	7,889	343	--	Pumping.
Morse	No. 1-Z Morse Ranch.	Davis Oil Co.-Petro- Search.	1	55 N	73 W	--do--	7,202	316	--	Flowing.
Paul	No. 1 Paul-Federal.	Davis Oil Co.	21	55 N	73 W	--do--	7,525	228	--	Pumping.
Forcupine	No. 1-20 Federal.	Natol Petroleum Co.- Arapahoe Petroleum Co.	20	42 N	70 W	--do--	10,417	151	--	Flowing.
Smith	No. 5-28 Smith.	Clyde G. Kissinger.	23	56 N	73 W	--do--	7,395	960	--	Do.
Teckla	No. 1-9 Apollo Drilling-Federal.	Royal Resources Co.	9	42 N	71 W	--do--	10,821	(1)	--	Do.
White	No. 1 Atlantic-Anderson.	Atlantic Richfield Co.	23	55 N	71 W	--do--	6,156	88	--	Pumping.
Carbon:										
Deep Creek	No. 81-81 Deep Creek Unit.	True Oil Co.	31	16 N	90 W	{ Cherokee Deep Creek Muddy	12,560	--	{ 1,560 Flowing. 2,785 Do. 4,085 Do.	
Diamond Ranch	No. 1 Diamond Ranch Unit.	Marathon Oil Co.	24	20 N	78 W	Lakota.	5,821	33	--	Pumping.
Overland	No. 60-1 Government.	Classic Mining Co.	30	20 N	83 W	Niobrara.	5,002	530	--	Flowing.
Converse:										
Dry Fork	No. 1 Hartley-Federal.	Champlin Petroleum Co.	11	38 N	73 W	Muddy.	14,811	279	1,405	Do.
Manning	No. 1 Manning Unit.	--do--	16	39 N	73 W	Parkman.	13,003	205	--	Do.
Crook:										
Wind Creek, North	No. 1 Ferley-State.	Lester Ferley	14	49 N	66 W	Lakota.	817	50	--	Pumping.

See footnotes at end of table.



Table 8.—Principal oil and gas discoveries in 1970—Continued

County and field	Well	Operator	Location		Producing formation	Total depth (feet)	Initial production		Remarks
			Section	Town-ship			Barrels of oil per day	Thousand cubic feet of gas per day	
Fremont:	No. 2 State	Travis Oil Co.	36	34 N	91 W	1,946	120	1,500	Pumping.
	No. 1 MKM-Government	Oil & Gas Futures, Inc. of Texas & Western Standard Uranium.	17	30 N	94 W	4,874	--	--	Do.
Reservoir Creek	No. 1-3 Unit	George G. Anderson, E. M. Bolands & White Shield Oil & Gas, Ltd.	3	37 N	90 W	11,197	84	--	Flowing.
Sublette:	Dry Finney	Mountain Fuel Supply Co.	9	27 N	114 W	11,560	368	--	Pumping.
Sweetwater:	No. 1 Fred-Federal	Davis Oil Co.	30	17 N	99 W	7,128	25	8,340	Flowing.
	No. 1 Government-Polly.	Indeco Oil Co.	23	12 N	97 W	8,525	--	2,330	Do.
Tipton	No. 1-2 Red Desert-Federal A.	Anderson Oil Co.	2	19 N	97 W	8,230	--	1,400	Do.
Washakie:	No. 13 Slick Creek	Tenneco Oil Co.	34	47 N	92 W	8,589	143	--	Do.
	No. 11 Slick Creek	do.	32	47 N	92 W	10,747	216	--	Do.
Weston:	No. 1 Matthewson-Federal.	Davis Oil Co.	30	45 N	67 W	7,896	303	--	Pumping.

<sup>1</sup> Not gauged.

Source: Petroleum Information Corp. 1970 Résumé, Oil and Gas Operations in the Rocky Mountain Region.

Sand production of 2,515,000 short tons was 22 percent above 1969 production. Unit value, however, decreased 2 percent to \$1.04 per ton. Principal use of produced sand was paving—91 percent.

Gravel production of 6,932,000 tons was

26 percent above the 1969 level. Average unit value increased to 96 cents per ton from 93 cents the previous year. Principal use for produced gravel was for paving—87 percent.

