Minerals yearbook: Area reports: domestic 1966. Year 1966, Volume III 1967

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Minerals Yearbook
1966

Volume III

AREA REPORTS: DOMESTIC

Prepared by staff of the
BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR

Stewart L. Udall, Secretary

BUREAU OF MINES • Walter R. Hibbard, Jr., 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, fish, 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.

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Foreword

In this edition of the Minerals Yearbook, covering calendar year 1966, *Volume I, Metals and Minerals,* and *Volume II, Mineral Fuels,* formerly published separately, are combined and issued as *Volume I-II, Metals, Minerals, and Fuels.* This volume contains all the customary statistical data on production, consumption, imports, exports, and related subjects, collected by the Bureau from sources all over the world. In addition, it includes a chapter reviewing the mineral industries, a statistical summary, and a chapter on technologic trends. The "Review of the Minerals Industries" chapter in this volume has been expanded and discusses the position of these basic industries in the national and international economies, as well as containing brief commodity highlights.

Volume III, Areas Reports: Domestic, follows the format of previous years and contains chapters covering each of the 50 States, the U.S. island possessions in the Pacific Ocean and the Carribbean 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Volume IV, Area Reports: International, will not be published for 1966. However, mineral production and trade tables for foreign countries are included in the combined Volume I-II.

These changes in content and format were made to expedite publication and are part of an effort by the Bureau to discharge as effectively as possible its obligation to compile information on mineral resources and to make it available to the public both promptly and in appropriate form. To this end we can be aided by constructive comments and suggestions of Yearbook users, and such comment is particularly invited.

WALTER R. HIBBARD, JR., *Director*

Acknowledgments

In preparing this volume of the Minerals Yearbook, the Bureau of Mines was assisted in collecting statistical data and mineral-industry information by State agencies, through cooperative agreements. Many State chapters 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. For this assistance acknowledgment is made to the following cooperating organizations:

Alabama: Geological Survey of Alabama.
Alaska: Division of Mines and Minerals, Department of Natural Resources.
Arizona: Arizona Bureau of Mines and Oil and Gas Conservation Commission.
Arkansas: Geological Commission; Arkansas Oil and Gas Commission; Department of Revenue.
California: Division of Mines and Geology.
Colorado: The Oil and Gas Conservation Commission; Coal Mines Inspections Department; and the Colorado Bureau of Mines.
Connecticut: Geological and Natural History Survey.
Delaware: Delaware Geological Survey.
Florida: Florida Geological Survey, Board of Conservation.
Georgia: Division of Conservation, Department of Mines, Mining and Geology.
Hawaii: Department of Land and Natural Resources.
Idaho: Bureau of Mines and Geology.
Illinois: State Geological Survey Division.
Indiana: Geological Survey, Department of Natural Resources.
Iowa: Iowa Geological Survey.
Kansas: Conservation Division, State Corporation Commission; and State Geological Survey.
Kentucky: Kentucky Geological Survey, University of Kentucky.
Louisiana: Louisiana Geological Survey; Louisiana Department of Conservation; Department of Labor, Division of Employment Security; and Department of Commerce and Industry.
Maine: Maine Geological Survey, Department of Economic Development.
Maryland: Maryland Geological Survey.
Michigan: Geological Survey Division, Department of Conservation.
Minnesota: Minnesota Geological Survey.
Mississippi: Mississippi Geological Survey; Mississippi State Oil and Gas Board; Oil and Gas Severance Tax Division, Mississippi State Tax Commission; and Mississippi Employment Security Commission.
Missouri: Division of Geological Survey and Water Resources, Department of Business and Administration.
Montana: Montana Bureau of Mines and Geology, The Oil and Gas Conservation Commission.
Nebraska: Conservation and Survey Division; and Oil and Gas Conservation Commission.
Nevada: Nevada Bureau of Mines.
New Hampshire: New Hampshire Division of Economic Development, Geologic Branch.
New Jersey: Bureau of Geology and Topography.
New Mexico: Oil and Gas Conservation Commission:

New York: Geological Survey—New York State Museum and Science Service.
North Carolina: Division of Mineral Resources, Department of Conservation and Development.
North Dakota: North Dakota Geological Survey.
Oklahoma: Oklahoma Geological Survey; Oil and Gas Conservation Department, Oklahoma Corporation Commission; and Gross Production Division, Oklahoma Tax Commission.
Oregon: State Department of Geology and Mineral Industries.
Pennsylvania: Bureau of Topographic and Geological Survey.
Puerto Rico: Mineralogy and Geology Section, Economic Development Administration, Commonwealth of Puerto Rico.
South Carolina: Division of Geology, State Development Board.
South Dakota: State Geological Survey.
Tennessee: Division of Geology, Department of Conservation.
Texas: Bureau of Economic Geology, The University of Texas, Oil and Gas Division, Railroad Commission of Texas; Oil and Gas Division, State Comptroller of Public Accounts.
Utah: Utah Geological and Mineralogical Survey; and Oil and Gas Conservation Commission.
Virginia: Division of Mineral Resources.
Washington: Division of Mines and Geology, Department of Conservation and Development.
West Virginia: West Virginia Geological and Economic Survey.
Wisconsin: Wisconsin Geological Survey.
Wyoming: The Geological Survey of Wyoming; and Oil and Gas Conservation Commission.

Except for the statistical summary and employment and injuries chapters, this volume was prepared by the staffs of the Mineral Resource Offices of the Bureau of Mines under the direction of the following Area Directors. Area I, G. W. Josephson; Area II, R. D. Thomson; Area III, Ottey Bishop; Area IV, K. F. Anderson (Acting); Area V, Robert W. Geehan; Area VI, D. R. Irving; Area VII, Mark L. Wright; Area VIII, Jared A. Herdlick.

The manuscripts upon which this volume was based were reviewed by the staff of the Division of Minerals Yearbook under the direction of Kathleen J. D'Amico to insure statistical consistency among the tables, figures, and text between this volume and volume I-II, and between this volume and those for former years.

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

ALBERT E. SCHRECK,
Chief, Division of Minerals Yearbook

Contents

Statistical Summary

By Kathleen J. D'Amico [1]

This summary appears in Minerals Yearbook volumes I—II, and III, which cover mineral production in the United States, its island possessions, the Canal Zone, and the Commonwealth of Puerto Rico, as well as the principal minerals imported into and exported from the United States. The sections of this chapter and the area chapters in volume III contain further details on production. A summary table comparing world and U.S. mineral production also is included.

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.

[1] Statistical officer, Division of Minerals Yearbook.

Table 1.—Value of mineral production [1] in the United States by mineral groups

(Millions)

Year	Mineral fuels	Nonmetals (except fuels)	Metals	Total
1960	12,142	3,868	2,022	18,032
1961	12,357	3,946	1,927	18,230
1962	12,784	4,117	1,937	18,838
1963	r 13,317	r 4,316	2,002	r 19,635
1964	13,623	4,623	2,261	20,507
1965 r	14,047	4,933	2,471	21,451
1966	15,108	5,177	2,621	22,906

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

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

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Mineral fuels:								
Asphalt and related bitumens (native):								
Bituminous limestone and sandstone and gilsonite short tons	1,632,645	$8,383	1,935,344	$10,038	1,911,664	$9,461	2,041,271	$8,438
Carbon dioxide, natural (estimate) thousand cubic feet	1,295,545	178	1,232,816	166	1,173,676	152	1,140,907	153
Coal:								
Bituminous and lignite [2] thousand short tons	458,928	2,013,309	486,998	2,165,582	512,088	2,276,022	533,881	2,421,293
Pennsylvania anthracite do	18,267	153,503	17,184	148,648	14,866	122,021	12,941	100,663
Helium:								
Crude thousand cubic feet	1,420,300	15,147	3,197,016	35,322	3,566,734	39,848	3,654,700	41,556
Grade A do	809,100	28,318	830,481	25,923	819,100	28,880	951,400	32,541
Natural gas million cubic feet	14,746,663	2,328,030	r 15,462,138	2,387,689	16,089,753	2,494,542	[3] 17,232,134	[3] 2,721,875
Natural gas liquids:								
Natural gasoline and cycle products thousand gallons	6,534,967	439,173	7,000,181	463,600	7,288,070	494,354	7,548,428	520,635
LP gases do	10,302,250	359,770	10,743,591	362,792	11,257,267	417,249	12,134,294	527,223
Peat short tons	546,621	5,423	639,690	6,198	603,746	6,080	605,858	6,501
Petroleum (crude) thousand 42-gallon barrels	2,752,723	7,965,743	2,786,822	8,017,078	[3] 2,848,462	[3] 8,158,150	[3] 3,028,084	[3] 8,727,387
Total mineral fuels	XX	r 13,317,000	XX	13,623,000	XX	r 14,047,000	XX	15,108,000
Nonmetals (except fuels):								
Abrasive stone [4] short tons	2,693	255	3,186	292	3,603	432	3,806	515
Asbestos do	66,396	5,108	101,092	8,143	118,275	10,162	125,928	11,056
Barite thousand short tons	824	9,402	830	9,796	852	10,192	947	11,259
Boron minerals do	700	54,981	776	60,871	807	64,180	866	68,209
Bromine [5] thousand pounds	203,333	48,558	283,530	66,064	328,115	77,259	326,498	78,883
Calcite (optical grade) pounds	-----	-----	4	2	(6)	(6)	(6)	(6)
Cement:								
Portland thousand 376-pound barrels	342,036	1,095,884	358,378	1,145,108	366,802	1,154,448	373,091	1,162,984
Masonry thousand 280-pound barrels	20,997	59,599	22,397	63,305	23,260	65,979	22,367	63,407
Natural and slag thousand 376-pound barrels	352	1,407	283	1,057	279	1,027	233	872
Clays thousand short tons	50,135	180,810	52,947	192,631	r 55,126	r 204,932	56,675	221,457
Emery short tons	6,732	119	9,214	172	10,720	204	11,102	210
Feldspar long tons	548,954	5,524	587,194	5,389	624,598	6,263	685,592	7,192
Fluorspar short tons	199,948	9,001	217,137	9,723	240,932	10,889	253,068	10,841
Garnet (abrasive) do	14,626	1,412	16,123	1,622	19,330	1,717	21,952	2,092
Gem stones (estimate)	NA	1,421	NA	1,474	NA	2,218	NA	2,437
Gypsum thousand short tons	10,388	38,138	10,684	38,874	r 10,033	r 37,375	9,647	35,681
Lime do	14,521	199,389	16,089	223,149	16,794	232,939	18,057	239,588
Magnesium compounds from sea water and brine (except for metals) short tons, MgO equivalent	520,699	39,323	599,698	42,177	r 637,857	r 47,197	650,300	46,610

Mica:								
Scrap—short tons	109,323	2,776	114,729	3,353	120,255	3,468	113,133	3,733
Sheet—pounds	102,961	13	242,662	58	716,086	185	4,500	1
Perlite—short tons	325,132	2,727	349,867	3,073	392,384	3,352	404,160	3,907
Phosphate rock—thousand short tons	22,238	139,861	25,715	161,067	r 29,482	r 193,323	39,050	261,121
Potassium salts—thousand short tons, K_2O equivalent	2,864	110,164	2,897	114,095	3,140	129,767	3,320	122,210
Pumice—thousand short tons	2,618	6,578	2,776	6,443	r 3,371	r 6,550	3,218	6,765
Pyrites—thousand long tons	825	5,698	847	5,471	875	5,333	873	5,088
Salt—thousand short tons	30,641	184,589	31,623	200,706	34,687	215,699	36,463	229,985
Sand and gravel—do	821,850	847,272	868,208	893,375	908,049	957,416	934,481	984,982
Sodium carbonate (natural)—short tons	1,119,081	27,616	1,274,745	30,451	1,494,105	34,717	1,737,511	40,674
Sodium sulfate (natural)—do	435,257	8,392	575,033	10,989	619,752	11,024	640,329	11,271
Stone [7]—thousand short tons	688,366	1,068,108	725,583	1,134,564	r 780,242	r 1,203,831	813,374	1,260,715
Sulfur:								
Frasch process mines—thousand long tons	4,995	99,014	6,035	120,776	7,251	r 164,654	7,721	201,292
Other mines—long tons	1,371	15	794	8	2,852	11	557	5
Talc, soapstone, and pyrophyllite—short tons	804,358	5,505	889,949	6,218	862,875	6,343	895,045	6,479
Tripoli—do	66,635	266	64,613	268	71,138	381	66,163	328
Vermiculite—thousand short tons	226	3,572	226	3,613	249	4,460	262	4,954
Value of items that cannot be disclosed: Aplite, brucite, (1965–66), calcium-magnesium chloride, diatomite, graphite, iodine, kyanite, lithium minerals, magnesite, greensand marl, olivine, staurolite, wollastonite, and values indicated by footnote 6	XX	53,616	XX	58,771	XX	65,028	XX	69,911
Total nonmetals	XX	r 4,316,000	XX	4,623,000	XX	r 4,933,000	XX	5,177,000
Metals:								
Antimony ore and concentrate short tons, antimony content	645	(8)	632	(8)	845	(8)	927	(8)
Bauxite—thousand long tons, dried equivalent	1,525	17,234	1,601	17,875	1,654	18,632	1,796	20,095
Copper (recoverable content of ores, etc.)—short tons	1,213,166	747,310	1,246,780	812,901	1,351,734	957,028	1,429,152	1,033,850
Gold (recoverable content of ores, etc.)—troy ounces	1,454,010	50,889	1,456,308	50,971	1,705,190	59,682	1,803,420	63,119
Iron ore, usable (excluding byproduct iron sinter) thousand long tons, gross weight	73,564	678,181	84,300	802,331	r 84,079	r 801,388	90,040	854,134
Lead (recoverable content of ores, etc.)—short tons	253,369	54,727	286,010	74,935	301,147	93,959	327,368	98,964
Manganese ore (35 percent or more Mn) short tons, gross weight	10,622	(8)	26,058	(8)	29,258	(8)	14,406	(8)
Manganiferous ore (5 to 35 percent Mn)—do	543,125	(8)	238,776	(8)	332,763	(8)	324,926	(8)
Mercury—76-pound flasks	19,117	3,623	14,142	4,452	19,582	11,176	22,008	9,722
Molybdenum (content of concentrate)—thousand pounds	65,839	91,096	65,097	97,121	77,310	120,801	91,670	144,327
Nickel (content of ore and concentrate)—short tons	13,394	(8)	15,420	(8)	16,188	(8)	15,036	(8)
Silver (recoverable content of ores, etc.) thousand troy ounces	35,243	45,076	36,334	46,980	39,806	51,469	43,669	56,463
Tin (content of concentrate)—long tons	(8)	(8)	65	185	47	126	97	265
Titanium concentrate:								
Ilmenite—short tons, gross weight	890,071	16,529	1,003,997	19,178	948,832	18,058	868,436	17,608
Rutile—do	11,311	1,262	10,547	1,016	(8)	(8)	(8)	(8)
Tungsten ore and concentrate short tons, 60 percent WO_3 basis	5,657	7,202	9,244	11,251	7,949	13,028	8,912	17,620
Uranium ore—short tons	r 5,613,570	r 115,220	5,359,653	111,707	r 4,385,995	r 84,154	4,352,651	77,524
Vanadium (recoverable in ore and concentrate) short tons	3,862	13,788	4,362	13,061	5,226	18,284	5,166	22,210

See footnotes at end of table

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

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals—Continued								
Zinc (recoverable content of ores, etc.)_____short tons__	529,254	$122,533	574,858	$156,308	611,153	$178,284	572,558	$166,044
Value of items that cannot be disclosed: Beryllium concentrate, cobalt, magnesium chloride for magnesium metal, manganiferous residuum, platinum-group metals (crude), rare-earth metal concentrates, zirconium concentrate, and values indicated by footnote 8_____	XX	36,827	XX	40,183	XX	r 44,804	XX	39,117
Total metals _____	XX	2,002,000	XX	2,261,000	XX	r 2,471,000	XX	2,621,000
Grand total mineral production_____	XX	r 19,636,000	XX	20,507,000	XX	r 21,451,000	XX	22,906,000

r Revised. NA Not available. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Includes small quantity of anthracite mined in States other than Pennsylvania.
[3] Final figure; superseded figure given in commodity section.
[4] Grindstones, pulpstones, millstones (weight not recorded), grinding pebbles, sharpening stones, and tube-mill liners.
[5] Bromine content 1963, gross weight 1964–66.
[6] Figure withheld to avoid disclosing individual company confidential data; value included with "Nonmetal items that cannot be disclosed."
[7] Excludes abrasive stone, bituminous limestone, bituminous sandstone, and ground soapstone, all included elsewhere in table.
[8] Figure withheld to avoid disclosing individual company confidential data; value included with "Metal items that cannot be disclosed."

Table 3.—Minerals produced in the United States and principal producing States in 1966

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

Table 3.—Minerals produced in the United States and principal producing States in 1966—Continued

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

Table 4.—Value of mineral production in the United States, and principal minerals produced in 1966

(Thousands)

State	Value	Rank	Percent of U.S. total	Principal minerals in order of value
Alabama	$249,778	21	1.09	Coal, cement, stone, petroleum.
Alaska	82,683	35	.36	Petroleum, sand and gravel, coal, stone.
Arizona	620,565	8	2.71	Copper, sand and gravel, molybdenum, cement.
Arkansas	190,127	26	.83	Petroleum, stone, sand and gravel, bauxite.
California	1,699,359	3	7.42	Petroleum, natural gas, cement, sand and gravel.
Colorado	352,005	17	1.54	Petroleum, molybdenum, coal, sand and gravel.
Connecticut	21,346	45	.10	Stone, sand and gravel, feldspar, lime.
Delaware	1,980	50	.01	Sand and gravel, stone, clays, gemstones.
Florida	295,447	19	1.29	Phosphate rock, stone, cement, clays.
Georgia	148,597	28	.65	Clays, stone, cement, sand and gravel.
Hawaii	21,253	46	.10	Stone, cement, sand and gravel, pumice.
Idaho	114,914	30	.50	Silver, phosphate rock, lead, zinc.
Illinois	618,313	9	2.70	Coal, petroleum, stone, sand and gravel.
Indiana	230,010	23	1.00	Coal, cement, stone, petroleum.
Iowa	119,313	29	.52	Cement, stone, sand and gravel, gypsum.
Kansas	568,392	11	2.48	Petroleum, natural gas, helium, natural gas liquids.
Kentucky	498,364	14	2.18	Coal, petroleum, stone, natural gas.
Louisiana	3,430,140	2	14.98	Petroleum, natural gas, natural gas liquids, sulfur.
Maine	16,734	47	.07	Sand and gravel, cement, stone, peat.
Maryland	74,161	39	.32	Stone, sand and gravel, cement, coal.
Massachusetts	38,473	43	.17	Sand and gravel, stone, lime, clays.
Michigan	602,127	10	2.63	Iron ore, cement, copper, sand and gravel.
Minnesota	550,277	12	2.40	Iron ore, sand and gravel, stone, cement.
Mississippi	211,360	25	.92	Petroleum, natural gas, sand and gravel, cement.
Missouri	227,950	24	1.00	Stone, cement, lead, iron ore.
Montana	245,268	22	1.07	Copper, petroleum, sand and gravel, phosphate rock.
Nebraska	78,521	36	.34	Petroleum, cement, sand and gravel, stone.
Nevada	112,632	31	.49	Copper, gold, sand and gravel, diatomite.
New Hampshire	7,000	48	.03	Sand and gravel, stone, clays, feldspar.
New Jersey	75,595	37	.33	Sand and gravel, stone, zinc, magnesium compounds.
New Mexico	820,327	7	3.58	Petroleum, natural gas, potassium salts, copper.
New York	301,264	18	1.32	Cement, stone, sand and gravel, salt.
North Carolina	71,878	39	.31	Stone, sand and gravel, cement, phosphate rock.
North Dakota	101,807	33	.44	Petroleum, sand and gravel, natural gas, coal.
Ohio	488,040	15	2.13	Coal, stone, sand and gravel, cement.
Oklahoma	997,391	4	4.35	Petroleum, natural gas, natural gas liquids, cement.
Oregon	107,484	32	.47	Stone, sand and gravel, cement, nickel.
Pennsylvania	903,408	5	3.94	Coal, cement, stone, sand and gravel.
Rhode Island	3,947	49	.02	Sand and gravel, stone.
South Carolina	45,593	42	.20	Cement, stone, clays, sand and gravel.
South Dakota	52,707	41	.23	Gold, sand and gravel, stone, cement.
Tennessee	182,584	27	.80	Stone, zinc, cement, phosphate rock.
Texas	5,019,750	1	21.91	Petroleum, natural gas, natural gas liquids, cement.
Utah	444,262	16	1.94	Copper, petroleum, coal, molybdenum.
Vermont	25,910	44	.11	Stone, asbestos, sand and gravel, talc.
Virginia	274,297	20	1.20	Coal, stone, cement, sand and gravel.
Washington	89,092	34	.39	Sand and gravel, cement, stone, zinc.
West Virginia	891,800	6	3.89	Coal, natural gas, natural gas liquids, stone.
Wisconsin	76,010	37	.33	Sand and gravel, stone, cement, zinc.
Wyoming	505,806	13	2.21	Petroleum, natural gas, sodium salts, iron ore.
Total	22,906,000	--	100.00	Petroleum, natural gas, coal, cement.

Table 5.—Mineral production [1] in the United States, by States

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ALABAMA								
Cement: [2]								
Portland—thousand 376-pound barrels	12,218	$38,417	12,870	$40,108	13,765	$42,604	16,394	$49,537
Masonry—thousand 280-pound barrels	2,386	7,242	2,574	7,794	2,598	7,853	2,570	7,613
Clays—thousand short tons	[3] 1,607	[3] 3,003	[3] 1,991	[3] 4,060	[3] 2,220	[3] 4,888	2,448	5,142
Coal (bituminous)—do	12,359	91,243	14,435	102,267	14,832	106,249	14,219	100,112
Gem stones	NA	2	----------	----------	----------	----------	----------	----------
Iron ore (usable)—thousand long tons, gross weight	2,126	11,806	2,106	11,812	1,495	8,241	1,508	8,702
Lime—thousand short tons	596	6,974	599	7,118	653	7,905	699	8,442
Natural gas—million cubic feet	177	21	165	18	203	26	252	32
Petroleum (crude)—thousand 42-gallon barrels	9,175	23,763	8,498	22,095	8,064	21,047	8,030	20,878
Sand and gravel—thousand short tons	5,363	5,778	5,840	6,191	6,422	7,195	7,082	7,953
Stone [4]—do	13,684	22,206	15,852	24,976	17,987	30,810	20,744	36,839
Value of items that cannot be disclosed: Native asphalt, bauxite, slag cement, clays (kaolin 1963–65, bentonite 1964–65), scrap mica, salt, stone (dimension limestone, dimension marble 1964–66, shell 1963–65, crushed sandstone 1965–66), talc, and tripoli (1965)	XX	5,415	XX	9,251	XX	9,446	XX	4,528
Total	XX	215,870	XX	235,690	XX	246,264	XX	249,778
ALASKA								
Antimony ore and concentrate—short tons, antimony content	----------	----------	14	$18	1	$1	8	W
Coal (bituminous)—thousand short tons	853	$5,910	745	5,008	893	6,095	927	$6,953
Copper (recoverable content of ores, etc.)—short tons	----------	----------	11	7	32	23	W	W
Gold (recoverable content of ores, etc.)—troy ounces	99,573	3,485	58,416	2,045	42,249	1,479	27,325	956
Lead (recoverable content of ores, etc.)—short tons	5	1	----------	----------	9	3	14	4
Mercury—76-pound flasks	400	76	303	95	W	W	W	W
Natural gas—million cubic feet	4,498	1,111	6,238	1,719	7,255	1,799	11,267	2,794
Peat—short tons	----------	----------	2,350	19	1,967	16	W	W
Petroleum (crude)—thousand 42-gallon barrels	10,740	32,650	11,059	33,627	11,128	34,073	14,358	44,007
Sand and gravel—thousand short tons	16,926	22,005	26,089	18,488	30,266	34,467	17,457	21,793
Silver (recoverable content of ores, etc.) thousand troy ounces	14	18	7	9	8	10	7	9
Value of items that cannot be disclosed: Barite (1966), gem stones, platinum-group metals, stone, tin (1964–66), uranium ore (1963–65) and values indicated by symbol W	XX	2,584	XX	4,912	XX	5,489	XX	6,167
Total	XX	67,840	XX	65,947	XX	83,455	XX	82,683

ARIZONA

Asbestos—short tons	W	W	W	W	3,469	$441	W	W
Clays [3]—thousand short tons	163	$203	168	$213	129	164	89	$121
Copper (recoverable content of ores, etc.)—short tons	660,977	407,162	690,988	450,524	703,377	497,991	739,569	535,004
Diatomite—do	W	W	450	16	295	8	1,353	36
Gem stones	NA	120	NA	120	NA	120	NA	120
Gold (recoverable content of ores, etc.)—troy ounces	140,030	4,901	153,676	5,379	150,431	5,265	142,528	4,988
Gypsum—thousand short tons	W	W	147	770	103	540	75	394
Helium, grade A—thousand cubic feet	W	W	46,000	1,610	58,000	2,030	63,500	2,222
Iron ore (usable)—thousand long tons, gross weight	W	W	4	32	8	51	W	W
Lead (recoverable content of ores, etc.)—short tons	5,815	1,256	6,147	1,611	5,913	1,845	5,211	1,575
Lime—thousand short tons	181	3,048	177	2,920	204	3,543	218	3,721
Mercury—76-pound flasks	W	W	77	24	158	90	363	160
Molybdenum (content of concentrate)—thousand pounds	5,553	7,584	6,296	9,532	9,399	15,880	10,161	17,812
Natural gas—million cubic feet	1,334	161	2,014	241	3,106	376	3,161	436
Petroleum (crude)—thousand 42-gallon barrels	68	W	64	W	97	W	132	370
Pumice—thousand short tons	800	1,877	880	1,635	r 1,161	r 1,515	1,103	1,674
Sand and gravel—do	15,037	14,466	18,116	20,868	14,918	16,621	18,730	20,448
Silver (recoverable content of ores, etc.) thousand troy ounces	5,373	6,873	5,811	7,513	6,095	7,881	6,339	8,196
Stone—thousand short tons	3,257	5,069	3,759	6,283	2,474	4,171	2,271	4,091
Tungsten ore and concentrate short tons, 60-percent WO_3 basis	----------	----------	16	17	3	5	2	5
Uranium ore—short tons	150,584	4,844	102,258	3,253	117,898	3,918	64,195	1,978
Vanadium (recoverable in ore and concentrate)—do	222	W	W	575	W	381	W	453
Zinc (recoverable content of ores, etc.)—do	25,419	5,846	24,690	6,716	21,757	6,353	15,985	4,636
Value of items that cannot be disclosed: Cement, clays (bentonite, fire clay 1963–64), feldspar, scrap mica, perlite pyrites, and values indicated by symbol W	XX	r 17,617	XX	14,501	XX	10,903	XX	12,125
Total	XX	r 481,027	XX	534,353	XX	r 580,092	XX	620,565

ARKANSAS

Barite—thousand short tons	236	$2,161	233	$2,202	249	$2,379	233	$2,266
Bauxite—thousand long tons, dried equivalent	1,478	16,701	1,562	17,431	1,593	17,974	1,718	19,439
Bromine and bromine in compounds—thousand pounds	W	W	W	W	32,254	7,171	42,307	10,467
Clays—thousand short tons	769	1,763	892	2,152	866	1,890	[3] 775	[3] 776
Coal (bituminous)—do	221	1,505	212	1,503	226	1,643	236	1,640
Gem stones	NA	42	NA	33	NA	31	NA	35
Lime—thousand short tons	167	2,237	189	2,814	192	2,776	207	3,004
Natural gas—million cubic feet	76,101	11,796	75,753	11,806	82,831	12,922	105,174	16,407
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	26,219	1,466	30,082	1,678	27,787	1,578	32,050	1,923
LP gases—do	66,377	2,497	61,616	2,460	69,752	3,139	64,664	3,233
Petroleum (crude)—thousand 42-gallon barrels	27,406	72,900	26,737	71,120	25,930	68,974	23,824	63,372
Sand and gravel—thousand short tons	12,099	13,589	11,794	14,836	12,806	15,836	16,056	21,038
Stone—do	18,913	22,727	20,241	26,172	21,241	26,778	19,109	24,588
Value of items that cannot be disclosed: Abrasive stones, cement, clays (kaolin and fire clay 1966), gypsum, iron ore (1963–65), mercury (1966), phosphate rock, soapstone, tripoli (1965–66), and values indicated by symbol W	XX	17,900	XX	20,611	XX	16,019	XX	21,939
Total	XX	167,284	XX	174,818	XX	179,110	XX	190,127

See footnotes at end of table.