**Sodium Carbonate.**—Sodium carbonate

Table 9.—Wyoming: Sand and gravel sold or used by producers, by counties  
(Thousand short tons and thousand dollars)

County	1969			1970		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Albany	12	573	\$422	10	1,517	\$1,563
Big Horn	4	44	46	5	236	194
Campbell	6	212	195	5	W	W
Carbon	13	834	838	9	W	1,016
Converse	5	122	118	5	133	130
Crook	6	113	102	4	W	W
Fremont	12	728	629	13	233	320
Goshen	6	339	333	5	W	W
Hot Springs	3	50	54	3	W	38
Johnson	10	609	597	12	958	880
Laramie	14	454	416	16	656	675
Lincoln	7	357	359	12	609	567
Natrona	13	662	752	7	697	600
Niobrara	3	78	64	3	W	W
Park	15	400	412	13	502	434
Platte	4	263	249	7	349	377
Sheridan	7	183	194	10	128	99
Sublette	6	106	67	5	W	W
Sweetwater	13	879	873	10	767	771
Teton	6	74	84	4	135	109
Tiuta	2	10	10	4	59	54
Washakie	4	138	138	5	76	237
Weston	4	197	185	6	W	W
Yellowstone National Park	3	144	151	2	W	W
Undistributed <sup>1</sup>	--	--	--	6	2,391	1,234
Total <sup>2</sup>	178	7,568	7,288	181	9,447	9,298

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

<sup>1</sup> Includes some sand and gravel that cannot be assigned to specific "Counties."

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

processed from trona increased in production 8.9 percent and 13 percent in value. The refined soda ash has a variety of uses, including glassmaking and paper manufacture, as a constituent of cleaning agents, and as a building block for other industrial chemicals. FMC Corp. started adding a 24-foot-wide fourth shaft, thereby increasing soda ash production potential at its Green River operation to 500,000 tons per year. Completion is expected by the last quarter of 1972.

In April 1970 Stauffer Chemical Co. completed a 150,000-ton-per-year expansion of natural soda ash production at Green River to meet continuing demands, and an additional 500,000-ton-per-year facility is expected to be operational in late 1972. These two expansions will increase Stauffer's total natural soda ash capacity to more than 1.5 million tons per year.

Texas Gulf Sulphur Co. was testing a 16-foot-thick section of trona deposits around 1,300 feet deep at the Black's Fork project, 8 miles northeast of Granger. Shaft exploration was completed to a final depth of 1,495 feet. The shaft was equipped with a temporary hoisting conveyance, and an experimental mining machine was tested.

**Stone.**—Crushed and broken stone was produced at 36 quarries by 21 operators in 19 counties. Production totaled 1,266,483 short tons, a decrease of 20 percent from the previous year; however, average unit value increased 15 percent to \$2.18 per short ton. Limestone, granite, marble, sandstone, and other stone were produced in the State. Principal uses were for railroad ballast and as raw material for the manufacture of cement and lime.

**Sulfur.**—Six plants recovered elemental sulfur as a coproduct of sour natural gas.

**Table 10.—Wyoming: Sand and gravel sold or used by producers, by classes of operations and uses**

(Thousand short tons and thousand dollars)

Class of operation and use	1969		1970	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building .....	162	\$251	145	\$227
Fill .....	74	30	82	61
Paving .....	130	165	561	600
Other uses .....	--	--	W	W
Total <sup>1</sup> .....	366	497	788	889
Gravel:				
Building .....	220	354	217	384
Fill .....	51	38	60	46
Paving .....	2,521	2,210	3,673	3,608
Railroad ballast .....	295	110	295	110
Miscellaneous .....	38	34	137	37
Other uses .....	--	--	168	127
Total <sup>1</sup> .....	3,126	2,746	4,550	4,312
<b>Government-and-contractor operations:</b>				
Sand:				
Building .....	( <sup>2</sup> )	( <sup>2</sup> )	--	--
Fill .....	1	1	--	--
Paving .....	1,696	1,688	1,726	1,725
Other uses .....	--	--	1	1
Total <sup>1</sup> .....	1,697	1,690	1,727	1,725
Gravel:				
Building .....	( <sup>2</sup> )	( <sup>2</sup> )	23	43
Fill .....	6	4	29	26
Paving .....	2,373	2,351	2,329	2,300
Other uses .....	--	--	1	1
Total .....	2,379	2,355	2,382	2,370
Total sand and gravel <sup>1</sup> .....	7,568	7,288	9,447	9,298

W Withheld to avoid disclosing individual company confidential data; included with fill sand.