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

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
CALIFORNIA								
Antimony ore and concentrate_short tons, antimony content	----------	----------	----------	----------	----------	----------	1	(5)
Asbestos_____short tons	19,591	$1,547	55,041	$4,419	74,587	$6,177	81,671	$6,945
Barite_____thousand short tons	5	31	6	45	4	21	15	104
Boron minerals_____short tons	700,183	54,981	776,000	60,871	807,000	64,180	866,000	68,209
Calcite (optical grade)_____pounds	----------	----------	4	2	W	W	W	W
Cement_____thousand 376-pound barrels	46,278	147,656	47,204	149,933	45,352	144,852	45,387	146,302
Clays_____thousand short tons	3,395	8,031	3,685	8,433	3,207	7,226	2,984	6,708
Copper (recoverable content of ores, etc.)_____short tons	916	564	1,035	675	1,165	825	1,078	780
Feldspar_____long tons	75,516	W	102,264	W	95,975	W	100,915	W
Gem stones	NA	200	NA	200	NA	200	NA	200
Gold (recoverable content of ores, etc.)_____troy ounces	86,867	3,040	71,028	2,486	62,885	2,201	64,764	2,267
Gypsum_____thousand short tons	1,756	4,222	1,893	4,539	1,611	3,881	1,207	3,064
Lead (recoverable content of ores, etc.)_____short tons	823	178	1,546	405	1,810	565	1,976	597
Lime_____thousand short tons	487	8,932	577	10,294	602	11,073	552	8,764
Magnesium compounds from sea water and bitterns (partly estimated) short tons, MgO equivalent	82,397	6,135	94,739	7,143	r 95,652	r 7,955	87,816	7,413
Mercury_____76-pound flasks	13,592	2,575	10,291	3,240	13,404	7,650	16,070	7,100
Mica, scrap_____short tons	977	14	W	W	W	W	W	W
Natural gas_____million cubic feet	646,486	189,420	660,444	198,551	660,384	204,059	[8] 715,113	[8] 223,175
Natural gas liquids:								
Natural gasoline and cycle products___thousand gallons	715,303	54,188	720,373	54,088	655,780	49,850	634,638	48,867
LP gases_____do	393,503	17,329	352,614	15,893	339,082	15,467	353,164	17,304
Peat_____short tons	39,873	450	35,391	443	30,905	434	29,235	384
Petroleum (crude)_____thousand 42-gallon barrels	300,908	746,252	300,009	729,022	316,428	753,099	345,295	812,834
Pumice_____thousand short tons	460	2,017	443	1,937	676	1,744	580	1,763
Salt_____do	1,716	W	1,525	W	1,638	W	1,693	W
Sand and gravel_____do	112,185	128,178	112,995	129,333	118,310	136,227	120,692	139,157
Silver (recoverable content of ores, etc.) thousand troy ounces	157	200	172	222	197	254	190	246
Stone_____thousand short tons	37,977	58,253	45,805	63,566	42,575	59,668	43,051	61,336
Sulfur ore_____long tons	785	4	520	3	360	2	557	5
Talc, soapstone, and pyrophyllite_____short tons	120,452	1,427	132,601	1,631	141,074	1,725	138,340	1,847
Tin (content of concentrate)_____long tons	W	W	W	W	W	W	13	21
Wollastonite_____short tons	3,000	28	3,625	36	W	W	W	W
Zinc (recoverable content of ores, etc.)_____do	101	23	143	39	225	66	335	97
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, carbon dioxide, coal (lignite), diatomite, iodine, iron ore, lithium minerals, molybdenum, perlite, platinum-group metals (crude), potassium salts, rare-earth metal concentrates, sodium carbonates and sulfates, tungsten concentrate, uranium ore, and values indicated by symbol W	XX	90,366	XX	113,043	XX	r 117,897	XX	133,870
Total	XX	1,526,241	XX	1,560,492	XX	r 1,597,298	XX	1,699,359

COLORADO

Beryllium concentrate—short tons, gross weight	[6] 751	W	W	W	W	W	W	W
Carbon dioxide, natural—thousand cubic feet	224,856	$38	211,830	$36	155,668	$26	147,292	$25
Clays—thousand short tons	686	1,334	558	1,275	631	1,446	569	1,054
Coal (bituminous)—do	3,690	21,888	4,355	23,427	4,790	24,431	5,222	26,075
Copper (recoverable content of ores, etc.)—short tons	4,169	2,568	4,653	3,034	3,828	2,710	4,237	3,065
Feldspar—long tons	W	W	W	W	521	3	891	6
Gem stones	NA	63	NA	80	NA	80	NA	80
Gold (recoverable content of ores, etc.)—troy ounces	33,605	1,176	42,122	1,474	37,228	1,303	31,915	1,117
Gypsum—thousand short tons	99	346	100	398	r 100	r 379	75	269
Iron ore (usable)—thousand long tons, gross weight	W	W	35	231	114	787	164	1,133
Lead (recoverable content of ores, etc.)—short tons	19,918	4,302	20,563	5,388	22,495	7,018	23,082	6,978
Lime—thousand short tons	128	2,104	138	2,193	118	2,074	126	2,327
Mica, scrap—short tons	440	7						
Molybdenum (content of concentrate)—thousand pounds	47,977	67,168	46,378	69,207	[7] 50,715	[7] 78,609	57,289	88,851
Natural gas—million cubic feet	105,705	12,367	113,691	13,489	126,381	16,303	136,667	17,767
Natural gas liquids:								
Natural gasoline—thousand gallons	56,869	3,191	52,400	2,845	54,180	3,034	59,420	3,565
LP gases—do	91,309	4,171	88,916	3,894	91,399	3,930	73,390	3,596
Peat—short tons	13,774	98	27,931	188	31,179	236	37,111	278
Petroleum (crude)—thousand 42-gallon barrels	38,283	110,255	34,755	100,094	33,511	96,512	33,492	97,462
Pumice—thousand short tons	60	87	61	114	56	134	46	104
Pyrites—thousand long tons	W	W	W	W	30	90	W	W
Sand and gravel—thousand short tons	20,385	20,929	20,746	22,227	20,810	22,041	22,245	23,485
Silver (recoverable content of ores, etc.) thousand troy ounces	2,307	2,951	2,626	3,396	2,051	2,652	2,085	2,697
Stone—thousand short tons	2,510	5,693	3,217	6,805	4,789	8,638	7,031	11,331
Tin (content of concentrate)—long tons	W	W	29	103	32	76	44	99
Tungsten—short tons	W	W	W	W	1,176	1,985	1,494	3,626
Uranium ore—do	1,014,206	15,864	833,282	13,389	574,795	10,651	633,113	10,530
Vanadium (recoverable in ore and concentrate)—do	3,047	W	3,312	9,916	4,017	14,056	3,697	15,888
Vermiculite—thousand short tons	[5]	1	[5]	1				
Zinc (recoverable content of ores, etc.)—short tons	48,109	11,065	53,682	14,602	53,870	15,730	54,822	15,898
Value of items that cannot be disclosed: Cement, fluorspar, molybdenum (1965) perlite, rare-earth metal concentrates (1966), salt, and values indicated by symbol W	XX	29,478	XX	18,205	XX	16,234	XX	14,699
Total	XX	317,144	XX	316,011	XX	r 331,168	XX	352,005

CONNECTICUT

Clays—thousand short tons	189	$339	212	$262	237	$322	192	$296
Gem stones	NA	8	NA	8	NA	8	NA	8
Lime—thousand short tons	35	666	39	689	W	W	W	W
Sand and gravel—do	10,503	9,343	10,088	9,437	9,940	9,106	9,561	8,963
Stone—do	5,318	9,612	5,864	10,764	5,871	10,444	5,618	10,482
Value of items that cannot be disclosed: Feldspar, scrap mica, peat, and values indicated by symbol W	XX	646	XX	690	XX	1,354	XX	1,597
Total	XX	20,614	XX	21,850	XX	21,234	XX	21,346

See footnotes at end of table.

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

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
DELAWARE								
Clays—thousand short tons	13	$13	11	$11	11	$11	11	$11
Gem stones	NA	1	NA	1	NA	1	NA	1
Sand and gravel—thousand short tons	1,094	1,136	1,282	1,280	1,545	1,441	1,610	1,443
Stone—do	W	W	180	450	180	450	210	525
Value of items that cannot be disclosed: Other nonmetals and values indicated by symbol W	XX	191	XX		XX		XX	
Total	XX	1,341	XX	1,742	XX	1,903	XX	1,980
FLORIDA								
Clays—thousand short tons	538	$7,777	627	$8,405	651	$9,752	762	$11,408
Lime—do	126	1,996	117	1,814	101	1,558	135	1,966
Natural gas—million cubic feet	35	7	40	5	107	14	212	30
Peat—short tons	21,049	129	19,813	102	19,253	109	11,500	91
Petroleum (crude)—thousand 42-gallon barrels	464	W	620	W	1,464	W	1,799	W
Phosphate rock—thousand short tons	16,343	101,050	19,161	119,667	21,563	141,258	W	W
Sand and gravel—do	7,542	5,823	7,420	6,427	7,298	6,377	7,403	6,417
Stone—do	31,900	38,173	33,157	38,362	35,730	41,148	35,023	38,167
Value of items that cannot be disclosed: Cement, gem stones (1963), magnesium compounds, natural gas liquids, rare-earth metals concentrates, staurolite, titanium concentrate, zirconium concentrate, and values indicated by symbol W	XX	46,665	XX	48,627	XX	49,104	XX	237,368
Total	XX	201,620	XX	223,409	XX	249,320	XX	295,447
GEORGIA								
Barite—thousand short tons	117	$2,013	109	$2,022	W	W	W	W
Clays—do	4,208	54,024	4,365	58,899	4,607	$63,158	5,128	$73,685
Coal (bituminous)—do	5	16	4	15				
Gem stones	NA	1						
Iron ore (usable)—thousand long tons, gross weight	260	1,304	354	1,752	r 430	r 2,208	447	2,200
Mica:								
Scrap—short tons	W	W	W	W	13,065	W	16,608	380
Sheet—pounds					2,793	(5)		
Sand and gravel—thousand short tons	3,817	3,922	3,588	3,594	3,675	3,588	3,915	4,185
Stone—do	19,582	46,044	22,822	46,428	23,421	48,265	24,690	48,193
Talc—short tons	42,000	93	40,400	135	44,800	313	41,000	255
Value of items that cannot be disclosed: Bauxite, cement, feldspar, kyanite, peat, rare-earth metal concentrates (1966), titanium concentrate (1965–66), zirconium concentrate (1965–66), and values indicated by symbol W	XX	12,059	XX	14,292	XX	17,688	XX	19,699
Total	XX	119,476	XX	127,137	XX	r 135,220	XX	148,597

HAWAII

Cement—thousand 376-pound barrels	1,483	$7,125	1,717	$8,877	1,564	$8,297	1,749	$9,046
Clays—thousand short tons	W	W	3	W	W	W	W	W
Gem stones	NA	36	NA	W	NA	W	NA	W
Lime—thousand short tons	12	428	9	321	9	305	10	320
Pumice—do	274	469	365	603	380	624	374	716
Sand and gravel—do	304	764	407	979	751	2,237	511	1,591
Stone—do	3,844	6,480	5,282	8,765	5,172	9,353	5,079	9,482
Value of items that cannot be disclosed: Other nonmetals and values indicated by symbol W	XX	5	XX	60	XX	19	XX	98
Total	XX	15,307	XX	19,605	XX	20,835	XX	21,253

IDAHO

Antimony ore and concentrate—short tons, antimony content	645	W	585	W	818	W	834	W
Clays [3]—thousand short tons	31	$15	29	$25	47	$33	23	$22
Cobalt—thousand pounds	----	----	----	----	----	----	1	6
Copper (recoverable content of ores, etc.)—short tons	4,172	2,570	4,666	3,042	5,140	3,639	4,961	3,589
Gem stones	NA	W	NA	W	NA	150	NA	180
Gold (recoverable content of ores, etc.)—troy ounces	5,477	192	5,677	199	5,078	178	5,056	177
Iron ore (usable)—thousand long tons, gross weight	6	40	4	33	9	84	11	97
Lead (recoverable content of ores, etc.)—short tons	75,759	16,364	71,312	18,684	66,606	20,781	72,334	21,867
Lime—thousand short tons	60	874	W	W	W	W	W	W
Mercury—76-pound flasks	W	W	83	26	1,119	639	1,134	501
Peat—short tons	W	W	900	8	W	W	W	W
Phosphate rock—thousand short tons	1,904	10,589	W	W	W	W	W	W
Pumice—do	161	275	59	100	46	79	55	107
Sand and gravel—do	12,433	10,615	9,582	8,691	12,151	13,198	7,544	6,672
Silver (recoverable content of ores, etc.)—thousand troy ounces	16,711	21,375	16,483	21,313	18,457	23,865	19,777	25,571
Stone—thousand short tons	1,168	2,217	1,144	2,773	1,831	3,440	2,694	5,415
Tungsten concentrate—short tons, 60-percent WO_3 basis	----	----	11	8	----	----	2	1
Vanadium (recoverable in ore and concentrate)—short tons	23	W	W	W	W	W	W	W
Zinc (recoverable content of ores, etc.)—do	63,267	14,551	59,298	16,129	58,034	16,946	60,997	17,689
Value of items that cannot be disclosed: Barite (1963–64), cement, clays (fire clay, bentonite, kaolin), abrasive garnet, scrap mica (1963–64), perlite, titanium concentrate, and values indicated by symbol W	XX	3,110	XX	15,231	XX	r 22,053	XX	33,020
Total	XX	82,787	XX	86,262	XX	105,085	XX	114,914

ILLINOIS

Cement:								
Portland—thousand 376-pound barrels	9,281	$30,577	9,790	$32,191	9,358	$30,622	9,203	$28,617
Masonry—thousand 280-pound barrels	472	1,440	596	2,038	615	1,907	614	1,868
Clays—thousand short tons	1,949	4,368	[3] 2,007	[3] 4,358	[3] 2,169	[3] 4,601	[3] 1,894	[3] 3,996
Coal (bituminous)—do	51,736	196,518	55,023	208,448	58,483	218,972	63,571	244,837
Fluorspar—short tons	132,060	6,547	127,454	6,452	159,140	7,861	176,175	8,002
Lead (recoverable content of ores, etc.)—do	2,901	627	2,180	571	3,005	938	2,285	691

See footnotes at end of table.

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

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ILLINOIS—Continued								
Natural gas—million cubic feet	9,459	$1,220	7,824	$905	7,396	$865	7,230	$860
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	14,939	1,077	14,109	1,030	W	W	W	W
LP gases—do	337,278	14,714	312,173	13,758	W	W	W	W
Peat—short tons	W	W	W	W	36,774	453	44,374	565
Petroleum (crude)—thousand 42-gallon barrels	74,796	222,892	70,168	205,592	63,708	186,664	[8] 61,982	[8] 185,947
Sand and gravel—thousand short tons	31,746	36,431	34,880	39,966	36,228	40,480	38,237	43,201
Stone—do	40,293	52,217	42,987	56,553	47,066	61,294	46,157	60,961
Zinc (recoverable content of ores, etc.)—short tons	20,337	4,678	13,800	3,754	18,314	5,348	15,192	4,406
Value of items that cannot be disclosed: Clay (fuller's earth 1964–66), gem stones, lime, tripoli, and values indicated by symbol W	XX	13,656	XX	15,520	XX	33,020	XX	34,362
Total	XX	586,962	XX	591,136	XX	593,025	XX	618,313
INDIANA								
Abrasive stones—short tons	5	$16	5	$16	5	$15	5	$15
Cement [2]—thousand 376-pound barrels	13,165	43,216	15,038	48,695	14,925	48,797	15,305	49,826
Clays—thousand short tons	1,546	2,347	1,545	2,264	1,459	2,160	1,491	2,196
Coal (bituminous)—do	15,100	57,120	15,075	57,246	15,565	59,927	17,326	67,857
Natural gas—million cubic feet	286	67	199	47	239	56	215	51
Peat—short tons	47,695	412	66,568	543	53,873	511	38,111	456
Petroleum (crude)—thousand 42-gallon barrels	11,902	35,230	11,283	32,157	[8] 11,429	[8] 32,458	10,617	31,850
Sand and gravel—thousand short tons	22,840	20,683	24,416	21,811	24,867	22,220	24,992	23,542
Stone—do	19,667	35,616	22,308	39,978	24,574	42,124	24,323	42,474
Value of items that cannot be disclosed: Cement (masonry), gem stones (1963), gypsum, and lime (1966)	XX	9,259	XX	9,026	XX	10,299	XX	11,743
Total	XX	203,966	XX	211,783	XX	218,567	XX	230,010
IOWA								
Cement:								
Portland—thousand 376-pound barrels	12,495	$42,891	13,607	$46,398	13,643	$46,273	14,058	$46,736
Masonry—thousand 280-pound barrels	551	1,754	585	1,847	608	1,867	633	1,890
Clays—thousand short tons	1,064	1,405	1,008	1,254	1,085	1,347	1,130	1,438
Coal (bituminous)—do	1,213	4,244	973	3,447	1,043	3,694	1,025	3,783
Gypsum—do	1,282	5,667	1,287	5,821	1,254	5,554	1,285	5,577
Sand and gravel—do	14,168	12,845	13,890	13,546	18,205	17,152	19,644	18,213
Stone—do	20,904	27,788	23,935	33,038	25,891	35,468	27,729	40,081
Value of items that cannot be disclosed: Gem stones, lime, peat, and petroleum (1963–64)	XX	1,076	XX	1,279	XX	1,428	XX	1,595
Total	XX	97,670	XX	106,630	XX	112,783	XX	119,313

KANSAS

Cement: [2]								
Portland—thousand 376-pound barrels	8,201	$25,372	8,483	$25,959	8,801	$26,972	8,979	$27,246
Masonry—thousand 280-pound barrels	387	1,183	384	1,173	404	1,178	395	1,151
Clays—thousand short tons	893	1,104	785	935	789	953	847	1,006
Coal (bituminous)—do	1,169	5,311	1,263	5,749	1,310	6,072	1,122	5,355
Helium: Crude—thousand cubic feet	740,900	8,150	2,170,512	24,941	2,551,026	29,518	2,624,200	30,951
Grade A—do	46,400	1,624	44,826	1,657	19,763	904	75,500	1,885
Lead (recoverable content of ores, etc.)—short tons	1,027	222	1,185	310	1,644	513	1,109	335
Natural gas—million cubic feet	732,946	97,482	764,073	96,031	793,379	105,519	847,495	114,412
Natural gas liquids:								
Natural gasoline—thousand gallons	165,370	9,811	162,725	8,713	153,485	7,791	175,053	9,399
LP gases—do	395,877	15,481	512,747	18,121	587,416	22,322	664,164	25,902
Petroleum (crude)—thousand 42-gallon barrels	109,107	317,501	106,252	310,256	104,733	305,820	103,738	306,027
Salt [9]—thousand short tons	924	11,993	930	11,799	1,053	12,376	969	13,388
Sand and gravel—do	12,062	8,676	12,968	9,108	12,544	8,473	11,627	8,374
Stone—do	13,558	18,483	14,138	18,912	15,270	20,538	14,027	18,789
Zinc (recoverable content of ores, etc.)—short tons	3,508	807	4,665	1,269	6,508	1,900	4,769	1,383
Value of items that cannot be disclosed: Natural cement, gypsum, pumice, and salt (brine)	XX	3,260	XX	3,277	XX	2,642	XX	2,789
Total	XX	r 526,460	XX	538,210	XX	553,491	XX	568,392

KENTUCKY

Barite—thousand short tons	6	$85	6	$96				
Clays [3]—do	984	2,397	920	1,801	1,059	$2,580	1,152	$2,277
Coal (bituminous)—do	77,350	295,743	82,747	309,896	85,766	324,523	93,156	363,440
Fluorspar—short tons	35,072	1,537	38,214	1,693	31,992	1,485	28,725	1,361
Lead (recoverable content of ores, etc.)—do	831	179	858	225	756	236	484	146
Natural gas—million cubic feet	74,634	17,838	76,940	18,257	78,976	18,638	76,536	18,139
Petroleum (crude)—thousand 42-gallon barrels	18,344	53,564	19,772	56,746	19,386	55,638	18,066	51,488
Sand and gravel—thousand short tons	6,480	6,071	6,560	6,297	6,742	6,332	8,064	7,524
Silver (recoverable content of ores, etc.) thousand troy ounces	2	2	2	2	2	2	1	1
Stone—thousand short tons	24,689	34,571	[4] 21,868	[4] 29,594	26,029	34,533	22,667	31,179
Zinc (recoverable content of ores, etc.)—short tons	1,461	336	2,063	561	5,654	1,651	6,586	1,910
Value of items that cannot be disclosed: Native asphalt (1966), cement, ball clay, gem stones (1963), natural gas liquids, and stone (dimension sandstone 1964)	XX	20,370	XX	19,211	XX	20,763	XX	20,899
Total	XX	432,693	XX	444,379	XX	466,381	XX	498,364

LOUISIANA

Clays—thousand short tons	655	$655	780	$797	909	$936	1,005	$983
Lime—do	657	6,862	725	8,312	842	9,980	835	9,274
Natural gas—million cubic feet	3,928,427	777,829	4,152,731	793,328	4,466,786	812,955	5,081,435	929,902
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	1,143,707	81,332	1,352,980	91,931	1,481,836	102,731	1,562,075	113,802
LP gases—do	1,113,670	41,043	1,247,484	45,935	1,300,088	46,101	1,469,716	72,016

See footnotes at end of table.

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

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
LOUISIANA—Continued								
Petroleum (crude)—thousand 42-gallon barrels	515,057	$1,608,120	549,698	$1,709,622	594,853	$1,841,714	674,318	$2,097,129
Salt—thousand short tons	6,199	30,450	6,401	36,056	8,126	41,812	8,736	44,189
Sand and gravel—do	12,500	14,701	13,594	15,253	14,298	16,405	18,216	22,504
Stone [4]—do	5,408	7,961	5,459	7,228	7,452	10,905	8,091	11,253
Sulfur (Frasch process)—thousand long tons	2,445	48,905	2,733	54,996	3,577	r 81,372	4,018	104,472
Value of items that cannot be disclosed: Cement, gypsum, and stone (crushed miscellaneous)	XX	20,531	XX	21,549	XX	23,350	XX	24,616
Total	XX	2,638,389	XX	2,785,007	XX	r 2,988,261	XX	3,430,140
MAINE								
Clays—thousand short tons	42	$55	45	$58	49	$63	45	$58
Gem stones	NA	25	NA	35	NA	35	NA	35
Peat—short tons	W	W	6,350	171	1,275	56	1,600	60
Sand and gravel—thousand short tons	11,195	4,673	13,552	6,463	17,294	7,831	15,036	7,027
Stone—do	947	3,581	1,414	4,506	1,100	3,409	1,092	3,622
Value of items that cannot be disclosed: Cement, feldspar, and values indicated by symbol W	XX	5,770	XX	6,341	XX	6,347	XX	5,932
Total	XX	14,104	XX	17,574	XX	17,741	XX	16,734
MARYLAND								
Clays—thousand short tons	580	$897	[3] 635	[3] $798	[3] 914	[3] $1,088	[3] 856	[3] $1,084
Coal (bituminous)—do	1,162	4,330	1,136	4,511	1,210	4,389	1,222	4,367
Gem stones	NA	3	NA	3	NA	3	NA	3
Lime—thousand short tons	W	W	W	W	37	481	29	386
Natural gas—million cubic feet	1,633	439	1,373	366	408	103	696	181
Sand and gravel—thousand short tons	13,310	16,063	15,041	18,071	16,200	21,188	15,108	20,383
Stone—do	13,012	26,407	13,348	26,715	14,553	28,432	13,868	27,229
Value of items that cannot be disclosed: Cement, ball clay (1964–66), diatomite (1963), greensand marl, peat, potassium salts, talc and soapstone, and values indicated by symbol W	XX	22,111	XX	23,429	XX	22,311	XX	20,528
Total	XX	70,250	XX	73,893	XX	77,995	XX	74,161

MASSACHUSETTS

Clays	thousand short tons	157	$213	138	$174	181	$238	202	$260
Gem stones		NA	2	NA	2	NA	2	NA	2
Lime	thousand short tons	145	2,426	171	2,703	170	2,779	182	2,712
Sand and gravel	do	19,905	15,592	21,341	16,794	22,141	16,172	17,321	17,846
Stone	do	5,570	14,396	6,519	16,663	6,168	16,980	6,424	17,624
Value of items that cannot be disclosed: Nonmetals		XX	32	XX	31	XX	27	XX	29
Total		XX	32,661	XX	36,367	XX	36,198	XX	38,473

MICHIGAN

Cement:								
Portland	thousand 376-pound barrels	25,016	$76,944	26,745	$84,316	27,565	$86,996	28,171	$87,413
Masonry	thousand 280-pound barrels	1,684	4,519	1,865	4,954	2,108	5,373	2,032	5,221
Clays	thousand short tons	1,958	2,149	2,385	2,592	2,402	2,580	2,450	2,620
Copper (recoverable content of ores, etc.)	short tons	75,262	46,361	69,040	45,014	71,749	50,798	73,449	53,133
Gypsum	thousand short tons	1,315	4,938	1,421	5,263	1,338	5,027	1,522	5,489
Iron ore (usable)	thousand long tons, gross weight	10,789	107,201	13,871	143,979	13,527	145,482	14,377	157,377
Lime	thousand short tons	1,371	18,431	1,430	19,246	1,095	13,057	1,701	20,016
Magnesium compounds from sea water and brine (except for metal)	short tons, MgO equivalent	266,740	23,062	306,494	23,385	319,389	26,143	342,482	28,105
Manganiferous ore (5 to 35 percent Mn)	short tons, gross weight	152,957	W						
Natural gas	million cubic feet	32,850	8,902	31,388	7,984	34,558	8,674	34,120	8,598
Natural gas liquids:									
Natural gasoline	thousand gallons	W	W	W	W	9,054	607	15,703	1,099
LP gases	do	W	W	W	W	76,299	3,815	79,719	4,385
Peat	short tons	251,809	2,413	269,074	2,412	230,950	2,134	235,842	2,175
Petroleum (crude)	thousand 42-gallon barrels	15,972	45,520	15,601	43,839	14,728	41,091	14,273	40,913
Salt	thousand short tons	4,244	33,656	4,345	35,711	4,171	36,087	4,465	38,611
Sand and gravel	do	50,458	43,433	51,921	44,405	53,168	47,176	55,123	49,521
Silver (recoverable content of ores, etc.)	thousand troy ounces	339	434	349	452	458	592	483	625
Stone	thousand short tons	30,316	32,065	34,650	37,002	34,713	36,438	37,864	40,380
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, gem stones, iodine, potassium salts, and values indicated by symbol W		XX	42,001	XX	54,278	XX	53,490	XX	56,446
Total		XX	492,029	XX	554,832	XX	565,560	XX	602,127

MINNESOTA

Clays [3]	thousand short tons	199	$298	213	$319	207	$311	224	$336
Iron ore (usable)	thousand long tons, gross weight	45,435	408,486	49,626	449,289	50,873	459,290	55,133	499,388
Manganiferous ore (5 to 35 percent Mn)	short tons, gross weight	347,336	W	188,481	W	280,705	W	275,581	W
Peat	short tons	8,110	294	19,188	405	7,346	123	11,366	197
Sand and gravel	thousand short tons	30,462	23,318	35,817	25,907	37,545	27,296	39,331	28,972
Stone	do	3,898	11,027	3,588	12,297	4,371	11,680	4,901	11,688
Value of items that cannot be disclosed: Abrasive stones, cement, fire clay, gem stones, lime, and values indicated by symbol W		XX	10,120	XX	9,278	XX	9,060	XX	9,696
Total		XX	453,543	XX	497,495	XX	507,760	XX	550,277

See footnotes at end of table.

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

Mineral	1963 Quantity	1963 Value (thousands)	1964 Quantity	1964 Value (thousands)	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
MISSISSIPPI								
Clays—thousand short tons	1,235	$5,968	1,331	$6,130	1,502	$6,997	1,727	$7,489
Natural gas—million cubic feet	176,807	31,825	180,428	31,385	166,825	28,861	156,652	27,257
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	28,757	1,755	27,485	1,644	26,582	1,606	23,765	1,483
LP gases—do	24,541	956	23,277	780	22,150	975	18,621	987
Petroleum (crude)—thousand 42-gallon barrels	58,619	161,788	56,777	151,595	56,183	148,437	55,227	146,353
Sand and gravel—thousand short tons	6,825	7,056	7,825	8,569	8,447	8,717	12,675	13,563
Stone—do	1,267	1,267	1,553	1,557	[4] 2,357	[4] 2,358	[4] 1,532	[4] 1,641
Value of items that cannot be disclosed: Cement, iron ore (1965–66), lime magnesium compounds, and stone (dimension sandstone 1965–66)	XX	9,579	XX	10,533	XX	r 12,082	XX	12,587
Total	XX	220,194	XX	212,193	XX	r 210,033	XX	211,360
MISSOURI								
Asphalt, native—short tons	1,779	$15	1,522	$13	W	W	W	W
Barite—thousand short tons	287	3,680	267	3,451	329	$4,219	337	$4,280
Cement:								
Portland—thousand 376-pound barrels	12,402	41,640	12,378	42,618	13,334	46,034	13,848	46,228
Masonry—thousand 280-pound barrels	417	1,345	334	1,046	377	1,173	382	1,075
Clays—thousand short tons	1,746	4,467	1,966	4,874	2,226	5,439	2,329	5,989
Coal (bituminous)—do	3,174	13,196	3,254	13,285	3,564	14,779	3,582	14,834
Copper (recoverable content of ores, etc.)—short tons	1,816	1,119	2,059	1,343	2,331	1,650	3,913	2,831
Iron ore (usable)—thousand long tons, gross weight	345	3,085	1,116	14,907	1,784	24,607	1,887	26,450
Lead (recoverable content of ores, etc.)—short tons	79,844	17,246	120,148	31,479	133,521	41,659	132,255	39,981
Lime—thousand short tons	1,240	14,386	1,219	14,328	1,442	16,782	1,494	17,910
Natural gas—million cubic feet	100	27	107	26	84	21	----------	----------
Petroleum (crude)—thousand 42-gallon barrels	53	150	65	163	73	W	97	W
Sand and gravel—thousand short tons	10,653	12,260	11,483	13,380	12,068	13,735	10,702	13,540
Silver (recoverable content of ores, etc.) thousand troy ounces	132	168	----------	----------	300	387	----------	----------
Stone—thousand short tons	30,885	46,130	31,487	47,984	36,247	53,574	35,240	53,393
Zinc (recoverable content of ores, etc.)—short tons	321	74	1,501	408	4,312	1,259	3,968	1,151
Value of items that cannot be disclosed: Tripoli (1965), and values indicated by symbol W	XX	----------	XX	----------	XX	250	XX	288
Total	XX	158,988	XX	189,305	XX	225,568	XX	227,950

MONTANA

Clays [3] thousand short tons	38	$45	49	$59	76	$98	53	$56
Coal (bituminous and lignite) do	343	967	346	925	364	1,050	419	1,290
Copper (recoverable content of ores, etc.) short tons	79,762	49,133	103,806	67,682	115,489	81,766	128,061	92,639
Gem stones	NA	W	NA	W	NA	77	NA	109
Gold (recoverable content of ores, etc.) troy ounces	18,520	648	29,115	1,019	22,772	797	25,009	875
Iron ore (usable) thousand long tons, gross weight	13	89	15	99	9	71	12	93
Lead (recoverable content of ores, etc.) short tons	5,000	1,080	4,538	1,189	6,981	2,178	4,409	1,333
Lime thousand short tons	114	1,290	136	1,385	159	1,512	225	2,116
Manganese ore (35 percent or more Mn) short tons, gross weight	5,260	W	20,264	W	23,621	W	W	W
Manganiferous ore (5 to 35 percent Mn) do	1,688	W	3,638	W	1,968	W	1,755	28
Natural gas million cubic feet	30,026	2,253	25,051	1,965	28,105	2,305	30,685	2,547
Petroleum (crude) thousand 42-gallon barrels	30,870	75,323	30,647	74,621	32,778	79,624	35,380	86,273
Pumice thousand short tons	----------	----------	W	W	----------	----------	22	5
Sand and gravel do	14,319	13,756	16,017	17,840	12,048	13,587	13,816	13,523
Silver (recoverable content of ores, etc.) thousand troy ounces	4,242	5,426	5,290	6,840	5,207	6,733	5,320	6,878
Stone thousand short tons	6,109	7,081	7,345	8,477	5,512	5,971	4,150	5,212
Zinc (recoverable content of ores, etc.) short tons	32,941	7,576	29,059	7,904	33,786	9,866	29,120	8,445
Value of items that cannot be disclosed: Antimony (1966), barite, cement, clays (fire clay 1963–64, bentonite 1964–66), fluorspar, gypsum, natural gas liquids, peat, phosphate rock, talc, tungsten (1966), uranium ore (1963–64, 1966), vermiculite, and values indicated by symbol W	XX	17,351	XX	21,447	XX	r 22,528	XX	23,846
Total	XX	182,018	XX	211,452	XX	r 228,163	XX	245,268

NEBRASKA

Clays thousand short tons	148	$148	143	$143	r 141	r $141	153	$153
Gem stones	NA	5	NA	5	NA	5	NA	5
Natural gas million cubic feet	13,051	2,454	11,094	1,707	10,720	1,565	10,196	1,621
Natural gas liquids:								
Natural gasoline thousand gallons	10,119	687	9,587	627	7,822	516	9,195	653
LP gases do	25,931	1,207	24,556	1,092	16,946	847	19,670	1,141
Petroleum (crude) thousand 42-gallon barrels	21,846	61,824	19,113	51,605	17,216	45,796	13,850	37,673
Sand and gravel thousand short tons	11,166	10,680	14,641	15,748	11,993	13,697	13,539	14,179
Stone do	3,700	6,192	3,779	6,417	4,198	6,637	5,055	7,916
Value of items that cannot be disclosed: Cement, lime, and pumice	XX	15,710	XX	14,615	XX	14,622	XX	15,180
Total	XX	98,907	XX	91,959	XX	r 83,826	XX	78,521

NEVADA

Antimony ore and concentrate short tons, antimony content	----------	----------	33	$20	26	$19	68	$63
Barite thousand short tons	120	$760	149	1,261	91	583	139	933
Copper (recoverable content of ores, etc.) short tons	81,738	50,351	67,272	43,861	71,332	50,503	78,720	56,946
Gem stones	NA	100	NA	100	NA	100	NA	100
Gold (recoverable content of ores, etc.) troy ounces	98,879	3,461	90,469	3,166	229,050	8,017	366,903	12,842

See footnotes at end of table.

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

Mineral	1963 Quantity	1963 Value (thousands)	1964 Quantity	1964 Value (thousands)	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
NEVADA—Continued								
Gypsum—thousand short tons	890	$3,216	799	$2,894	710	$2,518	594	$2,023
Iron ore (usable)—thousand long tons, gross weight	772	3,921	911	5,048	1,141	5,330	1,000	4,931
Lead (recoverable content of ores, etc.)—short tons	1,126	243	809	212	2,277	710	3,581	1,083
Mercury—76-pound flasks	4,944	937	3,262	1,027	3,333	1,902	3,355	1,482
Perlite—short tons	22,910	192	15,603	135	13,780	121	W	W
Petroleum (crude)—thousand 42-gallon barrels	118	W	255	W	209	W	307	W
Pumice—thousand short tons	W	W	W	W	68	187	55	190
Sand and gravel—do	9,688	10,513	14,142	14,427	9,455	11,796	9,085	9,134
Silver (recoverable content of ores, etc.)—thousand troy ounces	215	275	172	223	507	656	867	1,122
Stone—thousand short tons	639	1,101	788	1,396	1,248	2,247	2,002	2,519
Sulfur ore—long tons	586	11	274	5	336	6	----------	----------
Talc and soapstone—short tons	4,243	50	5,322	58	3,592	31	4,715	24
Zinc (recoverable content of ores, etc.)—do	571	131	582	158	3,858	1,127	5,827	1,690
Value of items that cannot be disclosed: Brucite (1965–66), cement (1965–66), clays, diatomite, fluorspar, lime, lithium minerals (1966), magnesite, molybdenum, peat (1964–66), salt, tungsten, uranium ore, and values indicated by symbol W	XX	10,215	XX	11,146	XX	r 14,113	XX	17,550
Total	XX	85,477	XX	85,137	XX	r 99,966	XX	112,632
NEW HAMPSHIRE								
Clays—thousand short tons	47	$40	46	$40	53	$47	51	$51
Peat—short tons	----------	----------	----------	----------	----------	----------	175	2
Sand and gravel—thousand short tons	7,581	4,376	8,768	4,996	10,584	5,559	7,626	4,807
Stone—do	137	1,566	202	2,138	153	1,932	206	2,091
Value of items that cannot be disclosed: Other nonmetals	XX	109	XX	128	XX	127	XX	49
Total	XX	6,091	XX	7,302	XX	7,665	XX	7,000
NEW JERSEY								
Clays—thousand short tons	498	$1,392	500	$1,441	506	$1,388	488	$1,319
Gem stones	NA	9	NA	10	NA	10	NA	10
Peat—short tons	23,685	241	W	W	40,480	431	36,312	489
Sand and gravel—thousand short tons	16,672	25,245	17,661	27,079	17,389	28,646	17,782	29,322
Stone—do	11,229	25,654	12,326	28,461	12,232	27,247	12,453	28,056
Zinc (recoverable content of ores, etc.) [10]—short tons	32,738	7,855	32,926	8,935	38,297	11,106	25,237	7,319

Value of items that cannot be disclosed: Iron ore, lime, magnesium compounds, manganiferous residuum, greensand marl, titanium concentrate, and values indicated by symbol W	XX	12,880	XX	12,246	XX	11,380	XX	9,080
Total	XX	73,276	XX	78,172	XX	80,158	XX	75,595
NEW MEXICO								
Barite—thousand short tons	1	$6	W	W	(5)	$2		
Carbon dioxide, natural—thousand cubic feet	854,339	63	816,168	$61	833,819	62	795,885	$58
Clays—thousand short tons	W	140	[3] 104	[3] 167	60	101	W	W
Coal (bituminous)—do	1,945	5,629	2,969	9,763	3,212	10,710	2,755	9,110
Copper (recoverable content of ores, etc.)—short tons	83,037	51,151	86,104	56,140	98,658	69,850	108,614	78,571
Fluorspar—do			137	3				
Gem stones	NA	45	NA	45	NA	45	NA	45
Gold (recoverable content of ores, etc.)—troy ounces	7,805	273	6,110	214	9,641	337	9,295	325
Gypsum—thousand short tons	179	656	W	W	W	W	146	545
Helium, grade A—thousand cubic feet	r 78,200	r 2,737	82,105	2,958	80,583	r 2,821	95,900	3,357
Lead (recoverable content of ores, etc.)—short tons	1,014	219	1,626	426	3,387	1,057	1,596	482
Lime—thousand short tons	27	377	25	352	33	465	34	472
Manganese ore (35 percent or more Mn) short tons, gross weight	5,362	137	5,794	149	5,637	156	W	W
Manganiferous ore (5 to 35 percent Mn)—do	41,144	W	46,657	300	50,090	328	47,590	324
Mica: Scrap—short tons	W	W	6,922	105	4,263	45	W	W
Natural gas—million cubic feet	808,377	96,197	873,947	101,932	937,205	110,590	998,076	124,760
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	291,388	17,555	356,047	21,570	358,487	20,824	338,732	19,736
LP gases—do	728,200	21,801	739,190	21,641	759,311	25,817	816,202	31,832
Perlite—short tons	259,113	2,212	286,329	2,568	331,011	2,905	343,334	3,423
Petroleum (crude)—thousand 42-gallon barrels	109,941	316,574	113,863	326,565	119,166	334,977	124,154	352,101
Potassium salts—thousand short tons, K_2O equivalent	2,643	101,458	2,675	104,861	2,848	117,771	2,953	108,653
Pumice—thousand short tons	322	850	260	760	264	915	245	787
Salt—do	54	472	62	559	64	572	66	716
Sand and gravel—do	8,402	12,843	8,781	10,160	11,763	12,130	15,503	13,029
Silver (recoverable content of ores, etc.) thousand troy ounces	256	328	242	313	288	372	243	314
Stone—thousand short tons	2,509	4,236	2,760	4,244	1,911	3,020	2,652	4,056
Uranium ore—short tons	2,304,577	41,372	2,093,350	38,203	2,013,861	38,311	2,080,481	38,754
Vanadium (recoverable in ore and concentrate)—do	23	W	W	154	W	221	W	53
Zinc (recoverable content of ores, etc.)—do	12,938	2,976	29,833	8,115	36,460	10,646	29,296	8,496
Value of items that cannot be disclosed: Cement, fire clay (1964), iron ore, molybdenum, tin (1964–66), and values indicated by symbol W	XX	8,249	XX	7,802	XX	8,070	XX	20,328
Total	XX	r 688,556	XX	720,130	XX	r 773,120	XX	820,327
NEW YORK								
Clays—thousand short tons	1,598	$2,186	1,499	$1,993	1,354	$1,717	1,464	$1,726
Emery—short tons	6,732	119	9,214	172	10,720	204	11,102	210
Gem stones	NA	10	NA	10	NA	10	NA	10

See footnotes at end of table.

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

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NEW YORK—Continued								
Gypsum—thousand short tons	647	$3,339	653	$3,321	662	$3,511	559	$2,998
Lead (recoverable content of ores, etc.)—short tons	1,009	218	732	192	601	188	1,097	332
Lime—thousand short tons	W	W	W	W	W	W	1,096	9,870
Natural gas—million cubic feet	3,962	1,169	3,108	963	3,340	1,029	2,699	837
Peat—short tons	21,358	178	32,574	261	25,098	232	27,211	250
Petroleum (crude)—thousand 42-gallon barrels	1,679	7,707	1,874	8,321	1,632	7,246	1,735	7,925
Salt—thousand short tons	4,782	34,228	4,816	34,216	5,002	35,771	4,980	36,203
Sand and gravel—do	37,381	37,274	39,282	38,583	39,225	40,370	41,903	43,091
Silver (recoverable content of ores, etc.)—thousand troy ounces	20	25	13	17	11	15	22	28
Stone—thousand short tons	26,611	44,549	29,141	46,669	30,801	48,675	34,130	54,543
Zinc (recoverable content of ores, etc.)—short tons	53,495	12,304	60,754	16,525	69,880	20,405	73,454	21,302
Value of items that cannot be disclosed: Cement, abrasive garnet, iron ore, talc, titanium concentrate, wollastonite, and values indicated by symbol W	XX	115,768	XX	137,202	XX	130,684	XX	121,939
Total	XX	259,074	XX	288,445	XX	290,057	XX	301,264
NORTH CAROLINA								
Abrasive stones (millstones)	NA	$2						
Clays [3]—thousand short tons	2,735	1,761	3,199	$2,064	3,383	$2,162	3,381	$2,241
Feldspar—long tons	267,654	2,821	r 281,449	r 2,342	278,990	3,153	301,610	3,157
Gem stones	NA	14	NA	15	NA	15	NA	15
Gold (recoverable content of ores, etc.)—troy ounces	33	1						
Iron ore (usable)—thousand long tons	1	10						
Lead (recoverable content of ores, etc.)—short tons	62	13						
Mica:								
Scrap—do	61,598	1,497	64,010	2,027	72,199	1,987	63,480	2,348
Sheet—pounds	92,961	13	242,662	58	713,293	185	4,500	1
Phosphate rock—thousand short tons			7	41			W	W
Sand and gravel—do	11,028	10,132	11,150	10,404	10,499	10,076	11,601	11,132
Silver (recoverable content of ores, etc.)—thousand troy ounces	27	34						
Stone—thousand short tons	15,701	25,683	r 17,943	r 30,378	r 18,835	r 30,920	r 22,377	r 36,136
Talc and pyrophyllite—short tons	106,652	446	106,035	495	109,721	556	113,366	576
Zinc (recoverable content of ores, etc.)—do	13	3						
Value of items that cannot be disclosed: Asbestos, cement, clay (kaolin), copper (1963), lithium minerals, olivine, stone (crushed and dimension marble and dimension slate 1964–66), tungsten concentrate (1963–64), and values indicated by symbol W	XX	2,095	XX	7,903	XX	11,329	XX	16,272
Total	XX	44,525	XX	55,727	XX	60,383	XX	71,878

NORTH DAKOTA

Clays	thousand short tons	[3] 5	[3] $10	85	$119	81	$114	68	$92
Coal (lignite)	do	2,399	5,250	2,637	5,659	2,732	5,848	3,543	6,976
Gem stones		NA	1	NA	1	NA	1	NA	1
Natural gas	million cubic feet	32,798	6,264	34,512	7,634	35,652	5,704	46,585	7,547
Natural gas liquids:									
Natural gasoline	thousand gallons	20,511	1,339	21,368	1,338	21,059	1,263	23,200	1,415
LP gases	do	79,653	3,166	84,338	2,960	85,174	3,066	91,884	3,859
Petroleum (crude)	thousand 42-gallon barrels	25,030	68,332	25,731	63,813	26,350	65,875	27,126	69,170
Sand and gravel	thousand short tons	9,529	9,193	10,520	10,142	7,574	7,895	10,145	10,568
Stone	do	132	132	31	56	356	624	170	305
Uranium ore	short tons	5,567	141	W	W	44,558	1,359	W	W
Value of items that cannot be disclosed: Clay (bentonite 1963, miscellaneous clay 1963), lime (1965–66), molybdenum (1964–66), peat, salt, vandium (1965), and values indicated by symbol W		XX	875	XX	1,144	XX	1,129	XX	1,874
Total		XX	94,703	XX	92,866	XX	92,878	XX	101,807

OHIO

Cement:									
Portland	thousand 376-pound barrels	16,218	$53,244	15,553	$50,647	14,786	$47,499	15,181	$48,740
Masonry	thousand 280-pound barrels	1,023	3,084	1,068	3,127	1,050	3,004	976	2,785
Clays	thousand short tons	4,841	13,959	5,005	14,426	5,070	14,816	5,089	14,522
Coal (bituminous)	do	36,790	136,113	37,310	137,776	39,390	146,028	43,341	164,444
Gem stones		NA	3	NA	3	NA	3	NA	3
Lime	thousand short tons	3,207	45,957	3,664	53,308	3,831	53,208	3,858	50,997
Natural gas	million cubic feet	36,817	8,909	37,106	8,880	35,684	8,421	43,133	10,223
Peat	short tons	6,910	109	6,363	83	5,352	80	5,214	84
Petroleum (crude)	thousand 42-gallon barrels	6,039	19,023	15,859	46,420	12,908	37,940	10,899	32,700
Salt	thousand short tons	4,245	29,682	4,537	31,092	5,026	34,816	5,138	35,735
Sand and gravel	do	37,790	44,368	37,771	45,567	40,852	49,305	43,851	52,909
Stone	do	37,537	62,787	[4] 37,715	[4] 61,814	42,263	66,969	45,002	72,900
Value of items that cannot be disclosed: Abrasive stone, gypsum, stone (calcareous marl 1964)		XX	1,742	XX	1,794	XX	2,163	XX	1,998
Total		XX	418,980	XX	454,937	XX	464,252	XX	488,040

OKLAHOMA

Clays [3]	thousand short tons	898	$911	835	$854	794	$806	745	$754
Coal (bituminous)	do	1,008	5,667	1,028	5,474	974	5,520	843	4,935
Gypsum	do	531	1,462	694	1,899	761	2,343	785	2,212
Helium, grade A	thousand cubic feet	[r] 300,400	[r] 10,514	298,803	8,591	[r] 310,700	[r] 10,874	352,400	12,333
Lead (recoverable content of ores, etc.)	short tons	3,192	689	2,781	729	2,813	878	2,999	907
Natural gas	million cubic feet	1,233,883	160,405	1,316,201	166,747	1,320,995	182,297	1,351,225	189,172
Natural gas liquids:									
Natural gasoline and cycle products	thousand gallons	555,467	35,131	554,053	34,011	570,129	34,561	576,124	35,715
LP gases	do	810,894	28,981	880,804	28,055	894,665	32,208	986,254	44,381
Petroleum (crude)	thousand 42-gallon barrels	201,962	587,709	202,524	587,320	203,441	587,944	224,839	654,281

See footnotes at end of table.

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

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
OKLAHOMA—Continued								
Salt thousand short tons	4	$26	6	$41	9	$65	W	W
Sand and gravel do	5,420	6,116	6,680	7,003	5,218	6,023	6,040	7,565
Stone do	13,817	16,160	13,987	15,087	16,417	18,071	15,334	17,393
Zinc (recoverable content of ores, etc.) short tons	13,245	3,046	12,159	3,307	12,715	3,713	11,237	3,259
Value of items that cannot be disclosed: Clay (bentonite), cement, copper (1965–66), lime, pumice, silver (1965–66), tripoli, and values indicated by symbol W	XX	22,929	XX	22,670	XX	23,953	XX	24,484
Total	XX	r 879,746	XX	881,788	XX	r 909,256	XX	997,391
OREGON								
Clays thousand short tons	279	$330	290	$356	291	$359	361	$362
Copper (recoverable content of ores, etc.) short tons	W	W	15	10	W	W	W	W
Diatomite do	150	3	W	W	W	W	W	W
Gem stones	NA	W	NA	W	NA	750	NA	750
Gold (recoverable content of ores, etc.) troy ounces	1,809	63	661	23	499	17	281	10
Lime thousand short tons	87	1,835	95	1,918	98	1,853	116	2,283
Mercury 76-pound flasks	W	W	126	40	1,364	779	700	309
Nickel (content of ore and concentrate) short tons	13,394	W	15,420	W	16,188	W	15,036	W
Peat do							900	17
Perlite do			5	(6)			W	W
Pumice thousand short tons	422	664	566	909	657	1,181	714	1,256
Sand and gravel do	15,715	18,850	18,253	25,158	21,800	32,849	35,327	34,986
Silver (recoverable content of ores, etc.) thousand troy ounces	58	74	14	19	9	11	(5)	(5)
Stone thousand short tons	19,692	24,197	16,120	19,296	21,212	27,301	33,288	48,335
Tungsten concentrate short tons, 60-percent WO_3 basis			1	1				
Uranium ore short tons	1,763	45	27	2				
Zinc (recoverable content of ores, etc.) do	3	1	W	W	W	W		
Value of items that cannot be disclosed: Cement, iron ore (pigment material 1963, 1965–66), lead (1963–65), vanadium (1964), and values indicated by symbol W	XX	16,630	XX	16,631	XX	r 17,866	XX	19,176
Total	XX	62,692	XX	64,363	XX	82,966	XX	107,484
PENNSYLVANIA								
Cement:								
Portland thousand 376-pound barrels	38,316	$118,203	37,663	$113,409	40,153	$116,925	40,004	$114,357
[illegible] thousand 280-pound barrels	2,510	6,611	2,818	7,594	3,006	7,991	2,960	7,860

Clays[illegible]thousand short tons	3,191	[illegible]4,717	3,187	15,814	3,394	17,697	3,293	17,033
Coal:								
Anthracite do	18,267	153,503	17,184	148,648	14,866	122,021	12,941	100,663
Bituminous do	71,501	350,085	76,531	388,218	80,308	407,267	81,443	425,168
Copper (recoverable content of ores, etc.) short tons	4,434	2,731	3,614	2,356	4,354	3,083	3,178	2,299
Gem stones	NA	4	NA	4	NA	4	NA	4
Lime thousand short tons	1,188	17,548	1,440	20,656	1,568	22,496	1,585	22,816
Natural gas million cubic feet	92,657	24,091	81,720	22,349	84,461	22,551	90,914	25,820
Natural gas liquids:								
Natural gasoline thousand gallons	1,311	78	1,138	64	1,022	55	3,211	186
LP gases do	1,721	118	1,481	100	1,683	109	1,863	121
Peat short tons	33,952	339	39,500	397	45,600	527	52,912	562
Petroleum (crude) thousand 42-gallon barrels	5,083	23,178	5,113	22,088	4,922	21,263	4,337	19,300
Sand and gravel thousand short tons	14,066	23,539	16,199	26,414	18,502	29,606	17,567	29,562
Stone do	49,536	83,450	52,829	91,075	56,806	99,627	59,088	99,233
Zinc (recoverable content of ores, etc.) [10] short tons	27,389	6,572	30,754	8,345	27,635	8,014	28,080	8,143
Value of items that cannot be disclosed: Clays (kaolin), cobalt, gold, iron ore, scrap mica, pyrites, pyrophyllite, silver, and tripoli	XX	32,644	XX	34,519	XX	34,587	XX	30,281
Total	XX	857,411	XX	902,050	XX	913,823	XX	903,408
RHODE ISLAND								
Sand and gravel thousand short tons	1,750	$1,838	1,647	$1,613	1,681	$1,811	2,276	$2,212
Stone do	442	968	450	935	437	1,119	535	1,734
Value of items that cannot be disclosed: Other nonmetals	XX	1	XX	1	XX	1	XX	1
Total	XX	2,807	XX	2,549	XX	2,931	XX	3,947
SOUTH CAROLINA								
Clays thousand short tons	1,491	$7,589	1,743	$8,309	1,837	$8,539	2,139	$8,830
Sand and gravel do	4,051	4,750	4,622	5,262	5,248	6,688	6,016	7,668
Stone do	7,262	10,926	[4] 6,109	[4] 9,176	[4] 5,948	[4] 8,447	8,129	12,510
Value of items that cannot be disclosed: Barite, cement, feldspar, gem stones (1963), kyanite, scrap mica, peat, pyrites, stone (crushed limestone 1964–65 and dimension granite 1965), and vermiculite	XX	13,214	XX	15,966	XX	17,587	XX	16,585
Total	XX	36,479	XX	38,713	XX	41,261	XX	45,593
SOUTH DAKOTA								
Beryllium concentrate short tons, gross weight	[5]	[5]	W	W	W	W	124	$40
Cement:								
Portland thousand 376-pound barrels	1,869	$5,909	2,001	$6,873	1,575	$5,127	1,974	6,367
Masonry thousand 280-pound barrels	60	198	57	200	55	180	51	170
Clays thousand short tons	240	960	245	1,076	223	1,220	231	870
Coal (lignite) do	16	62	13	63	10	49	10	45
Copper (recoverable content of ores, etc.) short tons	1	[5]	----------	----------	----------	----------	----------	----------

See footnotes at end of table.

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

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
SOUTH DAKOTA—Continued								
Feldspar—long tons	25,590	$157	26,980	$180	51,560	$346	83,950	$542
Gem stones	NA	20	NA	20	NA	20	NA	20
Gold (recoverable content of ores, etc.)—troy ounces	576,726	20,185	616,913	21,592	628,259	21,989	606,467	21,226
Gypsum—thousand short tons	24	97	19	76	7	27	17	68
Lead (recoverable content of ores, etc.)—short tons	4	1						
Lithium minerals—do	W	W	W	W	150	[6] 5	W	W
Mica:								
Scrap—do	W	W	996	32	W	W	W	W
Sheet—pounds	10,000	[5]						
Petroleum (crude)—thousand 42-gallon barrels	215	428	247	495	219	438	239	479
Sand and gravel—thousand short tons	20,806	16,313	13,770	13,641	13,998	14,155	13,630	13,585
Silver (recoverable content of ores, etc.) thousand troy ounces	117	150	133	172	129	167	110	142
Stone—thousand short tons	2,794	7,339	2,118	6,245	1,554	5,387	2,186	7,995
Uranium ore—short tons	72,088	1,931	110,147	1,551	44,738	303	W	W
Value of items that cannot be disclosed: Lime, molybdenum (1964–66), tin (1966), vanadium, and values indicated by symbol W	XX	366	XX	608	XX	762	XX	1,158
Total	XX	54,116	XX	52,824	XX	50,175	XX	52,707
TENNESSEE								
Barite—thousand short tons	24	$404	39	$519	31	$442	29	$412
Cement:								
Portland—thousand 376-pound barrels	8,283	26,760	8,343	26,791	8,724	27,535	8,177	25,718
Masonry—thousand 280-pound barrels	1,161	3,079	1,212	3,228	1,185	3,140	1,095	2,822
Clays—thousand short tons	[3] 1,238	[3] 5,248	[3] 1,310	[3] 5,576	1,495	6,103	[3] 1,359	[3] 4,909
Coal (bituminous)—do	6,121	22,689	5,990	22,674	5,865	20,930	6,309	23,763
Copper (recoverable content of ores, etc.)—short tons	13,717	8,450	13,889	9,056	14,823	10,495	15,410	11,148
Gem stones	NA	[5]						
Gold (recoverable content of ores, etc.)—troy ounces	137	5	133	5	122	4	141	5
Lead (recoverable content of ores, etc.)—short tons							181	55
Natural gas—million cubic feet	90	17	77	15	85	16		
Petroleum (crude)—thousand 42-gallon barrels	16	W	10	W	11	W	7	W
Phosphate rock—thousand short tons	2,634	17,876	2,734	18,971	2,954	22,296	3,125	23,886
Sand and gravel—do	7,613	9,443	7,972	10,245	8,193	10,690	8,628	11,142
Silver (recoverable content of ores, etc.) thousand troy ounces	108	138	91	117	94	122	101	130
Stone—thousand short tons	26,825	38,113	[4] 26,497	[4] 38,239	[4] 28,888	[4] 38,859	[4] 31,260	[4] 41,432
Zinc (recoverable content of ores, etc.)—short tons	95,847	22,045	115,943	31,536	122,387	35,737	103,117	29,904

Value of items that cannot be disclosed: Clay (fuller's earth) (1963–64, 1966), iron ore (1963), lime, pyrites, stone (crushed sandstone 1964–66), and values indicated by symbol W	XX	6,458	XX	6,993	XX	6,572	XX	7,258
Total	XX	160,725	XX	173,965	XX	182,941	XX	182,584
TEXAS								
Cement:								
Portland—thousand 376-pound barrels	29,104	$92,734	30,030	$94,492	30,820	$97,598	30,827	$97,188
Masonry—thousand 280-pound barrels	930	2,858	930	2,805	968	3,011	884	2,872
Clays—thousand short tons	[3] 4,199	[3] 6,849	[3] 4,156	[3] 6,695	4,469	6,865	4,516	7,187
Gem stones	NA	150	NA	140	NA	150	NA	150
Gypsum—thousand short tons	1,099	3,999	1,131	4,049	1,045	3,794	899	3,258
Helium: Crude—thousand cubic feet	679,400	6,997	1,026,504	10,381	1,015,708	10,330	1,030,500	10,605
Grade A—do	349,100	12,218	358,747	11,107	350,000	12,250	364,100	12,744
Lime—thousand short tons	1,131	13,026	1,350	17,201	1,338	19,663	1,473	18,696
Natural gas—million cubic feet	6,205,034	775,629	6,490,202	809,180	6,636,555	858,396	6,953,790	903,993
Natural gas liquids:								
Natural gasoline and cycle products—thousand gallons	3,320,416	218,975	3,512,460	232,245	3,772,471	256,959	3,890,267	269,332
LP gases—do	5,366,831	169,695	5,521,236	167,492	5,847,601	204,666	6,359,870	260,755
Perlite—short tons	----------	----------	300	3	1,000	8	W	W
Petroleum (crude)—thousand 42-gallon barrels	977,835	2,908,380	989,525	2,928,994	1,000,749	2,962,119	1,057,706	3,141,387
Salt—thousand short tons	5,965	22,355	6,410	28,797	6,964	30,771	7,724	33,797
Sand and gravel—do	33,256	36,311	29,155	33,394	32,649	36,075	26,222	31,313
Stone—do	43,142	54,007	40,240	52,070	39,520	53,659	43,578	56,659
Sulfur (Frasch process)—thousand long tons	2,550	50,109	3,302	65,780	3,674	[r] 83,282	3,703	96,820
Talc and soapstone—short tons	72,658	368	89,334	395	64,211	204	102,399	367
Values of items that cannot be disclosed: Native asphalt, barite, bromine, clays (fuller's earth 1963–65, kaolin 1964), coal (lignite), graphite, iron ore, magnesium chloride (for metal), magnesium compounds (except for metal), mercury (1965–66), pumice, sodium sulfate, uranium ore, and values indicated by symbol W	XX	62,777	XX	83,604	XX	[r] 78,328	XX	72,627
Total	XX	[r] 4,437,437	XX	4,548,824	XX	[r] 4,718,128	XX	5,019,750
UTAH								
Carbon dioxide, natural—thousand cubic feet	100,895	$7	96,432	$7	86,201	$6	94,006	$7
Clays [3]—thousand short tons	125	470	127	330	149	332	89	252
Coal (bituminous)—do	4,360	22,755	4,720	33,184	4,992	31,811	4,635	26,763
Copper (recoverable content of ores, etc.)—short tons	203,095	125,107	199,588	130,131	259,138	183,470	265,383	191,978
Fluorspar—short tons	247	7	W	W	W	W	W	W
Gem stones	NA	75	NA	75	NA	75	NA	75
Gold (recoverable content of ores, etc.)—troy ounces	285,907	10,007	287,674	10,069	426,299	14,921	438,736	15,356
Iron ore (usable)—thousand long tons, gross weight	1,881	12,900	2,082	14,306	2,139	14,229	1,956	13,478
Lead (recoverable content of ores, etc.)—short tons	45,028	9,726	40,249	10,545	37,700	11,762	64,124	19,385
Lime—thousand short tons	156	2,668	163	2,917	189	3,470	200	3,640
Natural gas—million cubic feet	77,122	14,036	79,739	10,904	71,616	8,952	69,366	8,809
Perlite—short tons	1,313	7	2,003	12	W	W	W	W
Petroleum (crude)—thousand 42-gallon barrels	33,435	90,943	28,575	74,867	25,298	66,045	24,112	63,760
Pumice—thousand short tons	28	46	W	W	W	W	W	W

See footnotes at end of table.