<sup>1</sup> Data may not add to totals shown because of independent rounding.

<sup>2</sup> Less than ½ unit.

**Table 11.—Wyoming: Stone sold or used by producers, by counties**

(Thousand short tons and thousand dollars)

County	1969			1970			Kind of stone produced in 1970
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value	
Big Horn .....	1	68	\$128	1	60	\$30	Other stone.
Campbell .....	1	1	1	1	W	W	Do.
Carbon .....	2	( <sup>1</sup> )	( <sup>1</sup> )	2	W	W	Do.
Crook .....	4	76	116	3	W	W	Limestone, other stone.
Fremont .....	2	( <sup>1</sup> )	( <sup>1</sup> )	2	W	W	Other stone.
Goshen .....	2	1	2	2	W	W	Do.
Johnson .....	1	1	1	1	W	W	Do.
Laramie .....	4	670	1,310	3	W	W	Limestone, other stone.
Lincoln .....	1	( <sup>1</sup> )	1	2	W	W	Other stone, sandstone.
Natrona .....	1	( <sup>1</sup> )	1	1	W	W	Other stone.
Sublette .....	1	( <sup>1</sup> )	1	1	W	W	Do.
Sweetwater .....	2	3	2	--	--	--	--
Uinta .....	1	( <sup>1</sup> )	( <sup>1</sup> )	1	W	W	Do.
Washakie .....	1	( <sup>1</sup> )	( <sup>1</sup> )	1	W	W	Do.
Weston .....	1	1	1	1	W	W	Do.
Undistributed <sup>2</sup> .....	14	764	1,448	14	1,206	2,678	
Total <sup>3</sup> .....	39	1,584	3,012	36	1,266	2,758	

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

<sup>1</sup> Less than ½ unit.

<sup>2</sup> Includes production for Albany, Park, Platte, Sheridan, and Teton Counties and counties for which no county breakdown is available.

<sup>3</sup> Data may not add to totals shown because of independent rounding.

Shipments of 44,315 long tons of sulfur were 3.0 percent less than in 1969; value of shipments, at \$784,000, was 16 percent less than in 1969.

The major sulfur producer—Amoco Production Co., formerly Pan American Petroleum Corp., in Fremont County—utilized the modified Claus process. Other recovery plants using the modified Claus process were Atlantic Richfield Co. in Carbon County, Amoco Petroleum Production in Park County, and the Husky Oil Co. plant in Park County. The Claus process was used in the Western Nuclear, Inc., plant in Fremont County and in the Chem-Gas Products Co. plant in Washakie County.

### METALS

**Iron Ore.**—Three companies mined and shipped iron ore from Wyoming by rail to customers. The United States Steel Corp.'s Atlantic City open pit mine, 30 miles southwest of Lander, was the largest producer. The CF&I Steel Corp. operated and shipped ore from its Sunrise underground mine for delivery to its steelworks at Pueblo, Colo. The third operator was Maxwell Mining Co., which shipped about 5,300 tons of magnetite ore from the open pit Iron Mountain mine in Albany County.

**Uranium.**—Value of uranium output ranked fourth in order of mineral production in the State. Value of uranium was \$38.8 million, a 4-percent (\$1.5 million) decline from the 1969 value.

Nationally, Wyoming with an output of 6.3 million pounds ranked second in uranium production. The State accounted for 26 percent of the U.S. total production.

There were a total of 37 active mining operations. Of these, 28 were in Fremont County, six in Carbon County, and the remaining operations were in Natrona and Big Horn Counties.

According to the U.S. Atomic Energy Commission (AEC) Wyoming's estimated year-end reserves at 150 property sites (at \$8.00 per pound of  $U_3O_8$ ) totaled 50.9 million tons of ore grading 0.19 percent  $U_3O_8$  which contained 95,300 tons of recoverable  $U_3O_8$ . Wyoming, with 42 percent of the total footage drilled, led all States in uranium drilling. The 9.8 million feet drilled was 29 percent below the 1969 record level of 13.8 million feet. Approx-

mately three-fourths of the year's total footage drilled was exploratory.

The AEC purchased 628 tons of  $U_3O_8$  concentrates valued at \$6.3 million from Wyoming in 1970, a decrease of 44 percent in quantity and 52 percent in value from the previous year. At yearend, 11 million acres of land were leased in Wyoming for uranium mining and exploration, comprising 45 percent of the acreage held by the U.S. uranium industry.

The Utah Construction & Mining Co.'s uranium processing plant at Shirley Basin was completed at yearend. The 1,200-ton-per-day mill was designed and constructed by Fluor Utah Engineers and Constructors, Inc., at a cost of about \$7 million. The mill has a designed capacity to produce 2.3 million pounds of  $U_3O_8$  per year.

Humble Oil & Refining Co. scheduled construction of a 2,000-ton-per-day uranium ore facility at an open pit mine, 25 miles northwest of Douglas, Wyo. The new plant is expected to reach full production in 1973. U.S. Jersey Nuclear will market the concentrates when produced in 1972.

The Petrotomics mill, a joint venture of Getty Oil Co., Skelly Oil Co., and Kerr-McGee Corp., and operated by Getty Oil was expanded in capacity from 1,000 to 1,500 tons per day to handle the Walker mine ore. The new milling capacity went on stream at the beginning of the year. This is the second expansion for the Shirley Basin mill.

Utah Construction & Mining completed a 1,200-ton-per-day uranium concentration plant in November. The \$7 million processing plant is 65 miles south of Casper in Shirley Basin, Wyo. Western Nuclear, Inc., started a new 375-foot shaft in the Crooks Gap area, 1 mile southwest of the Golden Goose mine.

Kerr-McGee began operations of the North Walker mine, which is expected to produce approximately 1 million pounds of  $U_3O_8$ , or yellowcake, per year.

The Union Carbide Corp. mine and mill at Gas Hills, Wyo., is one of Union's three mines involved in a 1970 contract with Pacific Gas and Electric (PG&E) for 4 million pounds of uranium. The uranium is to be supplied over a 3-year period, 1970 through 1973, for PG&E's nuclear plants Diablo I and Diablo II in central California.

Drilling operations were initiated on the Big Horn Mining Corp. uranium property adjacent to the Lucky Mac pit in the Gas Hill area of Wyoming. Thirty-six holes were drilled, some as deep as 400 feet.

The Cleveland-Cliffs Iron Co., Getty Oil Co., and Skelly Oil Co. announced delineation of uranium-bearing ore reserves of 1.25 million tons containing 4.2 million pounds of  $U_3O_8$  at a depth of 150 feet or less in the Powder River Basin.

The Natural Resource Division of Union Pacific Railroad and Urangesellschaft MBH & Co. K. G. of Frankfurt-am-Main, West Germany, announced signing of a joint venture agreement to explore and develop uranium deposits in the crossroads area of the Southern Powder River Basin, 18 miles northwest of Douglas. Urangesellschaft is a limited partnership composed of three companies engaged in uranium exploration, extraction, and trading of uranium

concentrates worldwide for nuclear power generation.

Exploration for uranium on the Wind River Indian Reservation of Fremont County was increased by Western Standard Uranium and Pioneer Nuclear Geologists, following confirmation of several radioactive anomalies previously detected and discovery of additional anomalies. Western Standard holds a prospecting permit on 80,000 acres.

Two distinct trends of uranium mineralization in Sweetwater County were discovered by Petro-Nuclear in a joint venture with Minerals Exploration Co. No commercial ore was found in the year.