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

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
UTAH—Continued								
Salt thousand short tons	325	$3,462	371	$3,848	384	$3,591	427	$3,770
Sand and gravel do	11,709	10,408	10,218	10,405	10,032	10,464	12,368	12,937
Silver (recoverable content of ores, etc.) thousand troy ounces	4,791	6,128	4,552	5,886	5,636	7,287	7,755	10,028
Stone thousand short tons	2,346	4,040	3,105	6,930	r 2,328	r 4,765	2,246	4,269
Sulfur ore long tons, gross weight	---	---	---	---	2,156	3	---	---
Uranium ore short tons	743,792	23,852	761,180	26,385	377,989	9,014	236,860	5,169
Vanadium (recoverable in ore and concentrate) do	382	W	405	1,214	387	1,353	353	1,519
Zinc (recoverable content of ores, etc.) do	36,179	8,321	31,428	8,548	27,747	8,102	37,323	10,824
Value of items that cannot be disclosed: Asphalt (gilsonite), beryllium (1963), cement, clays (fire clay, kaolin 1965–66), gypsum, magnesium chloride for metal (1966), molybdenum, natural gas liquids, phosphate rock, potassium salts, pyrites (1966), and values indicated by symbol W	XX	40,458	XX	40,867	XX	51,939	XX	52,243
Total	XX	385,423	XX	391,430	XX	r 431,591	XX	444,262
VERMONT								
Peat short tons	---	---	286	$4	780	$3	333	$5
Sand and gravel thousand short tons	2,375	$1,410	1,764	1,494	2,084	1,670	2,323	1,744
Stone do	2,159	19,193	2,070	20,652	2,591	21,564	2,650	19,926
Value of items that cannot be disclosed: Asbestos, clays, gem stones, lime, and talc	XX	3,788	XX	3,977	XX	4,155	XX	4,235
Total	XX	24,391	XX	26,127	XX	27,392	XX	25,910
VIRGINIA								
Clays thousand short tons	1,410	$1,558	1,440	$1,614	1,415	$1,657	1,486	$1,813
Coal (bituminous) do	30,531	120,972	31,654	123,123	34,053	139,291	35,565	153,341
Gem stones	NA	6	NA	6	NA	7	NA	7
Lead (recoverable content of ores, etc.) short tons	3,500	756	3,857	1,010	3,651	1,139	3,078	930
Lime thousand short tons	639	8,058	780	9,781	847	10,584	840	10,486
Natural gas million cubic feet	2,085	488	1,600	479	3,152	942	4,249	1,275
Petroleum (crude) thousand 42-gallon barrels	3	W	6	W	4	W	1	W
Sand and gravel thousand short tons	10,400	17,752	10,588	13,722	15,322	18,019	17,191	16,635
Soapstone short tons	3,696	9	3,775	9	3,549	9	3,989	10
Stone thousand short tons	27,653	45,529	30,407	52,153	36,350	59,397	34,151	55,550
Zinc (recoverable content of ores, etc.) [10] short tons	23,988	5,725	21,004	5,700	20,491	5,942	17,666	5,123
Value of items that cannot be disclosed: Cement, feldspar, gypsum, iron ore (pigment materials), kyanite, salt, titanium concentrate, and values indicated by symbol W	XX	28,211	XX	29,818	XX	30,990	XX	29,127
Total	XX	229,064	XX	237,415	XX	267,977	XX	274,297

WASHINGTON

Barite—thousand short tons					[5]	$1		
Carbon dioxide—thousand cubic feet	W	W	W	W	11,848	3	W	W
Cement:								
Portland—thousand 376-pound barrels	W	W	W	W	6,258	22,351	6,820	$24,340
Masonry—thousand 280-pound barrels	W	W	W	W	62	201	60	187
Clay [3]—thousand short tons	134	$123	128	$119	162	211	185	249
Coal (bituminous)—do	190	1,380	68	575	55	497	59	514
Copper (recoverable content of ores, etc.)—short tons	W	W	35	23	30	21	34	25
Gem stones	NA	W	NA	W	NA	75	NA	75
Lead (recoverable content of ores, etc.)—short tons	5,374	1,161	5,731	1,502	6,328	1,974	5,859	1,771
Peat—do	37,248	188	35,609	170	29,729	131	25,599	136
Sand and gravel—thousand short tons	22,760	20,490	31,920	25,971	31,301	27,234	29,002	26,806
Stone—do	12,934	16,346	10,498	15,204	12,461	17,446	13,250	20,273
Talc and soapstone—short tons	2,969	18	2,680	18	2,861	17	3,880	22
Uranium ore—do	117,286	2,545	147,005	3,601	73,495	1,871	W	W
Zinc (recoverable content of ores, etc.)—do	22,270	5,122	24,296	6,609	22,230	6,491	24,772	7,184
Value of items that cannot be disclosed: Abrasive stones (1963), clays (fire clay, bentonite 1965), diatomite, epsom salts (1963), gold, gypsum (1966), lime, pumice, magnesite, mercury (1965), olivine, silver, tungsten (1965), vanadium (1966), and values indicated by symbol W	XX	24,057	XX	27,518	XX	[r] 7,648	XX	7,510
Total	XX	71,430	XX	81,310	XX	86,172	XX	89,092

WEST VIRGINIA

Clays—thousand short tons	414	$2,044	[3] 261	[3] $309	[3] 289	[3] $328	[3] 300	[3] $334
Coal (bituminous)—do	132,568	634,794	141,409	693,572	149,191	726,096	149,681	753,851
Lime—do	W	W	W	W	W	W	240	3,492
Natural gas—million cubic feet	210,223	55,919	202,765	50,968	207,416	48,743	211,610	49,940
Petroleum (crude)—thousand 42-gallon barrels	3,350	13,367	3,370	12,975	3,530	13,591	3,674	14,623
Salt—thousand short tons	W	W	1,033	3,666	1,153	5,539	1,147	5,446
Sand and gravel—do	4,808	10,578	5,472	11,555	5,253	11,480	5,448	11,569
Stone [4]—do	9,452	14,489	7,481	13,105	8,482	14,587	9,738	16,354
Value of items that cannot be disclosed: Calcium-magnesium chloride, cement, clay (fire clay 1964–66), gem stones, natural gas liquids, stone (dimension sandstone) and values indicated by symbol W	XX	37,051	XX	36,541	XX	39,240	XX	36,191
Total	XX	768,242	XX	822,691	XX	859,604	XX	891,800

WISCONSIN

Abrasive stones—short tons	[11] 561	[11] $21	W	W	W	W		
Clays—thousand short tons	111	140	119	$147	119	$147	123	$148
Iron ore (usable)—thousand long tons, gross weight	938	W	524	W	141	W		
Lead (recoverable content of ores, etc.)—short tons	1,116	241	1,742	456	1,645	513	1,694	512
Lime—thousand short tons	W	W	W	W	197	3,076	204	3,186
Peat—short tons	2,667	136	3,261	136	3,090	122	2,379	164
Sand and gravel—thousand short tons	35,363	24,863	34,348	24,695	38,751	27,707	41,523	30,713

See footnotes at end of table.

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

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
WISCONSIN—Continued								
Stone—thousand short tons	13,583	$18,744	13,901	$20,232	15,344	$21,924	16,150	$23,73[5]
Zinc (recoverable content of ores, etc.)—short tons	15,114	3,476	26,278	7,148	26,993	7,882	24,775	7,18[5]
Value of items that cannot be disclosed: Abrasive stones (tube-mill liners, 1963–66), cement, gem stones, and values indicated by symbol W	XX	19,220	XX	17,193	XX	11,628	XX	10,367
Total	XX	66,841	XX	70,007	XX	72,999	XX	76,010
WYOMING								
Clays—thousand short tons	1,187	$12,385	1,271	$12,816	1,352	$13,633	1,559	$15,874
Coal (bituminous)—do	3,124	9,922	3,101	9,774	3,260	10,150	3,670	11,840
Copper (recoverable content of ores, etc.)—short tons	----------	----------	5	3	6	4	----------	----------
Gem stones	NA	110	NA	120	NA	120	NA	120
Gold (recoverable content of ores, etc.)—troy ounces	4	(5)	6	(5)	3	(5)	----------	----------
Iron ore (usable)—thousand long tons, gross weight	1,604	17,504	2,056	24,543	2,087	25,198	1,978	19,700
Natural gas—million cubic feet	209,060	29,687	231,613	29,808	235,849	31,840	243,381	35,290
Natural gas liquids:								
Natural gasoline—thousand gallons	86,014	5,523	86,803	5,607	95,093	6,195	96,372	6,281
LP gases—do	150,437	6,203	152,982	6,433	143,331	6,020	166,080	7,308
Petroleum (crude)—thousand 42-gallon barrels	144,407	361,018	138,752	351,043	138,314	345,785	134,470	344,243
Sand and gravel—do	7,901	7,874	5,632	5,936	7,996	8,373	7,187	7,496
Stone—do	1,940	2,991	2,154	3,671	1,594	2,791	1,393	2,560
Uranium ore—short tons	r 1,141,069	r 23,248	1,183,754	23,321	1,048,176	17,758	1,082,197	18,160
Vanadium (recoverable in ore and concentrate)—do	W	435	W	359	W	444	W	555
Value of items that cannot be disclosed: Beryllium concentrate (1963–65), cement, feldspar (1965–66), gypsum, lime, phosphate rock, pumice (1963–64), silver (1964–65), sodium carbonates and sulfates, vermiculite (1963), and values indicated by symbol W	XX	24,736	XX	26,822	XX	30,241	XX	36,379
Total	XX	r 501,636	XX	500,256	XX	498,552	XX	505,806

e Estimate. r Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes certain cement, included with "Value of items that cannot be disclosed."
[3] Excludes certain clays, included with "Value of items that cannot be disclosed."
[4] Excludes certain stone, included with "Value of items that cannot be disclosed."
[5] Less than ½ unit.
[6] Includes 750 tons of low-grade beryllium ore in 1963.
[7] Excludes shipments from Nye Metals, Inc., included with "Value of items that cannot be disclosed."

[8] Final figure, supersedes figure given in commodity section.
[9] Excludes salt in brine, included with "Value of items that cannot be disclosed."
[10] Recoverable zinc valued at the 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 mine.
[11] Grinding pebbles: tube-mill liners included with "Value of items that cannot be disclosed."

Table 6.—Mineral production [1] in the Canal Zone and islands administered by the United States[2]

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
American Samoa:								
Pumice thousand short tons							17	$22
Sand and gravel do	77	$193	22	$20	60	$55	20	18
Stone do	944	2,351	157	234	60	60	12	12
Total	XX	2,544	XX	254	XX	115	XX	52
Canal Zone:								
Sand and gravel thousand short tons	84	87	84	82	83	85	72	91
Stone (crushed) do	162	281	153	349	153	366	114	267
Total	XX	368	XX	431	XX	451	XX	358
Canton: Stone (crushed) thousand short tons	2	6						
Guam: Stone do	307	439	469	868	483	925	900	1,396
Virgin Islands: Stone (crushed) do	66	329	69	342	68	302	88	303
Wake: Stone (crushed) do	9	51	2	5	1	4	11	66

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Production data for Canton and Wake furnished by U.S. Department of Commerce, Civil Aeronautics Administration; Guam, by the Government of Guam: American Samoa, by the Government of American Samoa.

Table 7.—Mineral production [1] in the Commonwealth of Puerto Rico

Mineral	1963		1964		1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement thousand 376-pound barrels	7,217	$22,090	7,926	$23,879	7,284	$23,415	7,603	$24,277
Clays thousand short tons	200	158	341	271	357	288	350	271
Lime do	4	103	18	574	27	867	30	960
Salt do	8	131	5	74	8	138	11	183
Sand and gravel do	7,616	10,407	7,816	11,492	8,147	12,405	9,879	14,554
Stone do	5,334	8,237	5,504	8,586	5,344	9,111	5,732	10,541
Total	XX	41,126	XX	44,876	XX	46,224	XX	50,786

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Metals:				
Aluminum:				
Ingots, slabs, crude—short tons	203,642	$92,533	188,240	$90,012
Scrap—do	38,547	12,452	48,666	16,239
Plates, sheets, bars, etc—do	r 66,528	r 52,090	86,396	71,272
Castings and forgings—do	2,256	6,669	2,524	8,592
Antimony: Metals and alloys, crude—do	14	18	29	24
Bauxite, including bauxite concentrates—thousand long tons	147	10,736	62	4,275
Aluminum sulfate—short tons	15,641	501	22,059	652
Other aluminum compounds—do	r 336,590	31,430	353,864	37,374
Beryllium—pounds	119,761	624	61,254	1,083
Bismuth: Metals and alloys—do	341,868	940	89,382	226
Cadmium—thousand pounds	73	195	379	795
Chrome:				
Ore and concentrate:				
Exports—thousand short tons	7	285	19	740
Reexports—do	95	3,719	173	7,119
Chromic acid—do	1	574	1	482
Ferrochrome—do	12	3,021	4	1,870
Cobalt—thousand pounds	1,441	2,097	1,021	1,822
Columbium metals, alloys and other forms—thousand pounds	4	177	7	249
Copper:				
Ore, concentrate, composition metal and unrefined copper (copper content)—short tons	15,510	8,369	2,149	927
Refined copper and semimanufactures—do	379,498	317,338	319,314	338,184
Other copper manufactures—do	r 6,796	r 7,062	6,934	7,804
Copper sulfate or blue vitriol—do	2,135	1,288	3,563	1,725
Copper base alloys—do	80,049	70,116	56,311	60,069
Ferroalloys:				
Ferrosilicon—do	4,585	1,755	5,812	2,004
Ferrophosphorous—do	79,910	2,914	62,942	2,975
Gold:				
Ore and base bullion—troy ounces	49,836	1,744	49,117	1,719
Bullion, refined—do	36,667,207	1,283,352	13,017,549	455,614
Iron ore—thousand long tons	7,085	80,418	7,779	92,157
Iron and steel: Pig iron—short tons	28,225	1,665	12,122	731
Iron and steel products (major):				
Semimanufactures—do	r 2,155,991	r 381,880	1,375,884	282,130
Manufactured steel mill products—do	r 731,834	r 347,758	768,990	390,168
Advanced products—do	NA	r 99,623	NA	120,435
Iron and steel scrap: Ferrous scrap, including rerolling materials—short tons	6,248,728	199,745	5,880,925	177,461
Lead:				
Pigs, bars, anodes—do	7,811	3,714	5,435	3,966
Scrap—do	3,793	757	498	165
Magnesium:				
Metal and alloys and semimanufactured forms, n.e.c—short tons	18,320	11,525	15,448	10,240
Manganese:				
Ore and concentrate—do	14,150	1,387	16,487	1,491
Ferromanganese—do	3,273	727	545	228
Mercury:				
Exports—76-pound flasks	7,543	5,031	357	197
Reexports—do	494	316	476	280
Molybdenum:				
Ore and concentrates (molybdenum content)—thousand pounds	24,096	44,282	29,768	54,765
Metals and alloys, crude and scrap—do	111	414	59	251
Wire—do	23	631	19	624
Semifabricated forms, n.e.c—do	66	516	72	398
Powder—do	603	2,095	120	502
Ferromolybdenum—do	r 2,229	r 4,983	2,200	4,085
Nickel:				
Alloys and scrap (including Monel metal), ingots, bars, sheets, etc—short tons	r 16,553	26,437	21,435	38,597
Catalysts—do	2,547	r 6,064	3,135	6,589
Nickel-chrome electric resistance wire—do	380	1,914	475	2,203
Semifabricated forms, n.e.c—do	1,455	r 6,119	1,319	4,661
Platinum:				
Ore, concentrate, metal and alloys in ingots, bars, sheets, anodes, and other forms, including scrap—troy ounces	72,925	9,838	102,031	13,414

See footnotes at end of table.

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

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals—Continued				
Platinum—Continued				
Palladium, rhodium, iridium, osmiridium, ruthenium, and osmium (metal and alloys including scrap)—troy ounces	30,172	3,758	103,425	6,711
Platinum group manufactures, except jewelry	NA	2,515	NA	3,794
Rare earths:				
Cerium ore, metal, alloys and lighter flints—pounds	54,151	221	61,620	209
Silver:				
Ore and base bullion—thousand troy ounces	537	697	369	476
Bullion, refined—do	39,128	50,727	85,169	110,057
Tantalum:				
Ore, metal, and other forms—thousand pounds	305	1,656	198	1,798
Powder—do	25	757	51	1,564
Tin:				
Ingots, pigs, bars, etc:				
Exports—long tons	2,605	10,078	1,866	6,985
Reexports—do	224	880	981	3,849
Tin scrap and other tin-bearing material except tinplate scrap—long tons	1,354	1,220	7,233	1,957
Titanium:				
Ore and concentrate—short tons	1,201	203	1,300	213
Sponge (including iodide titanium) and scrap—do	2,132	2,070	1,733	1,988
Intermediate mill shapes—do	605	5,144	1,371	9,585
Mill products, n.e.c—do				
Dioxide and pigments—do	26,896	7,249	26,872	7,601
Tungsten: Ore and concentrate:				
Exports—do	11	18	98	223
Reexports—do	r 130	181	195	557
Vanadium ore and concentrate, pentoxide, etc. (vanadium content)—thousand pounds	1,856	3,540	1,771	4,226
Zinc:				
Slabs, pigs, or blocks—short tons	5,939	1,765	1,406	749
Sheets, plates, strips, or other forms n.e.c—do	5,120	3,051	4,921	3,198
Scrap (zinc content)—do	5,617	1,153	4,469	702
Semifabricated forms, n.e.c—do	2,764	1,931	1,768	1,207
Zirconium:				
Ore and concentrate—do	1,761	287	2,311	326
Metals and alloys and other forms—pounds	213,326	1,933	421,516	4,567
Nonmetals:				
Abrasives:				
Dust and powder of precious or semi-precious stones, including diamond dust and powder—thousand carats	1,148	3,268	2,403	6,815
Crushing bort—do	2,003	7,317	58	325
Industrial diamonds—do			1,097	4,470
Diamond grinding wheels—do	383	3,053	436	3,331
Other natural and artificial, metallic abrasives and products	NA	36,780	NA	36,812
Asbestos: Unmanufactured:				
Exports—short tons	42,995	r 5,271	46,690	5,712
Reexports—do	131	23	306	51
Boron: Boric acid, borates, crude and refined—do	174,016	16,922	207,359	20,682
Cement—thousand 376-pounds barrels	748	4,288	1,069	4,836
Clays:				
Kaolin or china clay—short tons	192,875	6,244	253,408	8,443
Fire clay—do	182,446	3,667	215,534	3,396
Other clays—do	474,443	15,828	605,625	19,354
Fluorspar—do	r 9,385	r 315	5,732	301
Graphite—do	3,196	419	3,161	428
Gypsum:				
Crude, crushed or calcined—thousand short tons	28	1,112	38	1,458
Manufactures, n.e.c	NA	920	NA	1,216
Kyanite and allied minerals—short tons	10,238	732	17,339	1,131
Lime—do	40,036	942	59,848	1,195
Mica sheet, waste and scrap and ground—pounds	7,802,539	589	10,810,194	929
Manufactured—do	523,338	1,635	537,556	1,612
Mineral-earth pigments: Iron oxide, natural and manufactured—short tons	4,656	1,380	4,753	1,307

See footnotes at end of table.

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

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Nonmetals—Continued				
Nitrogen compounds (major) thousand short tons	1,638	88,421	2,794	154,559
Phosphate rock do	r 7,474	r 66,558	9,255	85,335
Phosphatic fertilizers (superphosphates) do	r 631	r 32,147	763	40,705
Pigments and compounds (lead and zinc):				
Lead pigments short tons	2,286	890	2,599	1,044
Zinc pigments do	3,269	1,005	6,650	1,733
Potash:				
Fertilizer do	1,052,305	33,809	1,024,996	32,867
Chemical do	46,289	8,685	28,489	5,292
Quartz, natural, quartzite, cryolite, and chiolite do	4,362	848	2,779	472
Salt:				
Crude and refined thousand short tons	688	4,285	662	4,472
Shipments to noncontiguous Territories do	16	1,263	10	805
Sodium and sodium compounds:				
Sodium sulfate do	13	415	28	779
Sodium carbonate do	277	9,030	346	12,249
Stone:				
Dolomite, block do	253	2,032	101	1,692
Limestone, crushed, ground, broken do	1,165	2,905	1,207	3,500
Marble and other building and monumental thousand cubic feet	r 264	r 1,259	NA	1,104
Stone, crushed, ground, broken thousand short tons	73	1,955	276	3,406
Manufactures of stone	NA	1,480	NA	1,432
Sulfur:				
Crude thousand long tons	2,624	64,278	2,326	78,759
Crushed, ground, flowers of do	r 11	1,271	47	3,404
Talc, crude and ground short tons	69,597	3,486	70,377	3,917
Mineral fuels:				
Carbon black thousand pounds	274,608	26,658	297,281	28,407
Coal:				
Anthracite thousand short tons	851	11,488	766	9,755
Bituminous do	50,181	465,314	49,302	457,899
Briquets do	89	1,149	120	2,182
Coke do	834	16,307	1,102	23,415
Petroleum:				
Crude thousand barrels	1,004	2,841	1,478	4,130
Gasoline do	3,820	24,371	2,369	14,274
Jet do	154	621	118	548
Naphtha do	1,545	16,842	1,982	22,232
Kerosine do	166	1,275	249	2,214
Distillate oil do	5,042	17,576	6,251	18,407
Residual oil do	r 15,052	r 34,141	13,275	29,102
Lubricating oil do	14,191	165,135	14,767	189,648
Asphalt do	r 356	r 3,029	434	3,705
Liquefied petroleum gases do	7,511	27,231	8,171	30,007
Wax do	r 1,650	r 30,110	1,877	36,028
Coke do	13,263	42,027	16,235	49,604
Petrochemical feedstocks do	1,944	11,700	2,698	14,894
Miscellaneous do	1,333	20,086	1,357	37,074

rRevised. NA Not available.

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

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Metals:				
Aluminum:				
Metal—short tons	r 525,021	r $217,244	520,938	$216,977
Scrap—do	27,029	8,482	33,616	10,782
Plates, sheets, bars, etc—do	r 68,235	r 39,833	124,106	76,887
Antimony:				
Ore (antimony content)—do	10,360	4,310	12,460	4,754
Needle or liquated—do	23	18	63	42
Metal—do	2,650	2,112	2,767	2,031
Oxide—do	2,173	1,798	5,383	3,998
Arsenic: White (As_2O_3 content)—do	15,525	1,271	18,675	1,477
Bauxite: Crude—thousand long tons	r 11,199	142,989	11,529	147,335
Beryllium ore—short tons	7,791	2,056	2,147	581
Bismuth (general imports)—pounds	1,378,147	3,506	1,681,472	6,243
Boron carbide—do	13,801	48	183,321	513
Cadmium:				
Metal—thousand pounds	2,121	r 4,668	3,358	6,813
Flue dust (cadmium content)—do	1,531	1,521	1,181	989
Calcium:				
Metal—pounds	28,219	28	85,941	72
Chloride—short tons	3,658	100	2,477	76
Chromate:				
Ore and concentrate (Cr_2O_3 content) thousand short tons	685	25,239	841	30,379
Ferrochrome (chromium content)—do	r 36	13,236	66	22,076
Metal—do	1	1,522	2	3,739
Cobalt:				
Metal—thousand pounds	14,846	23,132	17,871	27,734
Oxide (gross weight)—do	947	1,011	1,279	1,411
Salts and compounds (gross weight)—do	r 186	r 179	150	81
Columbium ore—do	4,892	2,712	9,278	5,678
Copper: (copper content)				
Ore and concentrates—short tons	1,441	777	6,843	4,118
Regulus, black, coarse—do	83	72	117	85
Unrefined, black, blister—do	75,122	45,262	337,955	272,996
Refined in ingots, etc—do	103,269	70,937	77,783	63,654
Old and scrap—do	r 17,667	r 7,203	23,908	24,662
Old and clippings—do	1,490	1,151	5,056	5,846
Ferroalloys: Ferrosilicon (silicon content)—do	4,558	1,606	13,133	4,610
Gold:				
Ore and base bullion—troy ounces	292,167	10,199	333,119	11,698
Bullion—do	2,613,161	91,469	866,926	30,306
Iron ore—thousand long tons	45,103	443,788	46,259	462,354
Iron and steel:				
Pig iron—short tons	882,095	38,438	1,186,739	45,914
Iron and steel products (major):				
Iron products—do	45,038	15,013	36,452	7,776
Steel products—do	r 10,594,576	r 1,228,370	11,007,018	1,273,730
Scrap—do	193,482	6,999	390,205	7,672
Tinplate—do	18,988	451	16,450	535
Lead:				
Ore, flue dust, matte (lead content)—do	128,933	26,923	63,850	13,871
Base bullion (lead content)—do	566	380	1,928	575
Pigs and bars (lead content)—do	r 223,461	r 60,924	285,788	75,312
Reclaimed, scrap, etc. (lead content)—do	3,612	793	3,956	886
Sheets, pipe, and shot—do	880	273	919	283
Babbitt metal and solder (lead content) do	986	8,129	731	3,203
Manufactures—do	512	329	1,087	277
Magnesium:				
Metallic and scrap—do	2,551	1,101	3,265	1,613
Alloys (magnesium content)—do	327	760	689	1,656
Sheets, tubing, ribbons, wire and other forms (magnesium content)—do	103	128	5	36
Manganese:				
Ore (35 percent or more manganese) manganese content)—do	1,825,709	109,747	1,261,490	77,047
Ferromanganese (manganese content)—do	198,118	31,486	194,563	32,261
Mercury:				
Compounds—pounds	47,808	186	16,340	94
Metal—76-pound flasks	16,238	7,614	31,364	12,322
Minor metals: Selenium and salts—pounds	250,912	1,244	285,776	1,834
Nickel:				
Pigs, ingots, shot, cathodes—short tons	r 132,559	r 202,822	112,836	170,726
Scrap—do	r 1,163	r 873	941	709
Oxide—do	r 13,600	r 14,990	7,711	7,967

See footnotes at end of table.

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

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Metals—Continued				
Platinum group:				
Unrefined materials:				
Grains and nuggets, including crude, dust and residues—troy ounces	r 57,696	r 6,112	86,700	9,498
Sponge and scrap—do	4	(1)	851	86
Osmiridium—do	3,988	228	4,910	440
Refined metal:				
Platinum—do	r 317,000	r 32,448	272,482	31,655
Palladium—do	734,881	22,381	985,137	28,010
Iridium—do	10,839	943	8,161	1,130
Osmium—do	269	88	751	292
Rhodium—do	39,768	6,762	65,861	11,984
Ruthenium—do	8,198	307	10,164	385
Radium:				
Radioactive substitutes	NA	2,816	NA	2,104
Rare earths: Ferrocerium and other cerium alloys—pounds	7,916	36	13,903	65
Silver:				
Ore and base bullion—thousand troy ounces	47,831	56,065	35,992	43,601
Bullion—do	6,878	6,838	27,040	32,586
Tantalum: Ore—thousand pounds	1,196	2,150	2,143	4,782
Tin:				
Ore (tin content)—long tons	4,326	13,228	4,372	12,467
Blocks, pigs, grains, etc—do	40,816	159,506	41,699	152,761
Dross, skimmings, scrap, residues, and tin alloys, n.s.p.f—long tons	502	883	108	124
Tinfoil, powder, flitters, etc	NA	261	NA	251
Titanium:				
Ilmenite—short tons	r 166,315	r 4,771	186,539	6,698
Rutile—do	r 151,748	r 10,114	151,482	8,494
Metal—pounds	6,497,792	6,118	11,959,375	10,854
Ferrotitanium—do	33,919	12	60,461	21
Compounds and mixtures—do	99,503,628	18,259	96,465,373	17,495
Tungsten: (tungsten content)				
Ore and concentrate—thousand pounds	r 3,604	3,886	4,298	6,859
Metal—do	r 62	r 186	335	656
Ferrotungsten—do	386	404	379	696
Other alloys—pounds	43,890	117	75,227	227
Zinc:				
Ore (zinc content)—short tons	402,936	53,829	396,375	51,696
Blocks, pigs, and slabs—do	r 153,957	r 42,605	280,307	75,624
Sheets—do	1,381	453	1,708	670
Old, dross, and skimmings—do	4,701	1,004	6,563	1,295
Dust—do	244	57	1,286	398
Manufactures	NA	r 481	NA	545
Zirconium: Ore, including zirconium sand—short tons	58,873	1,690	57,976	1,652
Nonmetals:				
Abrasives: Diamonds (industrial)—thousand carats	r 12,992	r 55,678	18,569	69,110
Asbestos—short tons	719,559	70,457	726,459	73,100
Barite:				
Crude and ground—do	712,713	r 5,563	699,045	5,766
Witherite—do	r 2,569	112	2,138	100
Chemicals—do	r 4,205	565	6,552	927
Cement—thousand 376-pounds barrels	5,505	13,523	7,066	17,846
Clays:				
Raw—short tons	93,045	1,970	132,336	2,644
Manufactured—do	4,826	168	6,359	238
Cryolite—do	24,011	2,009	31,655	3,199
Feldspar: Crude—long tons	16	2	-----	-----
Fluorspar—short tons	816,546	19,958	878,546	21,968
Gem stones:				
Diamonds—thousand carats	3,160	307,285	3,485	373,776
Emeralds—do	190	5,397	220	6,025
Other	NA	r 41,167	NA	46,937
Graphite—short tons	58,056	2,387	56,748	2,545
Gypsum:				
Crude, ground, calcined—thousand short tons	5,912	11,913	5,481	15,852
Manufactures	NA	1,415	NA	1,429
Iodine, crude—thousand pounds	2,847	2,476	7,133	5,934
Kyanite—short tons	4,047	167	3,405	141

See footnotes at end of table.