Nuclear Exploration and Development announced a uranium discovery in the north Red Desert area of Sweetwater County based upon radiometric data on 79 holes. Approximately 400 acres of the 1,720-acre site were explored in 1970.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Monolith Portland Midwest Co.	Box 65677, Glassell Station Los Angeles, Calif. 90065	Plant.....	Albany.
<b>Clays:</b>			
American Colloid Co.....	5100 Suffield Court Skokie, Ill. 60076	Open pit mine and plant.....	Big Horn.
		Open pit mine.....	Crook.
		Open pit mine and plant.....	Weston.
		.....do.....	Do.
		.....do.....	Big Horn.
Black Hills Bentonite Co.....	Box 1, Mills, Wyo. 82644		
Dresser Industries, Inc., Dresser Minerals Division.	Box 6504 Houston Tex. 77005		
International Minerals & Chemical Corp., Eastern Clay Products Dept.	Administration Center Old Orchard Road Skokie, Ill. 60079	Open pit mines and plant.....	Crook.
NL Industries, Baroid Division.	Box 1675 Houston, Tex. 77001	.....do.....	Do.
Wyo-Ben Products, Inc.....	Box 1979 Houston, Tex. 77001	Open pit mines.....	Weston.
		Open pit mine and plant.....	Big Horn.
Youghiogeny & Ohio Coal Co.	4614 Prospect Ave. Cleveland, Ohio 44103	.....do.....	Crook.
		.....do.....	Weston.
<b>Coal:</b>			
The Kemmerer Coal Co.....	Frontier, Wyo. 83121	2 strip mines, crushing and oil treatment plant.....	Lincoln.
		Strip mine.....	Converse.
Pacific Power & Light Co.....	920 S.W. 6th Ave. Portland, Oreg. 97204		
<b>Gypsum:</b>			
Big Horn Gypsum Co.....	Box 590, Cody, Wyo. 82414	Open pit mine and wall- board plant.....	Park.
<b>Iron ore:</b>			
CP&I Steel Corp.....	Box 316 Pueblo, Colo. 81002	Underground mine and beneficiation mill.....	Platte.
United States Steel Corp. Western Ore Operations.	Lander, Wyo. 82520	Open pit mine and agglomerator.....	Fremont.
<b>Lime:</b>			
The Great Western Sugar Co.	Box 5308 Denver, Colo. 80217	Pot kiln at beet-sugar plant.....	Big Horn.
Holly Sugar Corp.....	Holly Sugar Bldg. Colorado Springs, Colo. 80902	Shaft kiln at beet-sugar plant.....	Goshen.
		.....do.....	Washakie.
<b>Natural gas and petroleum:</b> <sup>1</sup>			
<b>Phosphate rock:</b>			
Stauffer Chemical Co. of Wyoming.	636 California St. San Francisco, Calif. 94119	Open pit mine and beneficiation plant.....	Lincoln.

See footnotes at end of table.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel (commercial):			
Boatright-Smith-----	Box 1129 Casper, Wyo. 82002	Pit and plant-----	Natrona.
Gilpatrick Construction Co., Inc.	Box 973 Riverton, Wyo. 82501	Pit-----	Sublette.
		Pit-----	Sweetwater.
		Pit-----	Washakie.
Teton Construction Co.-----	Box 3243 Cheyenne, Wyo. 82001	Pit-----	Carbon.
		Pit-----	Johnson.
		Pit-----	Laramie.
Union Pacific Railroad Co.---	1416 Dodge Street Omaha, Nebr. 68102	Pit-----	Albany.
Sodium carbonate:			
Allied Chemical Corp.-----	Box 1139-R Morristown, N.J. 07960	Underground mine and refinery.	Sweetwater.
FMC Corp., Inorganic Chemicals Division.	Box 872 Green River, Wyo. 82935	---do-----	Do.
Stauffer Chemical Co. of Wyoming.	Box 513 Green River, Wyo. 82935	---do-----	Do.
Stone:			
The Great Western Sugar Co.	Box 5308 Denver, Colo. 80217	Quarry and plant.-----	Laramie.
Guernsey Stone Co.-----	Guernsey, Wyo. 82214	---do-----	Platte.
Monolith Portland Midwest Co.	Box 65677, Glassell Station Los Angeles, Calif. 90065	2 quarries and plants---	Albany.
Union Pacific Railroad Co.---	1416 Dodge Street Omaha, Nebr. 68102	Quarry and plant.-----	Laramie.
Uranium:			
Federal American Partners---	Box 991 Riverton, Wyo. 82501	3 open pit mines and mill.	Fremont.
Petrotomies Co.-----	Drawer 2450 Casper, Wyo. 82601	Open pit mine and mill.	Carbon
Utah Construction & Mining Co.	Box 911 Riverton, Wyo. 82501	2 open pit mines, leaching operation.	Do.
		2 open pit mines, 2 underground mines, and mill.	Fremont.
Western Nuclear, Inc.-----	1700 Broadway, Suite 1900 Denver, Colo. 80202	5 underground mines, 1 open pit mine, leach- ing operation, and mill.	Do.

<sup>1</sup> Most of the major oil and gas companies and many smaller companies operate in Wyoming, and several commercial directories contain complete lists of them.