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

Mineral		1965		1966	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Nonmetals—Continued					
Lime:					
Hydrated	short tons	532	10	203	5
Other	do	215,816	2,590	151,703	1,772
Dead-burned dolomite [1]	do	59,519	2,385	43,637	2,038
Magnesium:					
Magnesite	do	r 139,172	r 7,192	186,200	10,941
Compounds	do	12,008	546	11,864	542
Mica:					
Uncut sheet and punch	thousand pounds	2,116	2,142	3,247	3,993
Scrap	do	r 3,043	71	2,642	71
Manufactures	do	r 9,942	r 6,541	7,535	6,670
Mineral-earth pigments: Iron oxide pigments:					
Natural	short tons	2,978	155	3,662	200
Synthetic	do	10,071	1,748	15,234	2,626
Ocher, crude and refined	do	186	14	146	8
Siennas, crude and refined	do	1,025	105	1,192	145
Umber, crude and refined	do	3,195	118	3,762	135
Vandyke brown	do	296	25	554	49
Nitrogen compounds (major), including urea	thousand short tons	1,512	71,743	1,561	75,974
Phosphate, crude	do	148	2,980	178	4,256
Phosphatic fertilizers	do	58	3,139	67	3,740
Pigments and salts:					
Lead pigments and compounds	short tons	24,571	6,133	30,497	7,353
Zinc pigments and compounds	do	17,731	3,482	18,649	3,633
Potash	do	1,866,750	52,675	2,539,112	71,943
Pumice:					
Crude or unmanufactured	do	r 9,956	99	9,393	91
Wholly or partly manufactured	do	180,768	509	273,338	723
Manufactures, n.s.p.f		NA	27	NA	25
Quartz crystal (Brazillian pebble)	pounds	1,181,753	1,083	1,470,341	896
Salt	thousand short tons	2,410	6,505	2,479	6,464
Sand and gravel:					
Glass sand	do	11	39	18	95
Other sand and gravel	do	678	840	631	811
Sodium sulfate	do	273	4,763	237	3,981
Stone and whiting		NA	20,414	NA	20,739
Strontium: Mineral	short tons	9,741	221	11,517	267
Sulfur and pyrites:					
Sulfur:					
Ores and other forms, n.e.s	thousand long tons	r 1,486	r 27,298	1,514	33,525
Pyrites	do	14	76	16	84
Talc: Unmanufactured	short tons	21,022	r 867	21,908	834
Mineral fuels:					
Carbon black:					
Acetylene	pounds	6,359,080	1,094	7,058,926	1,185
Gas black and carbon black	do	r 186,068	36	385,381	61
Coal:					
Bituminous, slack, culm, and lignite	short tons	184,399	1,564	177,672	1,654
Briquets	do	12,621	205	10,856	163
Coke	do	89,620	1,379	95,761	1,790
Peat:					
Fertilizer grade	do	271,466	11,748	289,823	11,416
Poultry and stable grade	do	3,996	220	4,020	199
Petroleum	thousand barrels	r 900,772	r 2,148,595	939,162	2,206,606

r Revised.
NA Not available.
[1] Dead-burned basic refractory material consisting chiefly of magnesia and lime.

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

Mineral	1965			1966 p		
	World	United States		World	United States	
	Thousand short tons (unless otherwise stated)		Percent of world	Thousand short tons (unless otherwise stated)		Percent of world
Mineral fuels:						
Carbon black thousand pounds	NA	2,353,776	NA	NA	2,571,552	NA
Coal:						
Bituminous	r 2,059,588	509,045	25	2,106,089	530,001	25
Lignite	r 815,720	3,043	(1)	819,636	3,881	(1)
Pennsylvania anthracite	r 213,400	14,866	r 7	209,200	12,941	6
Coke (excluding breeze):						
Gashouse [2]	r 45,150	149	(1)	43,340	163	(1)
Oven and beehive	r 340,088	66,854	20	338,980	67,402	20
Fuel briquets and packaged fuel	r 127,300	369	(1)	124,500	340	(1)
Natural gas (marketable) million cubic feet	NA	16,039,753	NA	NA	17,116,795	NA
Peat	r 189,400	r 3 604	(1)	188,800	611	(1)
Petroleum (crude) thousand barrels	r 11,058,427	2,848,514	26	12,007,134	3,027,763	25
Nonmetals:						
Asbestos	r 3,140	118	r 4	3,350	126	4
Barite	r 3,860	846	22	4,070	1,007	25
Cement [4] thousand barrels	r 2,544,173	r 388,847	15	2,722,280	401,895	15
China clay	NA	3,604	NA	NA	4,385	NA
Corundum	11	-----	---	11	-----	---
Diamonds thousand carats	r 35,493	-----	---	37,451	-----	---
Diatomite	r 1,850	580	r 31	1,845	580	31
Feldspar thousand long tons	r 1,930	625	r 32	2,010	686	34
Fluorspar	r 3,110	241	8	3,280	253	8
Graphite	r 680	W	W	545	W	W
Gypsum	r 53,000	r 10,033	19	r 53,000	9,647	18
Lime (sold or used by producers)	NA	16,794	NA	NA	18,057	NA
Magnesite	r 10,425	W	W	10,385	W	W
Mica (including scrap) thousand pounds	435,000	241,226	55	415,000	226,268	55
Nitrogen, agricultural [4 5]	r 18,500	r 4,922	27	21,300	5,689	27
Phosphate rock thousand long tons	r 85,700	r 29,436	r 34	98,440	39,050	40
Potash (K_2O equivalent)	r 15,100	3,140	21	16,200	3,320	20
Pumice [6]	r 16,240	r 3,372	21	16,410	3,234	20
Pyrites thousand long tons	21,100	875	4	21,150	873	4
Salt [4]	r 119,450	34,695	29	122,810	36,474	30
Strontium [6]	r 16	-----	---	13	-----	---
Sulfur, elemental thousand long tons	r 15,270	7,332	48	16,350	8,239	50
Talc, pyrophyllite, and soapstone	r 3,920	863	22	4,040	895	22
Vermiculite [6]	r 380	249	r 66	382	262	69
Metals, mine basis:						
Antimony (content of ore and concentrate) short tons	r 66,700	845	1	65,800	927	1
Arsenic, white [6]	r 66	W	W	66	W	W
Bauxite thousand long tons	r 36,970	1,654	r 4	38,805	1,796	5
Beryllium concentrate short tons	r 7 4,900	W	W	7 3,600	W	W
Bismuth thousand pounds	r 8,600	W	W	8,600	W	W
Cadmium thousand pounds	r 26,100	9,671	r 27	26,600	10,460	39
Chromite	r 5,410	-----	---	5,450	-----	---
Cobalt (contained) short tons	r 19,100	W	W	22,100	W	W
Columbium-tantalum concentrates [6] thousand pounds	r 14,545	-----	---	27,065	-----	---
Copper (content of ore and concentrate)	r 5,590	1,352	24	5,855	1,429	24
Gold thousand troy ounces	r 46,700	1,705	4	47,100	1,803	4
Iron ore thousand long tons	r 608,202	r 87,439	r 14	618,609	90,147	15
Lead (content of ore and concentrate)	r 2,990	301	10	3,155	327	10
Manganese ore (35 percent or more Mn)	r 19,435	29	(1)	20,033	14	(1)
Mercury thousand 76-pound flasks	r 276	20	7	266	22	8
Molybdenum (content of ore and concentrate) thousand pounds	r 115,200	77,372	67	143,800	90,532	63

See footnotes at end of table.

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

Mineral	1965			1966 p		
	World	United States		World	United States	
	Thousand short tons (unless otherwise stated)		Percent of world	Thousand short tons (unless otherwise stated)		Percent of world
Metals, mine basis—Continued						
Nickel (content of ore and concentrate)	r 481	14	3	475	13	3
Platinum groups (Pt, Pd, etc.) thousand troy ounces	r 2,970	35	1	2,950	51	2
Silver—thousand troy ounces	r 254,100	39,806	16	253,000	43,669	17
Tin (content of ore and concentrate)—long tons	r 199,800	47	(1)	208,000	97	(1)
Titanium concentrates:						
Ilmenite [6]	r 2,723	969	36	2,889	965	33
Rutile [6]	243	W	W	277	W	W
Tungsten concentrate (60 percent WO_3)—short tons	r 63,100	7,949	13	65,300	8,912	14
Vanadium (content of ore and concentrate) [6]—short tons	r 9,083	5,226	r 58	9,300	5,166	56
Zinc (content of ore and concentrate)	r 4,695	611	13	4,920	573	12
Metals, smelter basis:						
Aluminum	7,415	2,754	37	8,025	2,968	37
Copper	r 6,100	1,434	24	6,440	1,581	25
Iron, pig (including ferroalloys)	r 369,495	91,016	25	382,167	94,000	25
Lead	2,905	418	14	2,995	441	15
Magnesium—short tons	r 178,300	81,361	r 46	175,200	79,794	46
Selenium [6]—thousand pounds	r 1,789	540	r 30	1,951	620	32
Steel ingots and castings	r 506,850	131,462	26	524,040	134,073	26
Tellurium [6]—thousand pounds	r 321	195	r 61	340	199	59
Tin—long tons	r 196,800	r [8] 4,326	2	201,200	[8] 4,372	2
Uranium oxide (U_3O_8) [6] short tons	r 21,100	10,442	r 49	19,700	9,483	48
Zinc	r 4,280	994	23	4,405	1,025	23

p Preliminary. r Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data.

[1] Less than ½ unit.

[2] Includes low- and medium-temperature and gashouse coke.

[3] Agricultural use only.

[4] Including Puerto Rico.

[5] Year ended June 30 of year stated (United Nations).

[6] World total exclusive of U.S.S.R.

[7] Not including U.S. output which was very small, but withheld to avoid disclosing individual company confidential data.

[8] U.S. imports of tin concentrates (tin content).

Employment and Injuries in the Mineral Industries

By Forrest T. Moyer [1]

The safety record of the mineral and mineral-fuel mining and processing industries in 1966 was improved slightly for the second consecutive year as indicated by reduced injury-frequency and injury-severity rates. The overall operating activity was higher in 1966, as measured by the increased number of men working and the total man-hours of worktime.

Injury Experience.—The rate of occurrence of all disabling work injuries in the mineral industries was 17.38 per million man-hours in 1966. This overall rate comprised frequencies of 0.28 for fatal and 17.10 for nonfatal work injuries, compared with respective rates of 0.28 and 17.26 in 1965. Fatalities totaled 543; 5 more than in 1965. The total of 33,091 nonfatal injuries was 291 higher than in 1965. However, the larger number of disabilities was offset by the increased worktime in 1966, so that the fatality frequency was unchanged and the nonfatal frequency rate decreased from 1965.

The overall injury-severity rate for the mineral industries in 1966 was 2,597 days lost per million man-hours, a slight improvement over the corresponding rate of 2,629 in 1965.

Although there was a slight overall improvement, the safety records of the separate mineral industry groups showed varying trends in 1966. (See summary section at end of table 1.) All general measures of injury experience were improved over 1965 only in the coal, peat, coke, and slag industries. In the metal and stone industries, both the injury-frequency and injury-severity rates worsened in 1966. The frequency rate of injuries in the oil and gas industries was improved, but the severity rate worsened. In the nonmetal, sand and gravel, native asphalt, and nonferrous smelting industries, the injury-frequency rate was worse but the injury-severity rate was more favorable than in 1965.

There were fewer fatal work injuries in 1966 in the coal, nonmetal, sand and gravel, coke, slag, and nonferrous smelting industries. However, these improvements were more than offset by increased numbers of fatalities in the metal, stone, and oil and gas industries.

The numbers of nonfatal injuries were lower in 1966 only in the coal, peat, oil and gas, coke, and slag industries. In all other mineral industry groups, nonfatal work injuries increased over 1965.

Employment and Worktime.—Of the mineral industries having an average of more than 10,000 men working daily, employment increased in the metal, nonmetal, sand and gravel, petroleum and natural gas, and primary nonferrous smelting industries. These gains more than offset decreased employment in the coal, stone, and coke industries, so the total number of men working daily in the mineral industries in 1966 was over 17,000 higher than in 1965.

Total worktime of over 1.9 billion man-hours was nearly 2 percent above 1965 data. Worktime in 1966 was increased in all except the coal, native asphalt, coke, and blast-furnace-slag industries.

State Data.—The mineral industries in West Virginia and Kentucky, in each of which underground coal mining was the dominant mineral industry, had the least favorable injury experience. The injury-frequency rate for West Virginia in 1966 was 56.75 and for Kentucky 45.85 per million man-hours worked; comparable rates for 1965 were 59.48 and 44.61 respectively. The mineral industries in Idaho, where

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metal mining and milling predominate, ranked third highest in injury frequency with a rate of 45.59 and had the highest injury-severity rate with 10,612 days lost per million man-hours worked. Of the major mineral producing States, Minnesota's industries (with 31 million man-hours) had the lowest frequency rate with 8.75 injuries per million man-hours. Similarly, the injury-severity rate of 1,725 for Minnesota operations was the lowest for States with major mineral industry activity.

The largest number of fatalities, 82, occurred in West Virginia. The States ranking next in number of fatalities were Kentucky with 47, Pennsylvania with 42, and Virginia with 30. The largest numbers of nonfatal injuries occurred in West Virginia with 4,425, Pennsylvania with 2,248, Kentucky with 1,833, and Virginia with 1,297.

The magnitude of mining and milling activity in the ranking States, as measured by worktime (in thousands of man-hours) was as follows: Pennsylvania (84,694); West Virginia (79,425); Kentucky (41,001); and California (38,671). States having the largest number of man-hours worked within the general groupings of mining and milling industries were the same as for 1965: Coal—West Virginia, metal—Arizona, nonmetal—California, sand and gravel—California, stone—Pennsylvania, peat—Michigan, and native asphalt—Utah.

Active Operations.—The numbers of active mineral-extractive and processing establishments in the United States during 1965 are presented for the first time in table 1 for each of the general groupings except for the oil and gas industries. Similar data for 1966 are not available.

Mineral and mineral-fuel producers and processors reported 28,944 active mines, quarries, pits, dredges, brine, and other types of mineral-extractive operations in 1965. Active mineral cleaning and processing mills totaled 5,096, excluding mechanical cleaning plants of the bituminous-coal industry.

Scope of Statistics.—Overall data are shown in this chapter for 1965 and 1966 injury experience, levels of employment, and worktime, as well as a count of 1965 operations. Data by States are presented for the mineral-extractive and processing industries. The State breakdown is not presented for the purely processing industries, coke, primary nonferrous smelting, and blast-furnace-slag, nor for petroleum and natural gas, but the totals for all these industries are included in the summarization at the end of the State table.

The figures for 1966 are preliminary except for the anthracite, coke, petroleum and natural gas, native asphalt, and slag industries, which are final. All data for earlier years are final. The figures represent full coverage for all industries except the oil and gas industries for which coverage is not complete, particularly with respect to small companies.

Injury and employment data were collected from coal producers as required by the Federal Coal Mine Safety Act (30 U.S.C., sec. 455). Producers of all other minerals (fuel and nonfuel) voluntarily reported the requested injury and employment data for 1965. Data for 1966 were collected as required by the Federal Metal and Nonmetallic Mine Safety Act (P.L. 89–577; 80 Stat. 772) from metal, nonmetal, stone, and sand and gravel producers. Various mineral producers, not covered under either of the acts, voluntarily reported the requested injury and employment data.

Table 1.—Employment and injury experience in the mineral industries (mines and mills) in the United States, by State [1]

State and industry group	Average men working daily		Man-shifts (thousands)		Man-hours worked (thousands)		Number of injuries				Injury rates per million man-hours				Count of operations 1965	
							Fatal		Nonfatal		Frequency		Severity			
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	Mines	Mills
Alabama:																
Coal	5,632	5,610	1,196	1,039	9,531	8,345	7	5	129	110	14.27	13.78	5,205	4,373	188	---
Metal	1,261	1,240	341	345	2,830	2,868	---	---	30	42	10.60	14.64	699	412	25	8
Nonmetal and native asphalt	972	1,050	268	294	2,157	2,370	---	1	26	42	12.05	18.14	3,009	2,827	45	23
Sand and gravel	510	500	143	138	1,286	1,230	2	1	17	16	14.78	13.82	12,386	11,485	47	---
Stone	2,679	2,655	787	768	6,493	6,361	3	1	60	73	9.70	11.63	3,706	4,672	65	61
Total or average	11,054	11,055	2,735	2,584	22,297	21,174	12	8	262	283	12.29	13.74	4,398	4,166	370	92
Alaska:																
Coal and peat	223	220	56	53	453	431	---	---	36	34	79.46	78.89	947	947	7	---
Metal	403	350	78	56	687	472	---	1	18	21	26.20	46.61	703	13,229	113	2
Nonmetal	---	5	---	1	---	5	---	---	---	---	---	---	---	---	---	---
Sand and gravel	1,006	630	235	145	1,898	1,174	---	---	42	24	22.13	20.44	449	436	144	---
Stone	296	315	34	37	283	306	---	---	6	7	21.24	22.88	690	503	20	13
Total or average	1,928	1,520	403	292	3,321	2,388	---	1	102	86	30.71	36.43	590	3,064	284	15
Arizona:																
Coal	4	5	1	1	4	4	---	---	---	---	---	---	---	---	1	---
Metal	11,208	10,650	3,409	3,330	27,263	26,628	11	9	652	588	24.32	22.42	4,066	3,180	190	34
Nonmetal	293	250	66	56	530	450	1	---	19	17	37.72	37.78	11,769	773	39	10
Sand and gravel	1,178	1,250	237	268	1,905	2,147	---	---	36	41	18.90	19.10	530	758	159	---
Stone	498	430	143	120	1,097	953	1	---	14	17	13.67	17.84	5,880	256	132	16
Total or average	13,181	12,585	3,856	3,775	30,799	30,182	13	9	721	663	23.83	22.26	4,044	2,879	521	60
Arkansas:																
Coal	123	110	22	20	175	151	---	---	7	5	39.95	33.11	765	629	16	---
Metal	1,948	1,985	585	595	4,681	4,757	1	---	35	34	7.69	7.15	1,463	434	6	4
Nonmetal	667	900	170	234	1,372	1,870	---	1	47	68	34.26	36.90	819	3,870	34	14
Sand and gravel	938	920	261	250	2,149	2,142	---	---	41	61	19.08	28.48	420	517	199	---
Stone	2,017	1,820	526	477	4,436	4,006	1	2	102	118	23.22	29.96	2,659	3,833	144	78
Total or average	5,693	5,735	1,564	1,576	12,813	12,926	2	3	232	286	18.26	22.36	1,624	2,001	399	96

See footnotes at end of table.

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

State and industry group	Average men working daily		Man-shifts (thousands)		Man-hours worked (thousands)		Number of injuries				Injury rates per million man-hours				Count of operations 1965	
							Fatal		Nonfatal		Frequency		Severity			
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	Mines	Mills
California:																
Coal and peat	35	35	7	6	58	51	---	---	2	---	34.52	---	86	---	6	---
Metal	2,770	3,080	675	759	5,397	6,077	1	5	137	164	25.57	27.81	2,049	6,832	296	33
Nonmetal	4,914	5,310	1,347	1,399	10,904	11,237	1	3	164	201	15.13	18.15	1,159	2,540	223	95
Sand and gravel	5,184	5,445	1,205	1,289	9,784	10,377	9	3	179	219	19.22	21.39	5,996	3,450	739	---
Stone	4,727	4,600	1,396	1,363	11,196	10,929	6	---	119	171	11.16	15.65	3,856	634	338	154
Total or average	17,630	18,470	4,630	4,816	37,339	38,671	17	11	601	755	16.55	19.81	3,362	2,917	1,602	282
Colorado:																
Coal	1,536	1,535	334	322	2,631	2,501	11	5	109	104	45.61	43.58	26,381	13,284	91	---
Metal	4,528	4,995	1,198	1,309	9,588	10,488	3	8	401	393	42.14	38.23	3,301	6,485	443	22
Nonmetal	528	450	93	71	752	567	1	---	21	12	29.26	21.16	8,784	610	107	18
Sand and gravel	1,278	1,265	257	247	2,093	1,994	3	3	45	41	22.94	22.07	8.995	9,703	336	---
Stone	749	685	183	150	1,506	1,207	1	2	28	43	19.26	37.28	4,341	10,896	105	36
Peat	35	21	3	3	23	23	---	---	2	---	87.39	---	2,840	---	17	---
Total or average	8,654	8,951	2,068	2,102	16,593	16,780	19	18	606	593	37.67	36.41	8,020	7,991	1,099	76
Connecticut:																
Nonmetal and peat	106	145	30	42	240	343	---	---	2	7	8.33	20.41	125	303	7	3
Sand and gravel	576	580	131	134	1,071	1,092	---	1	21	27	19.60	25.64	330	6,264	94	---
Stone	414	415	108	103	913	894	1	---	11	28	13.14	31.32	6,938	494	26	20
Total or average	1,096	1,140	269	279	2,224	2,329	1	1	34	62	15.74	27.05	3,022	3,171	127	23
Delaware:																
Nonmetal	13	15	4	4	33	33	---	---	---	1	---	30.30	---	545	1	1
Sand and gravel	52	65	11	13	89	106	---	---	1	---	11.27	---	45	---	12	---
Stone	10	10	2	2	20	20	---	---	---	---	---	---	---	---	1	1
Total or average	75	90	17	19	142	159	---	---	1	1	7.04	6.30	28	113	14	2
Florida:																
Metal	170	165	57	57	461	454	---	---	---	---	---	---	---	---	3	---
Nonmetal	3,267	3,675	1,114	1,241	8,957	9,969	4	4	60	143	7.14	14.75	2,924	2,860	39	34
Sand and gravel	449	440	115	111	1,002	986	---	---	20	22	19.96	22.31	937	1,166	72	---
Stone	2,868	2,810	822	802	7,014	7,022	2	---	114	136	16.54	19.37	3,141	1,337	97	87
Peat	22	14	5	4	42	29	---	---	---	---	---	---	---	---	7	---
Total or average	6,776	7,104	2,113	2,215	17,476	18,460	6	4	194	301	11.44	16.52	2,813	2,115	218	121

Georgia:																
Metal	188	235	47	65	366	536	---	---	2	14	5.46	26.12	106	576	22	4
Nonmetal and peat	3,108	3,710	932	1,171	7,498	9,364	2	---	173	256	23.34	27.34	2,830	1,755	62	41
Sand and gravel	212	240	47	62	383	549	1	1	4	12	13.05	23.68	15,891	11,361	28	---
Stone	2,671	3,305	694	858	5,877	7,173	2	2	113	193	19.57	27.19	3,157	3,350	99	69
Total or average	6,179	7,490	1,720	2,156	14,124	17,622	5	3	292	475	21.03	27.13	3,250	2,668	211	114
Hawaii:																
Nonmetal	117	90	9	8	70	64	1	---	---	---	14.33	---	85,957	---	25	5
Sand and gravel	152	50	18	10	145	77	---	---	1	1	6.90	12.99	207	273	11	---
Stone	520	585	129	152	1,067	1,240	---	---	35	56	32.81	45.16	608	5,820	45	29
Total or average	789	725	156	170	1,282	1,381	1	---	36	57	28.86	41.27	5,210	5,241	81	34
Idaho:																
Metal	2,572	2,555	678	660	5,424	5,291	9	10	242	263	46.27	51.60	13,269	12,933	106	15
Nonmetal and peat	771	545	172	128	1,390	1,098	1	1	28	37	20.87	34.61	4,854	6,226	24	9
Sand and gravel	426	385	82	66	659	517	---	---	17	11	25.80	21.28	399	368	204	---
Stone	308	265	32	30	261	244	1	---	4	4	19.13	16.39	23,493	1,713	29	24
Total or average	4,077	3,750	964	884	7,734	7,150	11	11	291	315	39.05	45.59	11,007	10,612	363	48
Illinois:																
Coal	8,312	8,600	2,096	2,114	16,351	16,680	14	8	687	710	42.87	43.05	7,356	5,134	97	---
Metal	67	75	17	18	133	146	---	---	5	10	37.47	68.49	1,169	1,068	7	1
Nonmetal	1,399	1,290	349	344	2,818	2,791	1	1	83	95	29.81	34.40	4,673	3,621	57	30
Sand and gravel	1,567	1,645	349	370	2,901	3,158	---	---	61	40	21.03	12.67	2,799	826	384	---
Stone	3,597	3,500	942	948	7,891	7,967	1	3	139	135	17.74	17.32	1,560	2,876	259	213
Peat	24	19	2	2	18	19	---	---	---	1	---	52.65	---	53	6	---
Total or average	14,966	15,129	3,755	3,796	30,112	30,761	16	12	975	991	32.91	32.61	5,115	3,947	810	244
Indiana:																
Coal	2,570	2,455	535	531	4,101	4,104	---	2	132	155	32.19	38.26	3,393	6.890	53	---
Nonmetal	827	800	216	206	1,728	1,621	---	---	32	26	18.51	16.04	964	2,512	33	20
Sand and gravel	1,129	1,190	282	291	2,529	2,502	1	3	32	38	13.05	16.39	4,875	7.550	268	---
Stone	2,812	3,075	776	896	6,389	7,383	3	2	127	153	20.35	20.99	4,349	3,748	137	106
Peat	41	30	7	8	62	70	---	---	2	4	32.52	57.31	3,740	1,118	9	---
Total or average	7,379	7,550	1,816	1,932	14,809	15,680	4	7	325	376	22.22	24.43	3,777	5,038	500	126
Iowa:																
Coal and peat	270	255	58	57	491	492	---	1	13	15	26.48	32.52	756	13,079	36	---
Nonmetal	1,018	1,065	294	290	2,379	2,338	---	---	28	53	11.77	22.67	1,261	1,630	29	20
Sand and gravel	1,374	1,405	276	292	2,432	2,592	---	3	46	49	18.92	20.06	1,450	7,506	303	---
Stone	2,553	2,455	717	687	6,091	5,905	1	1	75	98	12.48	16.77	1,437	1,573	260	142
Total or average	5,215	5,180	1,345	1,326	11,303	11,327	1	5	162	215	14.31	19.42	1,374	3,442	628	162

See footnotes at end of table.

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

State and industry group	Average men working daily		Man-shifts (thousands)		Man-hours worked (thousands)		Number of injuries				Injury rates per million man-hours				Count of operations 1965	
							Fatal		Nonfatal		Frequency		Severity			
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	Mines	Mills
Kansas:																
Coal	235	210	62	56	506	436	---	---	13	10	25.70	22.94	413	367	9	---
Metal	61	60	17	16	137	131	---	---	2	4	14.61	30.53	424	794	9	1
Nonmetal	1,199	1,110	335	312	2,685	2,495	1	2	49	64	18.62	26.45	2,538	5,498	30	18
Sand and gravel	869	875	187	190	1,610	1,619	---	---	21	42	13.05	25.94	371	715	234	---
Stone	2,001	1,830	456	426	3,745	3,516	---	3	35	38	9.35	11.66	469	5,522	180	113
Total or average	4,365	4,085	1,057	1,000	8,683	8,197	1	5	120	158	13.94	19.89	1,086	4,215	462	132
Kentucky:																
Coal	24,726	25,200	4,484	4,311	35,640	34,980	41	42	1,609	1,650	46.30	48.37	9,346	9,751	1,897	---
Metal and nonmetal	511	485	131	109	1,051	875	---	1	70	49	66.60	57.14	1,296	9,018	37	12
Sand and gravel	318	380	81	103	807	958	1	---	26	25	33.46	26.10	8,210	364	32	---
Stone	2,227	2,160	506	512	4,128	4,188	3	4	107	109	26.65	26.98	5,886	6,625	116	104
Total or average	27,782	28,225	5,202	5,035	41,626	41,001	45	47	1,812	1,833	44.61	45.85	8,778	9,197	2,082	116
Louisiana:																
Metal	1,088	1,065	397	388	3,182	3,255	---	---	15	25	4.71	7.68	203	328	---	3
Nonmetal	1,727	1,745	505	511	4,563	4,638	2	---	99	100	22.14	21.56	5,050	585	35	16
Sand and gravel	1,280	1,560	351	408	2,943	3,480	---	1	35	64	11.89	18.68	345	3,670	102	---
Stone	438	515	151	169	1,295	1,430	---	---	38	31	29.35	21.68	1,037	611	9	14
Total or average	4,533	4,885	1,404	1,476	11,983	12,803	2	1	187	220	15.77	17.26	2,173	1,361	146	33
Maine:																
Metal and nonmetal	195	120	41	23	330	181	1	1	22	7	69.73	44.20	18,844	34,569	19	5
Sand and gravel	1,652	1,620	389	378	3,128	2,499	---	---	56	50	17.90	20.01	378	530	168	---
Stone	466	445	115	110	960	913	---	---	12	28	12.50	30.67	222	697	17	14
Peat	20	21	2	3	17	23	---	---	---	---	---	---	---	---	3	---
Total or average	2,333	2,206	547	514	4,435	3,616	1	1	90	85	20.52	23.78	1,716	2,272	207	19
Maryland and District of Columbia:																
Coal and peat	424	425	81	81	652	668	---	---	13	18	19.95	26.95	9,935	892	94	---
Nonmetal	288	360	78	94	617	757	---	---	38	25	61.55	33.03	1,160	8,483	19	8
Sand and gravel	1,024	995	258	261	2,150	2,225	1	---	56	49	26.52	22.02	3,919	2,614	80	---
Stone	1,266	1,115	323	295	2,809	2,480	---	---	46	52	16.38	20.97	285	2,138	38	34
Total or average	3,002	2,895	740	731	6,228	6,130	1	---	153	144	24.73	23.49	2,636	2,959	231	42

Massachusetts:																
Nonmetal and peat	91	75	21	22	167	180	---	---	1	3	6.00	16.67	102	983	6	1
Sand and gravel	1,332	1,350	287	294	2,506	2,410	1	1	47	53	19.16	22.41	2,762	3,025	209	---
Stone	1,025	1,115	261	273	2,105	2,200	---	---	45	50	21.38	22.73	845	753	50	39
Total or average	2,448	2,540	569	589	4,778	4,790	1	1	93	106	19.67	22.34	1,824	1,905	265	40
Michigan:																
Metal	5,662	5,980	1,607	1,767	12,855	14,126	4	7	345	484	27.15	34.76	2,720	4,631	30	13
Nonmetal	1,548	1,790	410	487	3,310	3,901	---	---	31	39	9.37	10.00	1,244	847	54	17
Sand and gravel	2,547	2,505	567	551	4,822	4,659	2	2	85	83	18.04	18.24	3,342	3,656	556	---
Stone	3,414	3,490	998	1,039	7,997	8,348	---	1	61	90	7.63	10.90	457	1,428	89	42
Peat	189	162	30	31	270	281	---	---	3	2	11.11	7.11	148	747	28	---
Total or average	13,360	13,927	3,612	3,875	29,254	31,315	6	10	525	698	18.15	22.61	2,013	3,126	757	72
Minnesota:																
Metal	9,801	10,065	2,793	2,944	22,382	23,575	---	4	92	99	4.11	4.37	253	1,283	67	34
Nonmetal	225	220	60	60	484	482	1	1	33	29	70.27	62.24	13,876	14,822	9	5
Sand and gravel	2,334	2,330	374	390	3,187	3,367	---	2	57	60	17.89	18.41	416	4,021	609	---
Stone	1,601	1,615	384	387	3,170	3,203	---	---	57	73	17.98	22.79	376	599	91	52
Peat	38	25	2	3	16	19	---	---	---	---	---	---	---	---	9	---
Total or average	13,999	14,255	3,613	3,784	29,239	30,646	1	7	239	261	8.21	8.75	509	1,725	785	91
Mississippi:																
Metal and nonmetal	963	875	248	219	2,011	1,755	---	---	46	55	22.87	31.34	1,176	5,303	41	24
Sand and gravel	540	565	142	148	1,223	1,339	---	---	22	25	17.99	18.67	473	504	53	---
Stone	304	300	90	87	729	698	---	---	6	9	8.23	12.89	156	315	16	11
Total or average	1,807	1,740	480	454	3,963	3,792	---	---	74	89	18.67	23.47	772	2,690	110	35
Missouri:																
Coal	408	360	108	98	833	717	---	1	31	30	37.22	43.24	8.088	9.414	20	---
Metal	2,476	2,530	680	689	5,478	5,550	2	3	254	268	46.73	48.83	3,593	5,171	20	6
Nonmetal and native asphalt	1,035	1,075	242	245	1,962	1,974	---	---	63	61	32.11	30.90	868	777	148	25
Sand and gravel	789	710	191	171	1,594	1,409	---	1	24	19	15.06	14.19	4,241	4,696	222	---
Stone	4,899	4,830	1,272	1,288	10,359	10,519	1	9	200	191	19.40	19.01	1,049	5,644	249	193
Total or average	9,607	9,505	2,493	2,491	20,226	20,169	3	14	572	569	28.43	28.91	1,962	5,105	659	224
Montana:																
Coal and peat	111	105	17	16	132	124	---	1	9	9	67.96	80.65	1,495	49,984	22	---
Metal	4,391	4,160	1,115	1,254	8,920	10,030	7	7	149	189	17.49	19.54	6,768	5,623	152	9
Nonmetal	861	855	229	225	1,829	1,797	2	---	31	29	18.05	16.14	7,186	541	29	11
Sand and gravel	807	1,025	158	188	1,268	1,459	---	---	23	34	18.15	23.30	484	554	213	---
Stone	548	515	112	111	905	887	---	---	18	18	19.89	20.29	551	407	97	47
Total or average	6,718	6,660	1,631	1,794	13,054	14,297	9	8	230	279	18.31	20.07	5,731	4,528	513	67

See footnotes at end of table.

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

State and industry group	Average men working daily		Man-shifts (thousands)		Man-hours worked (thousands)		Number of injuries				Injury rates per million man-hours				Count of operations 1965	
							Fatal		Nonfatal		Frequency		Severity			
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	Mines	Mills
Nebraska:																
Nonmetal	14	70	3	16	28	141	---	---	---	7	---	49.65	---	922	7	3
Sand and gravel	937	1,030	211	231	2,045	2,160	4	1	16	24	9.78	11.57	11,953	3,182	317	---
Stone	566	575	150	162	1,248	1,342	1	---	16	14	13.63	10.43	5,962	321	42	31
Total or average	1,517	1,675	364	409	3,321	3,643	5	1	32	45	11.14	12.63	9,602	2,041	366	34
Nevada:																
Metal	2,189	2,210	650	648	5,206	5,229	1	2	117	141	22.67	27.35	1,746	3,460	157	9
Nonmetal and peat	772	735	213	189	1,712	1,521	---	---	47	38	27.45	24.98	3,503	1,384	52	15
Sand and gravel	648	610	133	122	1,072	977	---	---	12	19	11.20	19.45	192	657	108	---
Stone	213	205	62	54	494	433	---	---	7	5	14.18	11.55	352	460	39	11
Total or average	3,822	3,760	1,058	1,013	8,484	8,160	1	2	183	203	21.69	25.12	1,823	2,578	356	35
New Hampshire:																
Nonmetal and peat	23	25	4	5	33	36	---	---	2	1	61.30	27.78	705	139	7	---
Sand and gravel	329	335	64	62	536	518	---	---	10	11	18.66	21.24	411	647	85	---
Stone	198	200	43	44	349	352	---	---	6	12	17.18	34.09	166	344	32	18
Total or average	550	560	111	111	918	906	---	---	18	24	19.61	26.49	328	509	124	18
New Jersey:																
Metal	463	455	117	68	941	548	---	---	55	27	58.44	49.27	5,706	1,228	3	3
Nonmetal	395	400	111	113	886	904	---	---	27	16	30.46	17.70	1,173	497	19	12
Sand and gravel	976	1,045	244	275	2,104	2,274	---	---	39	55	18.54	24.19	395	663	110	---
Stone	1,111	1,035	276	252	2,282	2,124	---	1	57	49	24.98	23.54	602	3,381	31	31
Peat	16	19	4	4	33	31	---	---	---	---	---	---	---	---	4	---
Total or average	2,961	2,954	752	712	6,246	5,881	---	1	178	147	28.50	25.17	1,379	1,668	167	46
New Mexico:																
Coal	284	285	66	64	530	504	1	1	15	14	30.20	29.76	12,206	12,766	13	---
Metal	3,279	3,290	912	923	7,308	7,386	5	4	392	361	54.33	49.42	5,427	6,285	103	15
Nonmetal	2,889	2,905	997	989	7,974	8,069	---	2	255	222	31.98	27.76	2,341	3,141	41	25
Sand and gravel	1,109	1,650	195	294	1,572	2,360	---	---	33	56	21.00	23.73	503	602	181	---
Stone	219	210	56	49	526	380	1	---	13	13	26.60	34.21	11,955	566	40	12
Total or average	7,780	8,340	2,226	2,319	17,910	18,699	7	7	708	666	39.92	35.99	4,013	4,270	378	52

New York:																
Metal	1,732	1,675	459	467	3,671	3,743	1	4	59	48	16.34	13.89	4,114	9,479	6	6
Nonmetal	2,375	2,475	614	635	5,019	5,134	---	2	139	128	27.70	25.32	1,268	3,079	37	29
Sand and gravel	1,672	1,625	328	330	2,709	2,727	3	2	48	57	18.82	21.64	7,278	4,893	330	---
Stone	3,603	3,725	921	991	7,547	8,141	---	2	88	131	11.66	16.34	1,246	2,411	107	95
Peat	19	11	3	2	23	17	---	---	---	---	---	---	---	---	5	---
Total or average	9,401	9,511	2,325	2,425	18,969	19,762	4	10	334	364	17.82	18.93	2,667	4,264	485	130
North Carolina:																
Metal and nonmetal	1,749	1,800	416	470	3,297	3,799	3	---	91	95	28.51	25.01	6,727	738	92	35
Sand and gravel	863	1,000	197	217	1,702	1,839	---	---	34	32	19.98	17.40	412	410	128	---
Stone	1,848	1,985	438	477	3,614	3,996	---	---	46	69	12.73	17.27	910	4,373	83	60
Total or average	4,460	4,785	1,051	1,164	8,613	9,634	3	---	171	196	20.20	20.34	3,038	2,183	303	95
North Dakota:																
Coal and peat	324	330	63	61	500	476	1	---	22	20	46.00	42.02	14,018	2,017	34	---
Metal	55	55	12	14	96	113	---	---	2	1	20.93	8.85	6,477	9	8	1
Nonmetal	42	25	9	8	73	60	---	---	1	1	13.69	16.67	233	433	6	2
Sand and gravel	491	550	88	93	753	806	---	---	17	15	22.59	18.61	456	443	217	---
Stone	34	15	2	1	18	9	---	---	---	---	---	---	---	---	7	7
Total or average	946	975	174	177	1,440	1,464	1	---	42	37	29.86	25.27	5,577	918	272	10
Ohio:																
Coal	7,580	7,800	1,738	1,811	13,963	14,680	8	12	347	365	25.42	25.68	4,797	6,272	453	---
Nonmetal	2,494	2,575	642	672	5,154	5,375	2	---	125	122	24.64	22.70	3,425	1,107	166	40
Sand and gravel	2,214	2,240	526	536	4,369	4,464	4	3	60	68	14.65	15.91	6,024	4,764	377	---
Stone	5,560	5,380	1,524	1,520	12,333	12,419	4	2	134	196	11.19	15.94	2,286	2,060	176	159
Peat	18	17	2	2	14	15	---	---	---	---	---	---	---	---	8	---
Total or average	17,866	18,012	4,432	4,541	35,833	36,953	18	17	666	751	19.09	20.78	3,883	3,921	1,180	199
Oklahoma:																
Coal	261	230	51	46	407	351	---	---	7	10	17.20	28.49	658	1,083	27	---
Metal	306	335	84	87	668	697	1	---	13	17	20.95	24.39	9,761	581	68	1
Nonmetal	379	550	86	134	689	1,071	1	---	13	22	20.32	20.54	9,631	1,722	28	6
Sand and gravel	320	345	81	90	780	845	1	---	23	22	30.76	26.04	8,309	832	76	---
Stone	1,069	1,210	277	328	2,253	2,709	---	1	57	72	25.30	26.95	1,352	4,681	104	52
Total or average	2,335	2,670	579	685	4,797	5,563	3	1	113	143	24.18	25.38	4,786	2,822	303	59
Oregon:																
Coal and peat	6	5	1	1	5	6	---	---	---	---	---	---	---	---	1	---
Metal	194	165	38	36	303	292	1	---	13	7	46.18	23.97	21,642	729	40	4
Nonmetal	166	160	36	29	291	232	---	---	19	14	65.22	60.34	1,703	1,039	26	9
Sand and gravel	2,634	3,290	596	716	4,777	5,827	---	---	97	124	20.30	21.28	451	636	364	---
Stone	1,578	1,595	329	329	2,643	2,615	---	---	64	74	24.22	28.30	392	467	411	181
Total or average	4,578	5,215	1,000	1,111	8,019	8,972	1	---	193	219	24.19	24.41	1,278	600	842	194

See footnotes at end of table.

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

State and industry group	Average men working daily		Man-shifts (thousands)		Man-hours worked (thousands)		Number of injuries				Injury rates per million man-hours				Count of operations 1965	
							Fatal		Nonfatal		Frequency		Severity			
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	Mines	Mills
Pennsylvania:																
Bituminous coal	24,393	24,000	5,558	5,369	44,690	43,270	35	28	1,025	880	23.72	20.98	6,338	5,327	1,385	---
Anthracite	11,132	9,292	2,271	1,883	16,375	13,672	8	6	1,067	829	65.65	61.07	4,936	4,477	943	146
Metal	1,473	1,550	420	437	3,475	3,497	---	---	27	33	7.77	9.44	420	852	3	3
Nonmetal	1,601	1,750	404	439	3,309	3,578	2	---	135	137	41.41	38.29	4,421	766	128	36
Sand and gravel	1,157	1,210	275	277	2,300	2,351	---	1	46	49	20.00	21.27	329	3,869	111	---
Stone	8,393	8,260	2,273	2,216	18,582	18,217	6	7	303	320	16.63	17.95	2,674	3,375	292	247
Peat	59	60	11	14	90	109	---	---	1	---	11.05	---	309	---	12	---
Total or average	48,208	46,122	11,212	10,635	88,821	84,694	51	42	2,604	2,248	29.89	27.04	4,848	4,345	2,874	432
Rhode Island:																
Sand and gravel	128	155	25	29	199	233	---	---	3	2	15.06	8.58	497	948	15	---
Stone	46	55	11	13	90	111	---	---	1	4	11.05	36.04	365	1,441	5	4
Total or average	174	210	36	42	289	344	---	---	4	6	13.84	17.44	457	1,108	20	4
South Carolina:																
Nonmetal and peat	943	865	246	229	1,193	1,870	---	---	35	42	17.57	22.46	3,331	463	47	21
Sand and gravel	416	395	101	99	815	802	1	---	27	17	34.36	21.20	12,104	507	29	---
Stone	747	795	198	209	1,630	1,754	---	---	24	32	14.73	18.24	465	7,603	18	14
Total or average	2,106	2,055	545	537	4,438	4,426	1	---	86	91	19.60	20.56	3,889	3,300	94	35
South Dakota:																
Coal	4	5	1	[2]	4	4	---	---	---	---	---	---	---	---	1	---
Metal	1,877	1,830	561	547	4,487	4,359	3	1	83	85	19.17	19.73	6,612	2,234	18	3
Nonmetal	265	270	60	59	488	481	---	---	10	8	20.48	16.63	479	81	44	5
Sand and gravel	1,056	1,085	166	171	1,370	1,412	---	1	26	25	18.98	18.41	424	4,933	295	---
Stone	413	405	97	98	779	821	1	---	18	19	24.40	23.14	8,592	1,291	27	13
Total or average	3,615	3,595	885	875	7,128	7,077	4	2	137	137	19.78	19.64	5,215	2,516	385	21
Tennessee:																
Coal	2,503	2,490	454	395	3,672	3,215	11	6	108	90	32.40	29.86	19,020	12,205	293	---
Metal	1,712	1,685	458	410	3,665	3,301	3	2	114	98	31.92	30.29	8,352	6,622	18	6
Nonmetal	855	855	229	230	1,877	1,891	---	---	46	36	24.51	19.04	2,038	1,757	44	16
Sand and gravel	668	730	166	188	1,413	1,599	1	---	21	33	15.57	20.64	6,887	438	95	---
Stone	2,971	2,845	783	776	6,543	6,343	---	2	124	161	18.95	25.70	2,937	2,887	136	113
Total or average	8,709	8,605	2,090	1,999	17,170	16,349	15	10	413	418	24.93	26.18	7,760	5,103	586	135

Texas:																
Coal	102	90	28	25	226	195	---	---	3	5	13.28	25.64	235	462	2	---
Metal	1,409	1,465	430	445	3,442	3,562	---	---	22	21	6.39	5.90	172	182	9	4
Nonmetal and native asphalt	2,898	3,370	850	974	6,872	7,929	---	2	161	161	23.43	20.56	873	3,065	135	56
Sand and gravel	2,558	2,470	649	643	5,560	5,675	4	2	133	168	24.64	29.96	5,019	2,743	278	---
Stone	4,313	4,365	1,312	1,327	11,150	11,020	2	5	227	177	20.54	16.52	1,717	3,554	209	188
Total or average	11,280	11,760	3,269	3,414	27,250	28,381	6	9	546	532	20.26	19.06	1,971	2,811	633	248
Utah:																
Coal	1,495	1,500	317	305	2,524	2,400	2	5	92	87	37.24	38.33	8,382	13,769	36	---
Metal	5,055	4,955	1,550	1,521	12,402	12,171	6	10	235	215	19.43	18.49	3,582	5,997	188	11
Nonmetal	980	970	273	266	2,184	2,129	3	6	111	114	52.20	56.36	11,845	17,978	45	22
Sand and gravel	513	520	106	103	856	830	1	---	22	19	26.88	22.89	7,566	520	161	---
Stone	451	450	110	116	878	923	---	---	12	12	13.66	13.00	268	4,037	62	45
Native asphalt	239	189	59	51	470	410	1	---	19	17	42.53	41.42	14,954	387	10	3
Total or average	8,733	8,584	2,415	2,362	19,314	18,863	13	21	491	464	26.10	25.71	5,446	7,880	502	81
Vermont:																
Nonmetal and peat	324	310	88	86	713	693	---	---	22	16	30.85	23.09	8,927	1,042	8	6
Sand and gravel	221	210	43	39	355	327	---	---	5	8	14.08	24.46	803	554	58	---
Stone	1,813	1,875	455	476	3,707	3,914	1	---	131	136	35.61	34.75	2,981	1,339	53	30
Total or average	2,358	2,395	586	601	4,775	4,934	1	---	158	160	33.30	32.43	3,707	1,245	119	36
Virginia:																
Coal	11,195	11,185	2,248	2,222	17,914	18,180	25	30	958	995	54.87	56.38	11,722	13,349	1,585	---
Metal	301	335	79	89	629	714	---	---	35	30	55.61	42.02	1,447	1,979	2	2
Nonmetal	688	665	190	182	1,531	1,457	---	---	47	47	30.71	32.26	891	879	29	15
Sand and gravel	629	610	143	153	1,197	1,366	---	---	31	31	25.91	22.69	486	450	67	---
Stone	4,172	4,295	1,096	1,162	9,052	9,626	2	---	216	194	24.08	20.15	2,050	725	168	149
Total or average	16,985	17,090	3,756	3,808	30,323	31,343	27	30	1,287	1,297	43.33	42.34	7,631	8,071	1,851	166
Washington:																
Coal	83	80	18	18	145	138	---	---	12	11	82.57	79.71	2,959	2,870	8	---
Metal	427	370	128	104	1,028	831	1	1	74	52	72.97	63.78	7,552	15,197	26	5
Nonmetal	129	140	22	21	175	175	---	---	2	2	11.41	11.43	319	63	23	6
Sand and gravel	1,712	1,530	321	299	2,580	2,284	---	---	54	52	20.93	22.77	449	647	355	---
Stone	1,220	1,180	251	232	2,018	1,866	---	---	30	36	14.87	19.29	246	589	225	156
Peat	35	28	4	4	32	31	---	---	1	---	30.79	---	123	---	19	---
Total or average	3,606	3,328	744	678	5,978	5,325	1	1	173	153	29.11	28.92	1,657	2,932	656	167
West Virginia:																
Coal	44,495	43,500	9,580	9,269	75,999	73,420	95	80	4,678	4,335	62.80	60.13	11,619	10,494	1,829	---
Nonmetal	967	1,000	300	308	2,400	2,465	---	---	17	17	7.08	6.90	433	486	12	8
Sand and gravel	240	270	56	70	473	600	---	2	10	14	21.16	26.67	838	20,382	22	---
Stone	1,164	1,420	298	371	2,495	2,940	1	---	39	59	16.03	20.07	3,717	1,113	73	61
Total or average	46,866	46,190	10,234	10,018	81,367	79,425	96	82	4,744	4,425	59.48	56.75	10,984	9,911	1,936	69

See footnotes at end of table.

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

State and industry group	Average men working daily		Man-shifts (thousands)		Man-hours worked (thousands)		Number of injuries				Injury rates per million man-hours				Count of operations 1965	
							Fatal		Nonfatal		Frequency		Severity			
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	Mines	Mills
Wisconsin:																
Metal	323	255	64	71	513	562	---	1	30	30	58.47	55,16	2,002	20,402	22	4
Nonmetal	20	85	2	12	18	96	---	---	---	4	---	41.67	---	1,521	5	1
Sand and gravel	2,271	2,215	448	444	3,788	3,755	---	1	68	79	17.95	21.30	848	2,058	407	---
Stone	2,682	2,115	541	445	4,414	3,690	2	2	107	113	24.69	31.17	3,421	5,376	324	173
Peat	14	15	1	1	9	9	---	---	1	---	113,37	---	5,668	---	3	---
Total or average	5,310	4,685	1,056	973	8,742	8,112	2	4	206	226	23.79	28.35	2,218	4,829	761	178
Wyoming:																
Coal	328	330	74	71	574	546	---	---	17	16	29.60	29.30	1,299	1,289	17	---
Metal	1,421	1,650	383	389	3,079	3,198	1	1	72	80	23.71	25.33	3,324	3,393	72	11
Nonmetal	1,133	1,200	354	315	2,860	2,555	1	---	50	39	17.83	15.26	3,546	577	34	18
Sand and gravel	874	870	150	142	1,197	1,138	---	---	20	26	16.71	22.85	337	490	143	---
Stone	288	275	70	66	620	519	---	---	13	9	20.97	17.34	148	588	41	23
Total or average	4,044	4,325	1,031	983	8,330	7,956	2	1	172	170	20.89	21.49	2,595	1,746	307	52
United States totals: [3]																
Coal	148,734	146,192	31,513	30,234	248,988	240,642	259	233	11,138	10,504	45.77	44.62	8,960	8,409	9,151	[4] 146
Peat	623	523	94	96	784	804	---	---	13	10	16.57	12.44	593	373	154	---
Native asphalt	427	368	108	99	874	806	1	1	26	28	30.90	35.98	8,335	7,872	14	8
Metal	70,904	71,500	20,069	20,526	160,934	164,720	61	80	3,764	3,855	23.77	23.89	3,521	4,257	2,237	278
Nonmetal	48,429	50,900	13,430	14,106	108,735	114,260	31	27	2,472	2,685	23.02	23.74	3,050	2,578	2,167	845
Sand and gravel	54,159	55,900	11,947	12,391	100,083	103,240	40	35	1,870	2,110	19.08	20.78	3,214	2,929	9,807	---
Stone	89,580	89,300	23,535	23,801	194,000	196,255	48	52	3,305	3,830	17.28	19.78	2,330	2,828	5,414	3,585
Total or average	412,856	414,683	100,696	101,253	814,398	820,727	440	428	22,588	23,022	28.28	28.57	4,802	4,732	28,944	4,862
Petroleum and natural gas [5]	436,935	451,747	NA	NA	931,645	954,527	78	103	8,963	8,724	9.70	9.25	934	1,050	NA	NA
Coke	14,521	14,216	5,113	5,094	40,869	40,730	7	3	228	191	5.75	4.76	1,805	666	---	80
Blast-furnace-slag	1,537	1,472	425	407	3,415	3,332	1	---	50	44	14.93	13.20	3,173	709	---	65
Primary nonferrous smelting and refining	41,627	42,600	13,959	14,509	109,567	115,545	12	9	971	1,110	8.97	9.68	1,173	945	---	93
Grand total or average	907,476	924,718	120,193	121,263	1,899,894	1,934,861	538	543	32,800	33,091	17.55	17.38	2,629	2,597	28,944	5,100

NA Not available.
[1] All data for 1965 are final. All data for 1966 are preliminary except anthracite, peat, native asphalt, petroleum and natural gas, coke, and slag.
[2] Less than 500.
[3] Data may not add to totals shown because of rounding.
[4] Anthracite cleaning plants only; data not available for bituminous-coal cleaning plants.
[5] Includes data on officeworkers.

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

Year	Men working	Man-hours worked (thousands)	Number of injuries		Injury rate per million man-hours	
			Fatal	Nonfatal	Fatal	Nonfatal
1962	950,876	1,917,475	647	33,067	0.34	17.25
1963	926,700	1,898,476	568	32,659	.30	17.20
1964	r 892,422	r 1,849,921	542	r 32,413	.29	17.52
1965	907,476	1,899,895	538	32,800	.28	17.26
1966 p	924,718	1,934,861	543	33,091	.28	17.10

r Revised. p Preliminary.

Work Stoppages.—A total of 199 work stoppages in certain mineral industry groups during 1966 resulted in a time loss of approximately 747,000 man-days of work, according to the U.S. Department of Labor, Bureau of Labor Statistics. Comparable data for 1965 were 205 work stoppages with an aggregate time loss of approximately 493,000 man-days. A large increase over the 1965 time loss occurred in bituminous coal mining, where 160 work stoppages resulted in a loss of 629,000 man-days in 1966. Other mineral industries in which increases occurred were anthracite coal mining, lead-zinc mining, and ferroalloy metal ores.

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

Industry and year	Work stoppages	
	Number	Man-days lost (thousands)
Coal mining:		
Anthracite:		
1962	8	14.6
1963	4	3.0
1964	5	(1)
1965	3	1.7
1966	4	8.3
Bituminous:		
1962	121	191.0
1963	131	[2] 234.0
1964	111	340.0
1965	145	258.0
1966	160	629.0
Coke and byproducts, coke only:		
1962	NA	NA
1963	NA	NA
1964	NA	NA
1965	NA	NA
1966	NA	NA
Petroleum refining:		
1962	5	516.0
1963	1	[2] 314.0
1964	14	162.0
1965	7	[2] 31.4
1966	5	5.6
Metal mining:		
Iron:		
1962	3	17.4
1963	1	[2] 2.4
1964	3	5.5
1965	3	21.9
1966	---	---
Copper:		
1962	5	129.0
1963	5	27.6
1964	11	385.0
1965	3	60.5
1966	6	25.2
Lead-zinc:		
1962	4	160.0
1963	---	[2] 91.7
1964	9	14.9
1965	6	43.3
1966	4	[2] 66.0
Gold-silver:		
1962	1	8.8
1963	1	16.0
1964	---	[2] 21.6
1965	---	---
1966	---	---
Bauxite and other aluminum ores:		
1962	---	---
1963	---	---
1964	---	---
1965	---	---
1966	---	---
Ferroalloy metal ores:		
1962	1	211.0
1963	1	[2] 9.6
1964	---	---
1965	---	---
1966	1	(1)
Metal mining services:		
1962	---	---
1963	---	---
1964	---	---
1965	---	---
1966	---	---
Miscellaneous metal ores:		
1962	---	---
1963	---	---
1964	---	---
1965	---	---
1966	---	---
Mining and quarrying of nonmetallic minerals (except fuels):		
Dimension stone:		
1962	3	74.5
1963	1	(1)
1964	1	2.2
1965	3	[2] 2.1
1966	1	(1)
Crushed and broken stone:		
1962	4	6.3
1963	5	3.8
1964	8	24.7
1965	9	38.0
1966	7	9.2
Sand and gravel:		
1962	3	2.0
1963	2	(1)
1964	2	(1)
1965	10	3.5
1966	7	1.9
Clay, ceramic and refractory minerals:		
1962	1	(1)
1963	---	---
1964	1	(1)
1965	---	---
1966	---	---
Chemical and fertilizer mineral mining:		
1962	5	169.0
1963	1	[2] 88.6
1964	4	12.5
1965	1	(1)
1966	2	(1)
Nonmetallic minerals (except fuels) services:		
1962	---	---
1963	---	---
1964	---	---
1965	---	---
1966	---	---
Miscellaneous nonmetallic minerals (except fuels):		
1962	---	---
1963	---	---
1964	---	---
1965	1	(1)
1966	---	---
Cement, hydraulic:		
1962	1	(1)
1963	1	(1)
1964	1	7.4
1965	14	32.3
1966	2	1.7

NA Not available.
[1] Less than 1,000 man-days.
[2] Includes idleness from stoppages which began in the previous year.
Source: U.S. Department of Labor, Bureau of Labor Statistics.

SAFETY COMPETITIONS

The Bureau of Mines conducts annual safety competitions to aid in the promotion of accident-prevention activities in the nation's mines, pits, and quarries. A total of 1,230 operations participated in the 1966 competitions.

The National Safety Competition, cosponsored by the Bureau of Mines and the American Mining Congress, completed its 42d consecutive year in 1966 with an enrollment of 800 operations. A total of 341, or 43 percent of the 800 contestants, worked 22.7 million man-hours without a disabling work injury.

The National Safety Competition is divided into six competitive groups to assure equality of competition among operations with similar working conditions. The winning operation in each group is awarded the "Sentinels of Safety" trophy and plant flag. In addition, each employee at the winning plant receives the Bureau's "Certificate of Accomplishment in Safety" for his part in the winning record.

The following mines, pits, and quarries won 1966 trophies for being operated the greatest number of injury-free man-hours in each of the six competing groups:

Underground Coal Mines.—Karen Mine, United States Steel Corp., Fredericktown, Pa.

Surface Coal Mines.—No. 2 Mine, Consolidation Coal Co., Truax-Traer Coal Company Division, Pinckneyville, Ill.

Underground Metal Mines. — Calloway Mine, Tennessee Copper Co., Ducktown, Tenn.

Underground Nonmetal Mines.—Barberton Mine, Pittsburgh Plate Glass Company, Chemical Division, Barberton, Ohio.

Open-Pit Mines (Metal and Nonmetal).—Sherman Mine, United States Steel Corp., Minnesota Ore Operations, Chisholm, Minn.

Quarries. — Thorton Quarry, General Dynamics Corp., Material Service Division, Thornton, Ill.

A total of 210 operations participated in the National Sand and Gravel Safety Competition sponsored by the Bureau. Seventy percent of these operations were injury-free during 1966 and worked nearly 4.5 million man-hours, or more than half of the total worktime of all participants.

Three other safety contests, cosponsored respectively by the National Lime Association, the National Limestone Institute, and the National Slag Association were conducted during 1966. A total of 220 plants were entered in these contests.

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 Ronald P. Hollenbeck [1] and W. Everett Smith [2]

The value of mineral production in Alabama increased 1 percent above the record high set in 1965. Alabama ranked second among the States in the production of bauxite, third in the production of masonry cement, native asphalt, and scrap mica, sixth in the production of portland cement, ninth in the production of iron ore, and tenth in the production of lime.

The mineral industry of Alabama was dominated by the mining and processing of coal and stone, the manufacturing of cement, and the production of crude petroleum. These industries accounted for 87 percent of the State's total value of mineral production, compared with 85 percent in 1965.

[1] Mining engineer, Bureau of Mines, Knoxville, Tenn.
[2] Chief, Economic Geology Division, Geological Survey of Alabama, Tuscaloosa, Ala.

Table 1.—Mineral production in Alabama [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Cement: [2]				
Portland—thousand 376-pound barrels	13,765	$42,604	16,394	$49,537
Masonry—thousand 280-pound barrels	2,598	7,853	2,570	7,613
Clays—thousand short tons	[3] 2,220	[3] 4,888	2,448	5,142
Coal (bituminous)—do	14,832	106,249	14,219	100,112
Iron ore (usable)—thousand long tons, gross weight	1,495	8,241	1,508	8,702
Lime—thousand short tons	653	7,905	699	8,442
Natural gas—million cubic feet	203	26	252	32
Petroleum (crude)—thousand 42-gallon barrels	8,064	21,047	8,030	20,878
Sand and gravel—thousand short tons	6,422	7,195	7,082	7,953
Stone [4]—do	17,987	30,810	20,744	36,839
Value of items that cannot be disclosed: Asphalt (native), bauxite, slag cement, clay (bentonite 1965, kaolin 1965), scrap mica, salt, stone (dimension limestone, dimension marble, oystershell 1965, crushed sandstone), talc, and tripoli (1965)	XX	9,446	XX	4,528
Total	XX	246,264	XX	249,778

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes certain cement; included with "Value of items that cannot be disclosed."
[3] Excludes bentonite and kaolin.
[4] Excludes certain stone; included with "Value of items that cannot be disclosed."

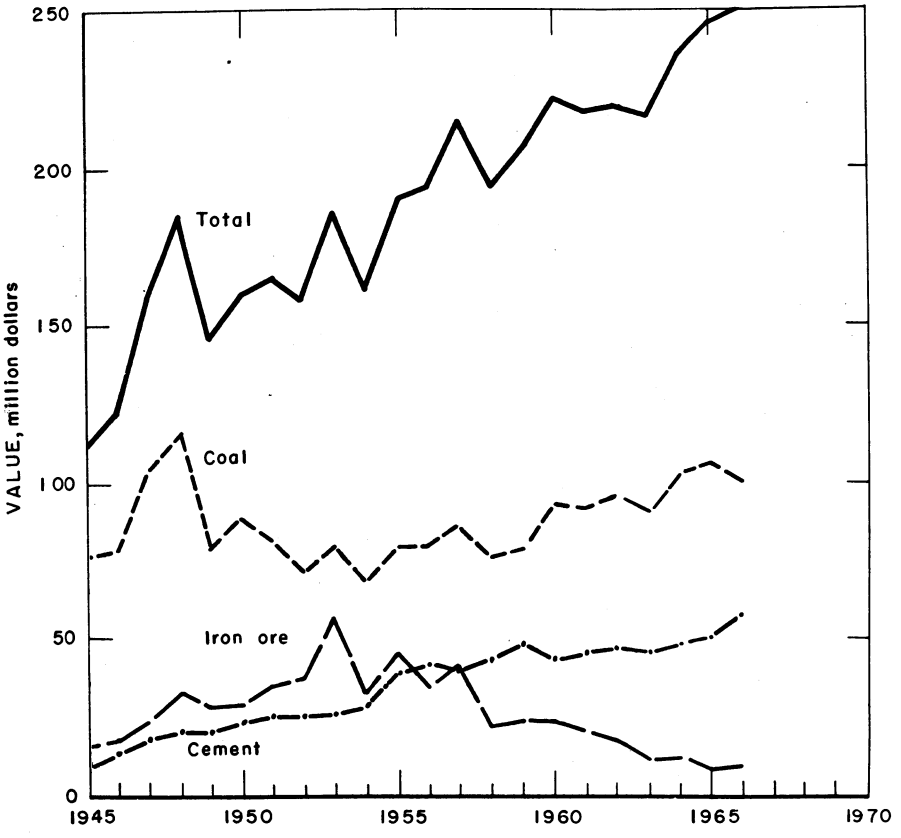

Figure 1.—Value of coal, cement, and iron ore, and total value of mineral production in Alabama.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value
1957	$213,605
1958	194,053
1959	205,416
1960	225,882
1961	224,815
1962	228,652
1963	226,802
1964	242,146
1965	r 255,222
1966	p 247,381

r Revised. p Preliminary.

Leading producing companies were United States Steel Corp. (coal, cement, limestone, shale, sandstone), Southern Cement Co. (cement, lime, limestone, shale), Southern Electric Generating Co. (coal), Woodward Iron Co. (coal, iron ore, limestone, lime), and Alabama By-Products Corp. (coal).

Trends and Developments.—Republic Steel Corp. continued its expansion program at the Gadsden plant which began about 10 years ago. Eight open-hearth furnaces have been torn down and replaced by two 150-ton basic oxygen furnaces. This is the first use of the basic oxygen process in the South. A new hot-strip mill was put into operation in December, and a new plate mill is scheduled for operation in 1967.

McWane Cast Iron Pipe Co. revealed plans to construct a $15 million pig iron operation near Mobile. The operation will use a new method developed by the McDowell-Wellman Engineering Co. in

Table 3.—Employment 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
1965:								
Coal	5,632	212	1,196	9,531	7	129	14.27	5,205
Metal	1,261	270	341	2,830	---	30	10.60	699
Nonmetal and native asphalt	972	276	268	2,157	---	26	12.05	3,009
Sand and gravel	510	280	143	1,286	2	17	14.78	12,386
Stone	2,679	294	787	6,493	3	60	9.70	3,706
Total	11,054	247	2,735	22,297	12	262	12.29	4,398
1966: p								
Coal	5,610	185	1,039	8,345	5	110	13.78	4,373
Metal	1,240	278	345	2,868	---	42	14.64	412
Nonmetal and native asphalt	1,050	280	294	2,370	1	42	18.14	2,827
Sand and gravel	500	275	138	1,230	1	16	13.82	11,485
Stone	2,655	289	768	6,361	1	73	11.63	4,672
Total	11,055	234	2,584	21,174	8	283	13.74	4,166

p Preliminary.

which a sintering machine and an electric smelting furnace are used to convert ore, coal, and limestone directly into iron. It is reported that this will be the first commercial version of the process.

Revere Copper and Brass, Inc., started construction of an aluminum rolling mill on Goose Pond Island in the Tennessee River near Scottsboro. The mill, which is scheduled for completion in the latter part of 1967, will be one of the most modern mills in the world.

Reynolds Metals Co. announced construction of a new cold-rolling mill for aluminum strip at its Listerhill alloy plant. It is scheduled to begin operation in mid-1967.

Alabama By-Products Corp. reported its first production from a new coal mine, Chetopa, near Graysville in the latter part of the year. The mine was developed by a slope and two shafts in the Mary Lee coal seam. The mine and plant facilities use the latest in equipment for mining and processing the coal.

The firm also announced construction of a new 78-oven battery of coke ovens at its Tarrant coke and coal chemicals complex. This battery will incorporate the latest design in extra tall, large-capacity ovens and air and water pollution control equipment. The initial unit is expected to be completed and put in operation during the first quarter of 1968.

Peabody Coal Co. was developing its new Warrior mine near Oak Grove, in the Warrior River. A shovel with a 75-cubic-yard bucket has been ordered for this operation.

Tennessee Valley Authority decided to build a 2,304,000-kilowatt capacity nuclear-power plant at Browns Ferry on Wheeler Reservoir in northern Alabama. An award for two nuclear generating units of 1,152,000-kilowatt capacity each, the largest such units in the world, went to General Electric. This will be TVA's first nuclear-fueled, steam-electric generating station. Onsite construction is expected to begin in the spring of 1967.

Several companies were actively engaged in exploration for copper in the Alabama Piedmont region. Interest in gold recovery continued to increase. Several small operations were initiated during the year at previously abandoned gold mines. Interest in lead occurrences was high, and several companies initiated preliminary exploration activities. A number of major companies made preliminary investigations of phosphate rock during the year.

Legislation and Government Programs.—The Bureau of Mines Tuscaloosa Metallurgical Research Laboratory conducted research on many problems connected with the mineral industries. The Bureau's Area II Mineral Resource Field Office also at Tuscaloosa investigated heavy minerals resources in the southeastern United States and phosphate rock resources in northern Alabama. Projects completed consisted of an investigation, in cooperation with the

Geological Survey of Alabama, of anthophyllite asbestos deposits in Tallapoosa County; case studies of factors that influence the accumulation of automobile scrap in Jefferson County; and case studies of conflicting mineral-land use in Jefferson County.

At yearend, 426 miles of Alabama's Interstate and Defense Highways was open to traffic. This represents 48 percent of the total 880 miles designated for Alabama. Work was in progress on 431 miles.

The Geological Survey of Alabama neared completion of mineral resource maps of Barbour, Henry, Houston, Pike, Crenshaw, Geneva, Butler, Bullock, Conecuh, Coffee, Covington, Dale, and Escambia Counties, and started resource maps of Etowah, Calhoun, DeKalb, Marion, Winston, Marengo, Clarke, Wilcox, Choctaw, Washington, Monroe, Baldwin, and Mobile Counties. The Geological Survey of Alabama, working in cooperation with the Ground Water Branch of the U.S. Geological Survey, released geologic maps of Lawrence, Barbour, Coffee, Cherokee, and Pickens Counties.

The Geological Survey of Alabama began a test drilling program in the Barbour-Henry County bauxite district with the hope of expanding the limits of the district and researching the use of kaolinitic clays associated with the bauxite. Test drilling has been supplemented by seismic studies. Clay samples are being evaluated with the aid of differential thermal analysis, chemical, and X-ray data. Firing tests on the samples are being conducted in cooperation with the Tuscaloosa Metallurgy Research Laboratory.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Mineral fuels accounted for 49 percent of the total value of Alabama's mineral production, compared with 52 percent in 1965.

Asphalt (Native).—Alabama Asphaltic Limestone Co. crushed bituminous limestone at its Margerum quarry in Colbert County. Production decreased 6 percent and was 16 percent below the 1964 record. Alabama ranked third among the States in the production of native asphalt.

Coal (Bituminous).—Bituminous coal was mined at 183 mines in 11 counties, compared with 206 mines in 12 counties in 1965. Total coal output decreased 4 percent and was 32 percent below the 1926 record. The leading producing counties were Jefferson, Walker, and Tuscaloosa. Leading producers among the companies were United States Steel Corp., Southeastern Electric Generating Co., Alabama By-Products Corp., and Peabody Coal Co., which together supplied 43 percent of the State's total production. The average output per mine increased from 72,000 tons in 1965 to 77,000 tons. Captive tonnage was 46 percent of the total production, compared with 49 percent in 1965.

Of the total production, 63 percent was from 116 underground mines, 36 percent from 61 strip mines, and 1 percent from 6 auger mines. Rail or water transportation was used to ship 84 percent of the coal; 16 percent was shipped by truck.

Ninety-four percent of the coal mined underground was mechanically loaded; 92 mobile loading machines loaded 82 percent; 6 continuous miners loaded 5 percent; and 1 self-loading and 27 hand-loaded face conveyors loaded 2 percent.

Equipment used at underground mines included 130 cutting machines, which cut 93 percent of the tonnage; 183 power drills, which drilled 94 percent; 140 locomotives; 37 tractors; 172 shuttle cars; and 129 mother conveyors.

Equipment used at strip mines included 72 power shovels, 39 draglines, 3 carryall scrapers, 94 bulldozers, 43 power drills, and 110 trucks. An estimated 94 million cubic yards of overburden was removed.

Equipment used at auger mines included 6 augers, 1 bulldozer, and 8 trucks.

Of the total production, 73 percent was cleaned at 27 cleaning plants. The average recovery at these plants was only 60 percent; 40 percent was refuse.

Coke.—Six companies produced byproduct metallurgical coke at seven plants in Jefferson, Etowah, and Tuscaloosa Counties. Leading producers were United States Steel Corp. and U.S. Pipe & Foundry Co.

Natural Gas.—Marketed production of natural gas increased slightly. The white House gasfield in Marion County was the only producing field.

Table 4.—Coal (bituminous) production, by counties

County	1965		1966	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Bibb	203,040	$946	139,525	$735
Blount	53,384	270	182,084	1,084
Cullman	4,393	32	2,200	16
Etowah	134,227	712	W	W
Jackson	272,419	1,002	544,883	1,970
Jefferson	7,330,030	58,733	7,013,638	56,501
Marion	477,365	1,848	499,345	2,373
St. Clair	35,000	148	-------	-------
Shelby	674,751	6,091	521,962	4,809
Tuscaloosa	1,187,750	5,154	1,382,254	6,047
Walker	4,305,506	30,544	3,798,151	25,858
Winston	153,727	769	W	W
Undistributed	-------	-------	134,680	719
Total	14,831,592	106,249	14,218,722	100,112
Earliest record to date	1,027,066,000	NA	1,041,285,000	NA

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
NA Not available.

Petroleum.—Production of crude petroleum decreased slightly and was 12 percent below the 1963 record. Five fields in five counties contributed to the total production. The Citronelle field in Mobile County was the leading producer, followed by the Pollard field, Escambia County; the Gilbertown field, Choctaw County; the South Carlton field, Clarke and Baldwin Counties; and the Tensaw field, Baldwin County. Oil drilling operations decreased during the year as compared with 1965. A total of 27 wells were drilled in 1966; 5 were completed as oil wells; 4 wells in the existing oilfields were dry holes; and 18 wildcat wells were dry holes. No wells were drilled in the State's largest producing area, the Citronelle field. The Citronelle field was originally developed on 40-acre spacing, and most of the productive area has been developed. A secondary recovery program was in progress, and some of the undrilled acreage on the flanks of the field would probably be developed on 80-and-160 acre spacing during 1967. There were 524 producing wells in the five counties as follows: Baldwin, 10; Choctaw, 65; Clarke, 13; Escambia, 30; and Mobile, 406.

The Cotton Valley formation and the Smackover formation discoveries in adjacent Mississippi have created interest in the Jurassic sediments in Alabama. Drilling of two test wells in the Smackover formation was in progress at the end of 1966, and three additional locations were staked. The most recent leasing and geophysical activity has been along the Jurassic trend, and an increasing number of wells were expected to be drilled in this horizon in 1967.

NONMETALS

Nonmetals accounted for 48 percent of the State's total value of mineral production, compared with 45 percent in 1965.

Cement.—Eight companies produced masonry cement at nine plants in five counties. Leading producers were Southern Cement Co. and Ideal Cement Co. Shipments decreased 2 percent below the 1965 record. Alabama ranked third among the States in the production of masonry cement. Consumption of masonry cement in Alabama was 25 percent of the total shipments. Other shipments were made to Georgia, 34 percent; Florida, 13 percent; South Carolina, 7 percent; Mississippi, 6 percent; Louisiana, 6 percent; North Carolina, 4 percent; Tennessee, 3 percent; and other States, 2 percent.

Table 5.—Crude petroleum production, by counties

(42-gallon barrels)

County	1965	1966
Baldwin	36,797	70,177
Choctaw	310,468	282,203
Clarke	126,701	121,123
Escambia	509,174	453,389
Mobile	7,080,860	7,103,108
Total	8,064,000	8,030,000
Earliest record to date	73,940,000	81,970,000

Source: State Oil and Gas Board.

Seven companies produced portland cement at eight plants in five counties. The annual capacity of portland cement plants was 16.7 million barrels. Leading producers were Lone Star Cement Corp., Southern Cement Co., and Ideal Cement Co. Shipments increased 3 percent over the 1965 record. Alabama ranked sixth among the States in the production of portland cement. Consumption of portland cement in Alabama was 37 percent of total shipments. Other shipments were made to Georgia, 24 percent; Mississippi, 13 percent; Florida, 7 percent; South Carolina, 5 percent; Louisiana, 4 percent; and other States, 10 percent.

Raw materials used in manufacturing portland cement included cement rock, which accounted for 49 percent; limestone and oystershell, 32 percent; clay and shale, 11 percent; and other materials, 8 percent of the total.

Fifty-eight percent of the portland cement was used for ready-mixed concrete; highway contractors accounted for 16 percent; manufacturers of concrete products, 15 percent; building material dealers, 6 percent; and other users, 5 percent.

Southern Cement Co. and Cheney Lime & Cement Co. produced slag cement at Jefferson and Blount County plants. Shipments decreased 16 percent and were 80 percent below the 1952 record.

Clays.—Thirteen companies mined fire clay for refractories at 15 mines in 6 counties. Leading producers were Donoho Clay Co. and Russell Coal & Clay Co., with mines in Calhoun and Walker Counties. Production was 1 percent below the 1965 record.

Twenty companies mined 1.9 million tons of miscellaneous clay at 24 mines in 12 counties for heavy clay products, portland cement, and lightweight aggregate. Leading counties were Jefferson and Russell. Leading producers were Bickerstaff Brick Co. Inc., in Russell County, and Jenkins Brick Co., with plants in Montgomery and Elmore Counties. Production increased 6 percent above the 1965 record.

Harbison-Walker Refractories Co. and Thomas Alabama Kaolin Co. mined kaolin in Henry and Marion Counties for a variety of uses. Production was 30 percent above the 1965 record. American Colloid Co., in their third year of operation, produced bentonite in Lowndes County; production increased 33 percent.

Lime.—Six companies produced quicklime and hydrated lime at seven plants in Shelby and Dallas Counties for construction, agricultural, chemical, and industrial uses. Leading producers were Southern Cement Co. and Longview Lime Corp. Production increased 7 percent over the 1965 record. Consumption of lime in Alabama accounted for 59 percent of total shipments, Florida accounted for 16 percent of the total out-of-State shipments; Georgia, 15 percent; Tennessee, 2 percent; and other States, 8 percent.

Six companies operating seven papermills recovered quicklime as a byproduct. Leading firms were Scott Paper Co., Mobile County, and American Can Co., Choctaw County.

Mica.—U.S. Gypsum Co. and Black Warrior Petroleum Co. Inc. mined scrap mica in Randolph County. Production decreased 19 percent from the 1965 record. Alabama ranked third among the States in the production of scrap mica.

Salt.—Olin Mathieson Chemical Corp. produced salt in brine in Washington County. Production increased 2 percent over the 1965 record.

Sand and Gravel.—Fifty-two commercial and three Government-and-contractor

Table 6.—Fire clay sold or used by producers, by uses

Use	1965			1966		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Firebrick and block	233,996	$947,244	$4.05	193,509	$755,173	$3.90
Kiln furniture	-------	-------	----	161,497	W	W
Foundries and steelworks	221,457	2,237,567	10.10	W	W	W
Other uses [1]	4,997	34,790	6.96	100,107	1,418,947	14.17
Total	460,450	3,219,601	6.99	455,113	2,174,120	4.78

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."
[1] Includes mortar, exports (1965), and uses indicated by symbol W.

Table 7.—Lime sold or used by producers, by uses

Use	1965			1966		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Paper	179,541	$2,251,069	$12.54	204,367	$2,454,613	$12.01
Construction	W	W	W	136,081	1,841,123	13.53
Water purification	46,842	599,852	12.81	54,602	708,699	12.98
Steel electric furnaces	49,032	620,155	12.65	29,341	337,270	11.49
Sugar refining	W	W	W	4,721	59,687	12.64
Tanning	1,125	14,319	12.73	W	W	W
Other uses [1]	376,697	4,419,860	11.73	270,169	3,040,292	11.25
Total	653,237	7,905,255	12.10	699,281	8,441,684	12.07

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."
[1] Includes lime used for agriculture, alkalies, aluminum, brick sand-lime and slag, brick silica, calcium carbide, coke, food, insecticides, magnesium, metallurgy, petroleum refining (1965), oil-well drilling (1966), ore concentration, paint, sewage, steel basic oxygen, steel open-hearth furnaces, other uses, and uses indicated by symbol W.

operations mined sand and gravel in 33 counties. Commercial operations accounted for 98 percent of the total production. Leading producers were Vulcan Materials Co., in Montgomery and Macon Counties; Alabama Gravel Co., in Elmore and Montgomery Counties; and Dallas Sand & Gravel Co. Inc., in Autauga County. Leading counties were Montgomery, Macon, and Chilton. Forty stationary plants, and 10 portable plants, and 17 dredges were in operation. Production increased 10 percent over the 1965 record. Virtually the entire production was processed by washing. Of the total commercial production, 59 percent was shipped by truck, 33 percent by rail, and 6 percent by water. The size of the commercial operations producing sand and gravel is illustrated by the fact that 58 percent of the operations had annual outputs of less than 100,000 tons, and accounted for only 16 percent of the total State production.

Stone.—Forty-six commercial and two Government-and-contractor operations mined and crushed limestone in 21 counties. Commercial operations accounted for practically all of the production. Leading counties were Shelby, Jefferson, Madison, and Colbert. Leading producers were Vulcan Materials Co., Southern Cement Co., Lone Star Cement Corp., and Madison Limestone Co. Inc. Production increased 8 percent over the 1965 record. Major use was for concrete and roads, followed by cement, lime, and flux.

Georgia Marble Co. quarried dimension limestone in Franklin County for building stone, including dressed, rough construction, and rough architectural. Production decreased 22 percent. Thompson-Weinman & Co., Moretti-Harrah Marble Co., and Georgia Marble Co. crushed and ground marble at Sylacauga, Talladega County, for paint, putty, rubber, plastics, roofing granules, and other uses. Production increased 5 percent over the 1965 record.

Moretti-Harrah Marble Co. and Georgia Marble Co. quarried dimension marble at Sylacauga for rough and dressed building stone and dressed monumental stone. Production increased 23 percent.

Radcliff Materials, Inc., and Southern Oystershell Mining Corp. crushed oystershell from Mobile Bay for cement, concrete, roads, and poultry grit.

United States Steel Corp. and Enos Vann crushed sandstone in Jefferson County. Production increased 3 percent.

Talc.—American Talc Co. mined and ground talc at Winterboro for toilet preparations, paint, and other uses. Production increased 44 percent but was 31 percent below the 1964 record.

Vermiculite.—Zonolite Co., Division of W. R. Grace & Co. exfoliated vermiculite at its plant near Birmingham, using crude materials from other States.

METALS

Aluminum and Bauxite.—Wilson-Sneed Mining Co., Harbison-Walker Refractories Co., and National Properties & Mining Co. mined crude bauxite in Barbour and Henry Counties for refractories and chemicals. Production increased 33 percent but was 57 percent below the 1943 record. Ala-

Table 8.—Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1965		1966	
	Quantity	Value	Quantity	Value
Barbour	26	$38	15	$15
Cherokee	2	5	2	W
Cleburne	----	----	22	20
Coffee	----	----	50	37
Dallas	281	281	W	W
Escambia	424	467	518	533
Fayette	W	W	68	109
Franklin	W	W	317	W
Geneva	W	W	30	W
Hale	----	----	2	2
Jefferson	20	18	36	32
Macon	601	796	642	W
Marion	25	38	32	W
Mobile	499	500	W	W
Monroe	69	62	42	46
Montgomery	1,327	1,321	1,643	1,581
Morgan	W	W	198	W
Tuscaloosa	W	W	176	229
Undistributed [1]	3,148	3,669	3,289	5,349
Total	6,422	7,195	7,082	7,953

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes Autauga, Baldwin (1966), Bibb (1966), Chilton, Clarke, Conecuh (1965), Crenshaw, Elmore, Etowah, Greene (1966), Houston, Marshall (1966), Russell, Sumter (1966), Talladega (1966), and Washington Counties, and counties indicated by symbol W.

Table 9.—Sand and gravel sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1965			1966		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	2,348	$2,266	$0.97	2,353	$2,270	$0.96
Paving	717	656	.91	548	508	.93
Filtration	56	56	1.00	W	W	W
Fill	17	14	.82	28	10	.36
Other sands [1]	297	486	1.64	403	589	1.46
Total	3,435	3,478	1.01	3,332	3,377	1.01
Gravel:						
Structural	2,098	2,590	1.23	2,262	2,826	1.25
Paving	559	669	1.20	642	782	1.22
Other gravel [2]	330	458	1.39	846	968	1.14
Total	2,987	3,717	1.24	3,750	4,576	1.22
Total sand and gravel	6,422	7,195	1.12	7,082	7,953	1.12

W Withheld to avoid disclosing individual company confidential data.
[1] Includes engine, molding, and other sands, and uses indicated by symbol W.
[2] Includes fill and other gravel.

bama ranked second among the States in the production of bauxite. Reynolds Metals Co. produced aluminum at its Listerhill plant at Sheffield.

Iron Ore.—Shipments of iron ore increased 1 percent. Of the total shipments, 10 percent was direct-shipping ore, compared with 8 percent in 1965, 13 percent in 1964, and 15 percent in 1963. The number of operating mines decreased from 24 to 19; average usable production per mine increased from 62,000 to 79,000 tons. Alabama ranked ninth among the States in production of iron ore.

Woodward Iron Co. mined red iron ore (hematite) at the Pyne mine in Jefferson County and at the Vance mine in Tuscaloosa County. Production increased 11 percent but was 91 percent below the 1942 record.

Seventeen operations mined brown iron ore (limonite) in seven counties. Leading counties were Franklin, Pike, and Butler. Leading producers were Shook & Fletcher Supply Co., in Blount, Franklin, and Shelby Counties; U.S. Pipe & Foundry Co., in Franklin County; and Glenwood Mining Co., in Pike County. Production decreased 3 percent and was 56 percent below the 1942 record.

Magnesium.—Alabama Metallurgical Corp. produced magnesium metal from dolomite at Selma.

Pig Iron and Steel.—United States Steel Corp., Republic Steel Corp., U.S. Pipe & Foundry Co., and Woodward Iron Co. pro-

Table 10.—Crushed limestone sold or used by producers, by counties

County	1965		1966	
	Short tons	Value	Short tons	Value
Calhoun	453,051	$730,882	293,613	$470,000
Colbert	1,120,379	1,328,341	1,251,170	1,593,971
Cullman	------	------	39,860	61,169
Henry	10,447	31,341	3,327	5,420
Jackson	------	------	130,000	156,000
Jefferson	4,042,196	4,700,295	4,606,217	5,897,334
Limestone	51,027	76,540	45,281	67,921
Madison	W	W	2,329,479	2,155,255
Marengo	W	W	321,930	222,100
Marshall	258,773	387,720	225,000	337,000
Shelby	4,872,315	6,741,595	4,861,146	6,677,815
Washington	W	W	746,870	515,300
Undistributed [1]	6,677,979	6,596,182	3,995,154	4,808,558
Total	17,486,167	20,592,896	18,849,047	22,967,843

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes Bibb, Covington, DeKalb, Etowah, Franklin, Lee, Morgan, St. Clair, and Talladega Counties, and counties indicated by symbol W.

Table 11.—Crushed limestone sold or used by producers, by uses

Use	1965			1966		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	10,185,299	$12,208,595	$1.20	10,370,282	$12,753,356	$1.23
Cement manufacture	3,969,157	2,757,899	.69	4,356,243	3,249,417	.75
Fluxing stone	867,124	1,394,739	1.61	1,244,050	2,055,800	1.65
Lime manufacture	1,115,403	1,758,515	1.58	981,059	1,647,459	1.68
Agstone	546,291	892,282	1.63	666,144	1,152,891	1.73
Riprap	77,383	101,608	1.31	W	W	W
Other uses [1]	725,510	1,479,258	2.04	1,231,269	2,108,920	1.71
Total	17,486,167	20,592,896	1.18	18,849,047	22,967,843	1.22

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."
[1] Includes refractory stone, rock dust for coal mines, railroad ballast, alkali, paper, asphalt filler, fertilizer, filler (1966), filter beds, mineral food, stone sand, and other uses, and uses indicated by symbol W.

Table 12.—Mine production and shipments of crude iron ore

	1965		1966	
	Number of mines	Long tons	Number of mines	Long tons
Mine production:				
By varieties:				
Hematite	2	759,143	2	942,722
Limonite	22	3,343,800	17	3,225,200
By mining methods:				
Open pit	23	3,443,800	18	3,390,200
Underground	1	659,143	1	777,722
Shipments from mines:				
Direct to consumers	1	121,766	1	149,755
To beneficiation plants	23	3,936,754	18	3,976,146

Table 13.—Usable iron ore shipments, by counties

County	1965		1966	
	Long tons	Value	Long tons	Value
Barbour	97,929	$479,230	W	W
Butler	152,842	799,150	140,667	$747,700
Crenshaw	24,265	140,000	16,973	120,000
Jefferson	539,051	W	621,527	W
Pike	228,318	1,169,200	170,356	922,700
Tuscaloosa	34,378	W	19,193	W
Undistributed [1]	417,889	5,653,677	539,443	6,912,014
Total	1,494,672	8,241,257	1,508,159	8,702,414

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes Blount, Franklin, and Shelby Counties, and counties indicated by symbol W.

Table 14.—Usable iron ore production and shipments

	1965		1966	
	Long tons	Iron content, natural (percent)	Long tons	Iron content, natural (percent)
Production:				
Hematite	634,342	34	704,688	34
Limonite	906,092	44	876,740	44
Shipments:				
Direct-shipping ore	121,766	34	149,755	34
Concentrates and sinter	1,372,906	43	1,358,404	41

duced 4,389,000 tons of basic, foundry, and malleable pig iron, compared with 4,296,000 tons in 1965. Value of shipments was $231 million, compared with $235 million in 1965. Imports of iron ore, chiefly from Venezuela and Brazil, remained about the same as in 1965.

Consumption of iron ore in agglomerating plants, blast furnaces, and steel furnaces was 36 percent domestic ore and 64 percent foreign ore. This was the third straight year that consumption of foreign ore exceeded consumption of domestic ore.

REVIEW BY COUNTIES

Mineral production was reported from 54 of the 67 counties as compared with 51 in 1965. The major producing counties were Jefferson, Mobile, Shelby, and Walker, which together furnished 73 percent of the total State value.

Baldwin.—Production of crude petroleum increased 91 percent for a record year. The South Carlton field in Clarke and Baldwin Counties and Alabama's newest field, Tensaw Lake, contributed to the total production. The Tensaw Lake field had three oil wells and two dry holes completed. The Alabama State Highway Department and Hinote Sand Supply mined structural and paving sand and gravel. Fairhope Clay Products Co. mined miscellaneous clay for heavy clay products.

Barbour.—H. D. Loflin and Phillips-Holmes Co., Inc., mined brown iron ore. National Properties & Mining Co., Inc., and Wilson-Sneed Mining Co. mined bauxite for chemicals and refractories. McKenzie Construction Co. mined building sand and gravel.

Bibb.—Southern Materials Co. and Alamet Corp. crushed limestone for roadstone and for lime used in manufacturing magnesium metal. Ten coal mines were active; leading producers were Moss Thornton Co., Inc., (Marvel strip mine), Black Diamond Coal Mining Co. (West Blocton strip mine), and Cane Creek Mining Co. (McCulley Hill strip mine). Cobern Sand Co. mined structural sand.

Blount.—Six coal mines were active; leading producers were Calvert and Youngblood Coal Co. (Thermal strip mine), Youngblood Coal Co. (Lehigh strip mine), and D. D. Cupps and Sons Coal Co. (Cupps No. 1 strip mine). Shook & Fletcher Supply Co. mined brown iron ore

Table 15.—Value of mineral production in Alabama, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Autauga	W	W	Sand and gravel.
Baldwin	$100,640	W	Petroleum, sand and gravel, miscellaneous clay.
Barbour	W	W	Iron ore, bauxite, sand and gravel.
Bibb	W	W	Limestone, coal, sand and gravel.
Blount	W	W	Coal, iron ore, cement, fire clay.
Butler	799,150	$747,700	Iron ore.
Calhoun	W	W	Fire clay, limestone, miscellaneous clay.
Cherokee	5,000	W	Sand and gravel.
Chilton	W	W	Do.
Choctaw	810,321	705,507	Petroleum.
Clarke	W	W	Petroleum, sand and gravel.
Cleburne	------	20,000	Sand and gravel.
Coffee	------	37,000	Do.
Colbert	W	W	Limestone, native asphalt.
Conecuh	W	------	
Covington	W	W	Limestone.
Crenshaw	W	W	Iron ore, sand and gravel.
Cullman	31,673	77,207	Limestone, coal.
Dallas	W	W	Lime, sand and gravel.
De Kalb	W	W	Limestone.
Elmore	W	W	Sand and gravel, miscellaneous clay.
Escambia	W	1,686,422	Petroleum, sand and gravel, miscellaneous clay.
Etowah	W	955,518	Coal, limestone, sand and gravel, fire clay.
Fayette	W	109,000	Sand and gravel.
Franklin	3,641,954	3,286,842	Iron ore, limestone, sand and gravel, fire clay.
Geneva	W	W	Sand and gravel.
Greene	------	W	Do.
Hale	------	2,000	Do.
Henry	W	W	Kaolin, bauxite, limestone.
Houston	W	W	Sand and gravel.
Jackson	1,002,671	2,126,418	Coal, limestone.
Jefferson	94,316,913	92,196,194	Coal, cement, limestone, iron ore, miscellaneous clay, sand and gravel, sandstone.
Lauderdale	W	------	
Lee	W	W	Limestone.
Limestone	76,540	67,921	Do.
Lowndes	W	W	Bentonite.
Macon	796,000	W	Sand and gravel.
Madison	W	W	Limestone, miscellaneous clay.
Marengo	W	W	Cement, limestone.
Marion	W	W	Coal, kaolin, sand and gravel.
Marshall	390;290	W	Limestone, sand and gravel.
Mobile	W	W	Petroleum, cement, oystershell, sand and gravel, miscellaneous clay.
Monroe	62,000	46,000	Sand and gravel.
Montgomry	1,442,350	1,702,000	Sand and gravel, miscellaneous clay.
Morgan	W	W	Limestone, sand and gravel.
Pike	1,169,200	922,700	Iron ore.
Randolph	W	W	Mica.
Russell	W	W	Miscellaneous clay, sand and gravel.
St. Clair	W	W	Cement, limestone, fire clay, miscellaneous clay.
Shelby	27,828,773	28,183,862	Lime, cement, limestone, coal, iron ore, miscellaneous clay.
Sumter	------	W	Sand and gravel.
Talladega	W	W	Marble, limestone, sand and gravel, talc.
Tuscaloosa	W	W	Coal, sand and gravel, iron ore.
Walker	W	W	Coal, fire clay, miscellaneous clay.
Washington	W	W	Salt, limestone, sand and gravel.
Winston	768,635	W	Coal.
Undistributed [2]	113,021,890	116,905,709	
Total	246,264,000	249,778,000	

W Withheld to avoid disclosing individual company confidential data.

[1] The following counties are not listed because no production was reported: Bullock, Chambers, Clay, Coosa, Dale, Lamar, Lawrence, Perry, Pickens, Tallapoosa, and Wilcox.

[2] Includes value of natural gas and counties indicated by symbol W.

at the Champion mine. Cheney Lime & Cement Co. produced masonry and slag cements at the Graystone mill. Harbison-Walker Refractories Co. mined fire clay at its Thermal mine for refractories.

Butler.—Pigeon Creek Mining Co., KMC Mining Co., Luverne Mining Co., C. G. Kershaw Construction Co., and T. H. Foster mined brown iron ore.

Calhoun.—Donoho Clay Co. and Dixie Clay Co. mined fire clay for refractories. Hodges and Co. crushed limestone at the Anniston quarry for concrete, roads, agricultural stone (agstone), and fluxing stone. Frame Brick and Tile Co. mined miscellaneous clay at its Frame and Dubois mines for heavy clay products.

Choctaw.—Production of crude petroleum from the Gilbertown field, Alabama's oldest field, was 9 percent below that of 1965. Two oil wells and two dry holes were completed in the Gilbertown field.

Clarke.—Production of crude petroleum from the South Carlton field was 4 percent below that of 1965. No wells were completed in this field in 1966. Jackson Sand & Gravel Co. and Whatley Sand & Gravel, Inc., mined building sand and gravel.

Colbert.—Vulcan Materials Co., Alabama Asphaltic Limestone Co., and Ralph Rogers & Co., Inc. crushed limestone for concrete, roads, agstone, riprap, and railroad ballast, Alabama Asphaltic Limestone Co. mined native asphalt for roadstone.

Crenshaw.—McGhee & Merrill Co. mined brown iron ore at its Searcy mine near Dozier. Southern Sand Co. mined molding sand at its Brantley mine.

Cullman.—The Alabama State Highway Department crushed limestone for concrete and roads. Crapps Coal Co. operated the No. 4 coal mine.

Dallas.—Alabama Metallurgical Corp. produced lime for use in manufacturing chemicals and magnesium metal. C. Pierson Cosby mined building, engine, and filtration sand at its mine near Selma.

Elmore.—Alabama Gravel Co. mined building sand and gravel. Jenkins Brick Co. mined miscellaneous clay at its Coosada mine.

Escambia.—Production of crude petroleum from the Pollard field, Alabama's second largest producing field, decreased 11 percent from that of 1965. No wells were completed in this field in 1966. Escambia Materials Co., Flomaton Gravel Co., Inc., Dixie Sand & Gravel Co., and East Brewton Materials Co. mined building and paving sand and gravel and railroad ballast gravel. Container Corp. of America produced lime for use in manufacturing paper. Keego Clay Products Co. mined miscellaneous clay for heavy clay products at its Brewton pit.

Etowah.—Republic Steel Corp. produced pig iron and steel at its Gadsden plant. Robbins Coal Co., Inc. mined coal at its Southview strip mine. Vulcan Materials Co. and Herbert Construction Co. crushed limestone for concrete and roads, riprap, and agstone. Southside Sand Co. mined building and paving sand and gravel at its Gadsden mine. R & F Sand Co. mined fire clay for refractories near Gadsden.

Franklin.—U.S. Pipe & Foundry Co., Shook & Fletcher Supply Co., and Hester & Farned mined brown iron ore. Vulcan Materials Co. crushed limestone for concrete, roads, riprap, and agstone at its Isbell quarry near Russellville. Tennessee Valley Sand & Gravel Co. and North Alabama Sand & Gravel Co., Inc. mined building and paving sand and gravel. Georgia Marble Co. quarried dimension limestone for rough construction, rough architectural, and dressed building stone. Tennessee Valley Sand & Gravel Co. mined fire clay for refractories at its Spruce Pine mine near Sheffield.

Henry.—Harbison-Walker Refractories Co. and Wilson-Snead Mining Co. mined bauxite. Harbison-Walker Refractories Co. mined kaolin for refractories at its Eufaula mine. Abbeville Lime Co. crushed limestone for agstone at its Abbeville quarry.

Jackson.—Farco Co., Inc. (Fies No. 1 strip mine), Goforth & Smith Coal Co. (Campbell No. 3 mine), and Skyline Coal Co. (Darby No. 1 mine) mined coal. B & L Limestone Co. crushed limestone for concrete and roads.

Jefferson.—Sixty-six coal mines were active; leading producers were United States Steel Corp. (Concord No. 1 mine), Alabama By-Products Corp. (Maxine mine), and Woodward Iron Co. (Mulga mine).

United States Steel Corp., Lehigh Portland Cement Co., Alpha Portland Cement Co., and Lone Star Cement Corp. produced masonry and portland cements. Southern Cement Co. produced masonry and slag cements.

Dolcite Quarry Co., United States Steel Corp., Wade Sand & Gravel Co., Inc., Southern Rock Products Co., Inc., Lehigh Portland Cement Co., U.S. Pipe & Foundry Co., Lone Star Cement Corp., and Alpha Portland Cement Co. crushed limestone for cement, concrete, roads, fluxing stone, agstone, asphalt filler, coal dust, stone sand, and metallurgical uses.

Woodward Iron Co. mined red iron ore at its Pyne mine. United States Steel Corp., Woodward Iron Co., U.S. Pipe & Foundry Co., and Republic Steel Corp. produced pig iron. United States Steel Corp. produced steel.

Vulcan Materials Co. mined shale at its Parkwood mine for expanded shale production. United States Steel Corp., Lehigh Portland Cement Co., Natco Corp., Birmingham Clay Products Co., Lone Star Cement Corp., Stephenson Brick & Tile Co., Watkins Brick Co., and W. S. Dickey Clay Manufacturing Co. mined miscellaneous clay for cement and heavy clay products. United States Steel Corp. and Enos Vann crushed sandstone for cement, foundries, and refractories. Zonolite Co., Division of W. R. Grace & Co. exfoliated vermiculite at its Birmingham plant.

Macon.—Vulcan Materials Co., Sharpe Sand & Gravel Co., and Tri-State Sand Co. mined building, paving, and fill sand and gravel, and molding sand.

Madison.—Madison Limestone Co., Inc., South Parkway Quarry, Inc., and Vulcan Materials Co. crushed limestone for concrete, roads, agstone, and riprap. General Shale Products Corp. mined miscellaneous clay for heavy clay products.

Marengo.—Lone Star Cement Corp. produced portland cement and crushed limestone for cement.

Marion.—Thirty-two coal mines were active; leading producers were Coalite, Inc. (Brilliant strip mine), Brookside-Pratt Mining Co. (New River strip mine), and Liberty Coal Co. (Liberty No. 2 mine). Thomas Alabama Kaolin Co. mined kaolin at its Hackelburg mine. Thompson Sand & Gravel Co. mined building sand and gravel at its Winfield mine.

Marshall.—C. A. Langford Co., Inc. crushed limestone for concrete, roads, and agstone. Alpine Sand & Gravel Co. and Sand Materials Co. mined structural sand and gravel.

Mobile.—Production of crude petroleum from the Citronelle field, Alabama's largest producing field, increased slightly over that of 1965. No wells were completed in this field in 1966. Ideal Cement Co. produced masonry and portland cements from oystershell at Mobile. Southern Oystershell Milling Corp. and Radcliff Materials, Inc., dredged oystershell from Mobile Bay for cement, concrete, roads, and poultry grit. Radcliff Materials, Inc., Hicks Sand Co., and Ideal Cement Co. mined building, paving, and fill sand, and building and paving sand and gravel. Ideal Cement Co. mined miscellaneous clay for cement.

Montgomery.—Vulcan Materials Co., Alabama Gravel Co., C. T. Thackston Sand & Gravel Co., Mitylene Asphalt Co., and Dixie Sand & Gravel Co., Inc. mined building, paving, molding and engine sand and building and paving gravel. Jenkins Brick Co. mined miscellaneous clay for heavy clay products.

Morgan.—Watters Quarries, Inc. (Lacon No. 1, Burden, and Priceville quarries), and Trinity Stone Co., Inc. crushed limestone for concrete, roads, agstone, and riprap. Decatur Sand & Gravel Co. mined building sand and gravel near Decatur.

Pike.—Glenwood Mining Co., Inc., Armco Mining Co., Dunbar Mining Co., Inc., and Gibson Mining Co. mined brown iron ore.

Randolph.—U.S. Gypsum Co. and Black Warrior Petroleum Co. mined and ground scrap mica.

Russell.—Bickerstaff Clay Products, Inc., mined miscellaneous clay for heavy clay products at three mines. Consolidated Gravel Co., Inc., mined building sand and gravel at its Dixieland mine.

St. Clair.—National Cement Co. produced portland and masonry cements at the Ragland mill and crushed limestone for use in manufacturing cement. Riverside Clay Co. mined fire clay for refractories at the McAffee and Pell City mines. Ragland Brick Co. and National Cement Co. mined miscellaneous clay for heavy clay products and cement.

Shelby.—Southern Cement Co., Longview Lime Corp., U.S. Gypsum Co., Alabaster Lime Co., and Cheney Lime & Cement Co. produced quicklime and hydrated lime for building, agriculture, chemical, and industrial uses. Southern Cement Co. produced masonry and portland cements at the Ca-

lera mill. Vulcan Materials Co., Southern Cement Co., Longview Lime Corp., Southern Rock Products Co., Inc., Alabaster Lime Co., Montevallo Limestone Co., Cheney Lime & Cement Co., and U.S. Gypsumy Co. crushed limestone for lime, cement, concrete, roads, fluxing stone, agstone, riprap, asphalt filler, mineral food, alkali, and other chemicals.

Nine coal mines were active; leading producers were Southern Electric Generating Co. (Segco No. 2 mine), Alabama Red Ash Coal Co. (No. 2 mine), and River Valley Coal Co. (River Valley No. 8 mine).

Shook & Fletcher Supply Co. mined brown iron ore. Southern Cement Co. mined miscellaneous clay for cement.

Talladega.—Thompson-Weinman & Co., Moretti-Harrah Marble Co., and Georgia Marble Co. crushed marble for whiting and roofing granules. Vulcan Materials Co. and Talladega Materials Co. crushed limestone for concrete, roads, and riprap. American Talc Co. mined talc at its Winterboro mine for paint, paper, and toilet preparations. Riverside Aggregate Co. and Builders Supply Co. mined sand and gravel. Moretti-Harrah Marble Co. and Georgia Marble Co. quarried dimension marble for rough and dressed interior bilding stone and for dressed monumental stone.

Tuscaloosa.—Twelve coal mines were active; leading producers were Peabody Coal Co. (Seminole strip mine), Abston Construction Co. (Lima strip mine), and Alco Mining Co. (Alco strip mine). Gulf States Paper Corp. produced regenerated lime for use in manufacturing paper. Tuscaloosa Sand & Gravel Co., Yazoo Gravel Co., Inc., Davis Sand & Gravel Co., and American Sand & Gravel Co. mined building sand and gravel. Woodward Iron Co. mined red iron ore at the Vance mine.

Walker.—Forty-one coal mines were active; leading producers were Southern Electric Generating Co. (Segco No. 1 mine), Bankhead Mining Co., Inc. (Cobb strip mine), and Peabody Coal Corp. (Tiger strip mine). Russell Coal & Clay Co., Natco Corp., Ruby Mining Co., Harbison-Walker Refractories Co., Marigold Coal Co., Aaron Clay Co., and Contract Mining, Inc., mined fire clay. K & S Coal & Clay Corp. mined miscellaneous clay for heavy clay products.

Washington.—Olin Mathieson Alabama Chemical Corp. produced salt in brine. Lone Star Cement Corp. crushed limestone for cement at its St. Stephens quarry. Mid-South Materials, Inc., mined paving sand at its Chickasaw mine.

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, and the Division of Mines and Minerals of the Alaska Department of Natural Resources, for collecting information on all minerals.

By Kevin Malone,[1] Donald P. Blasko [2] and Phil R. Holdsworth [3]

Significant offshore crude oil production from Middle Ground Shoal, start of construction on major chemical-fertilizer plants on the Kenai Peninsula with natural gas as the raw material, and important progress on plans to ship liquefied natural gas to Japan featured mineral industry advances in 1966. Four new oil discoveries, all of them offshore in Cook Inlet and all testing out at 1,400 barrels per day or more, were made. New gas discoveries were brought in at North Fork, Nicolai Creek, and Ivan River.

Value of mineral production was $82.7 million compared with $83.5 million in 1965. Crude oil and natural gas from the Kenai Peninsula fields, supplemented by the first appreciable oil production from Middle Ground Shoal, accounted for $46.8 million or 57 percent of total value of production. Value and physical volume of sand and gravel, reflecting less demand as construction and rehabilitation arising from the 1964 earthquake approached completion, and shifts in patterns of highway uses were both sharply lower. Output of gold again declined, decreasing to just below $1 million in value.

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Table 1.—Mineral production in Alaska [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Antimony ore and concentrate, short tons, antimony content	1	$1	8	W
Coal (bituminous)—thousand short tons	893	6,095	927	$6,953
Copper (recoverable content of ores, etc.)—short tons	32	23	W	W
Gold (recoverable content of ores, etc.)—troy ounces	42,249	1,479	27,325	956
Lead (recoverable content of ores, etc.)—short tons	9	3	14	4
Natural gas—million cubic feet	[2] 7,255	1,799	11,267	2,794
Peat—short tons	1,967	16	W	W
Petroleum (crude)—thousand 42-gallon barrels	11,128	34,073	14,358	44,007
Sand and gravel—thousand short tons	30,266	34,467	17,457	21,793
Silver (recoverable content of ores, etc.), thousand troy ounces	8	10	7	9
Value of items that cannot be disclosed: Barite, gem stones, mercury, platinum group metals, stone, tin, and uranium ore (1965) and values indicated by symbol W	XX	5,489	XX	6,167
Total	XX	83,455	XX	82,683

W Withheld to avoid disclosing individual company confidential data. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] 1965 includes 653,538 thousand cubic feet sold (leased) from Kenai unit to Swanson River field but does not include Swanson River gas produced and reinjected.

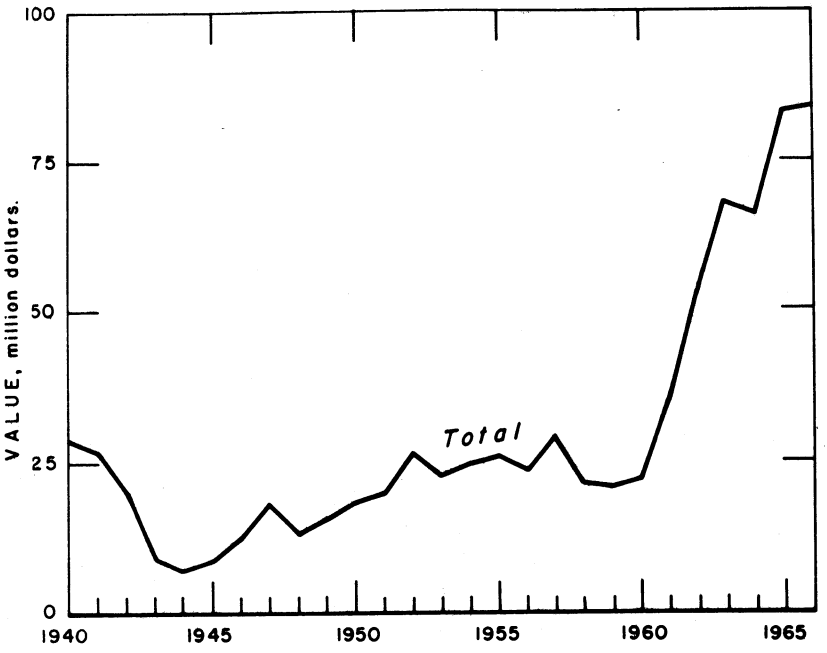


Figure 1.—Total value of mineral production in Alaska.

Table 2.—Value of mineral production in constant 1957–59 dollars
(Thousands)

Year	Value [1]
1957	$28,583
1958	21,511
1959	20,709
1960	22,201
1961	35,264
1962	54,309
1963	63,323
1964	65,714
1965	83,453
1966	[p] 83,457

[1] Data for 1957–65 revised.
[p] Preliminary.

Table 3.—Expenditures by major companies for exploration and prospecting
(Thousand dollars)

Type and region	1965	1966
Metals exploration:		
Southeastern Alaska	$222	$289
Copper River and Prince William Sound	232	79
Kuskokwim River and Yukon River	88	62
Northwestern Alaska	1,220	1,150
Other	[1] 1,425	[1] 1,065
Total	3,187	2,645
Oil and gas:		
Exploration	66,020	66,400
Development drilling	5,261	17,600
Production	19,250	55,800
Refinery construction and maintenance	2,000	6,520
Pipeline construction	9,550	21,080
Total	102,081	167,400
Grand total	105,268	170,045

[1] Including southwestern Alaska.
Source: Division of Mines and Minerals, Department of Natural Resources, Alaska.

Legislation and Government Programs.—The Federal Field Committee for Development Planning in Alaska submitted its report to the President through the Review Committee for Development Planning in Alaska. The two committees were established by the President in 1964 to provide a coordinated Federal-State approach to developing the economic potential of the State.

The study showed that reconstruction spending after the 1964 earthquake provided momentum for further State development, with economic and political settings favorable for orderly progress in Alaska's economy. The momentum was reinforced by continued development in certain extractive industries, particularly petroleum and natural gas and forestry products, cou-

pled with a modest but healthy expansion of the fishing industry. The Committee noted that, although Alaska remained too dependent on the Federal establishment as its major industry, timely and major economic developments, in the national interest, would still require heavy Federal participation for some time.

The Bureau of Land Management established a 12-man Multiple-Use Advisory Board for Alaska to provide advice and recommendations for the management of public domain. Alaska, with 265 million acres of public domain, was expected to benefit substantially from its creation. Members, meeting once or twice a year, were to discuss and make recommendations on regulations for the use, management, and disposition of public lands, and on proposed legislation, conflicts in competing uses, and similar broad policy items. Minerals, forestry, soil and water conservation, and State government, among others, had representation on the board.

The Congress approved a $750,000 appropriation for the start of construction on the Snettisham hydroproject 28 miles southeast of Juneau. To be built in two stages with the first phase costing $40 million, ultimate capacity was put at 70,000 kilowatts. Availability of such new power, a prime requirement for a pulp industry in the Juneau area, was seen as a massive stimulant to economic development with a beneficial spillover to the mineral industries.

Claims were initiated by different native groups seeking to secure aboriginal rights to large areas of lands long considered as public domain. Claims were filed covering most of the Seward Peninsula and three offshore islands, a 120,000 square mile section of the Yukon-Kuskokwim Delta, 26,000 square miles in the Glennallen area, and the entire Arctic Slope from the Canadian boundary to the Chukchi Sea. Among other mineral resources in the lands claimed, the oil and gas potential of the Arctic Slope was considered one of the most promising in all Alaska.

A partial tax exemption under the State Industrial Incentive Act was granted for a proposed methane liquefaction plant on the Kenai Peninsula. Property tax to the Kenai Peninsula Borough was limited to 5 mills for 10 years; State corporate income taxes and business license fees were to be waived for 10 years.

Wages and Hours.—For the fiscal year 1966, the Employment Security Division of the Alaska Department of Labor reported total insured wages in mining of $14.4 million ($12.4 million in 1965); insured jobs were listed as 1,171 (1,092) with 108 (110) units reporting. In the mineral industries covered by the Employment Security Act (operators with hired labor), monthly earnings averaged $1,062. Monthly earnings in metal mining were $848, in nonmetals $963, in coal mining $1,084, and in oil and gas including production and exploration $1,105. The figures for 1965 were $768, $1,008, $1,095, and $1,050, respectively.

Table 4.—Employment 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
1965:								
Coal and peat	223	249	56	453	---	36	79.46	947
Metal	403	193	78	687	---	18	26.20	703
Nonmetal	---	---	---	---	---	---	---	---
Sand and gravel	1,006	233	235	1,898	---	42	22.13	449
Stone	296	116	34	283	---	6	21.24	690
Total	1,928	209	403	3,321	---	102	30.71	590
1966: p								
Coal and peat	220	242	53	431	---	34	78.89	947
Metal	350	159	56	472	1	21	46.61	13,229
Nonmetal	5	200	1	5	---	---	---	---
Sand and gravel	630	230	145	1,174	---	24	20.44	436
Stone	315	117	37	306	---	7	22.88	503
Total	1,520	192	292	2,388	1	86	36.43	3,064

p Preliminary.

Transportation.—In reviewing the transportation study ordered by Congress in 1963 and reported upon in 1965, the U.S. Department of Commerce noted that the U.S. Congress stipulated the report contain specific recommendations for roads through undeveloped areas of Alaska and for connections with Canadian roads. Complying with the instructions, the Department's Bureau of Public Roads discussed joint programs with officials of British Columbia and the Yukon Territory.

The discussions brought out that while some of the proposed routes had merit, the high construction costs could not be justified; joint action was not considered timely. The Department noted, however, that a route connecting the Canadian road system with one of the ports of the Alaska Panhandle was an exception to the above conclusions. Late in the year a Calgary economic research firm was awarded a $50,000 contract to prepare a feasibility report on a road connecting the Yukon and Skagway. Major emphasis was to be on moving mineral and other natural resources to tidewater at minimum cost.

Included in a bill authorizing $19.7 billion in Federal highway grants was a special $70 million highway program for Alaska over the 5-year period of 1968–72. The Alaska program, for the first time, authorized use of Federal funds for maintenance as well as construction of highway projects. The bill also authorized construction in Alaska of access and development roads to serve resource development purposes, among others, with funds from the Federal highway trust fund.

The U.S. Department of Commerce earlier had recommended to the Congress that Alaska be allowed to use 10 percent of its annual Federal-aid highway allocations for maintenance of such roads and an additional 10 percent for construction of access and development roads and for equipment and facilities for the Alaska ferry system. Bureau of the Budget had approved the use of funds for maintenance, but recommended against use of highway funds for access and development roads and for ferry purposes. At yearend, appropriations to implement the authorizations had not been made.

In water transport, ferry service linking Prince Rupert, British Columbia, the southern terminus of the Alaska ferry system, with Kelsey Bay on Vancouver Island and thence by road and ferry to the southern 48 States was started in May. The first ship, owned and operated by the Province of British Columbia, had a capacity of 430 passengers, 80 cars, and some freight. Plans for a second ship for the same run were announced in the fall.

Table 5.—Coastwise receipts and foreign mineral trade
(Short tons)

Commodity	1965		
	Coastwise receipts	Imports	Exports
Bituminous coal and lignite	181	------	------
Gasoline	333,432	------	221
Kerosine, distillate, and residual fuel oil	853,750	------	697
Asphalt, tar, and pitches	40,342	------	------
Lubricating oils and greases	6,550	------	27
Petroleum and coal products, not elsewhere classified	22,510	------	------
Building cement	102,664	15,519	------
Building stone, unworked; and crushed and broken stone	69	45	------
Clay, ceramic and refractory materials	1,000	------	------
Structural clay products including refractories	2,164	------	------
Sulfur	------	11,608	------
Sand and gravel	2,617	------	------
Iron ore and concentrates	51	------	------
Iron and steel scrap	837	------	------
Iron and steel products	16,795	3,445	72
Aluminum and aluminum alloys, unworked	232	------	------
Lead and zinc including alloys, unworked	26,006	------	------
Nonferrous metal ores and concentrates, not elsewhere classified	101	------	------
Nonferrous metals primary smelter products, basic shapes, wire, castings and forgings, except copper, lead, zinc and aluminum	60	------	------
Fertilizer materials	2,243	------	------

Source: U.S. Army Corps of Engineers. Waterborne Commerce of the United States. Part 4, Pacific Coast, Alaska, and Pacific Islands. Calendar year 1965.

Southeastern Alaska shippers, attempting to use the new ferry system for moving freight from the southern 48, ran into the prohibitions of the Jones Act. This 1920 act limited shipment of cargo in interstate commerce to water carriers owned and operated by the United States. In June U.S. Customs made a constructive seizure of freight consigned to Juneau, later releasing the shipment with no penalties announced. At yearend legislation was submitted to the Senate to permit use of the British Columbia ferry system for the transportation of cargo to Alaska. The Alaska Ferry System, put into service in 1963, had proved to be a boon to the Panhandle in movement of specialized freight; similar advantages were expected from use of the new system if the Jones Act prohibitions were eased.

Rate reductions as high at 40 percent for the Canadian National Railway Aquatrain rail-ferry service to Alaska from Prince Rupert, British Columbia were announced. Reductions ranged from 5 to 40 percent depending on the commodity and the minimum weight of shipment. For a minimum 20,000 pound shipment of building materials between Prince Rupert-Anchorage, rates decreased from $4.60 to $2.80 per 100. Aquatrain was started by Canadian National in 1962.

Trans-Pacific Freight Conference of Japan announced rate reductions that put Anchorage on an equal basis with West Coast ports. The reductions were expected to result in greatly increased imports of goods into Anchorage from Far East ports; on some items savings of 10 to 15 percent were expected. Japan had been a major supplier of pipe for oil and gas development on the Kenai Peninsula and in Cook Inlet.

In air transport, Alaska Air Lines continued to develop air freighting of oil well drilling and related equipment, using the four-engine Hercules C–130 propjet. The plane, first used in 1965 to transport drilling equipment from Fairbanks to the North Slope, was used to transport the drilling rig, equipment, and other supplies to a site near Ugashik on the Bristol Bay side of the Alaska Peninsula. The drilling operator estimated air-freighting at about one-sixth of the cost of barging equipment to the site.

In December, Pacific Northern Airlines and Western Airlines applied to the Civil Aeronautics Board for approval to merge the two lines. Pacific Northern had linked Seattle with Southeast Alaska at Annette and Juneau, and with Anchorage in South-central Alaska. Intrastate connections served Cordova, Yakutat, the Kenai Peninsula, Kodiak Island, and King Salmon. Western was a major West Coast-based carrier.

Table 6.—Freight rates, Seattle to selected Alaskan cities in 1966 Hydrotrain service [1]

(Cents per hundred pounds)

Commodity	Minimum shipment (pounds)	Seattle to—		
		Anchorage via Whittier	Fairbanks via Whittier	Seward via Whittier
Groceries	60,000	218	277	213
Do	80,000	173	232	168
Do	[2] 100,000	104	163	99
Iron or steel articles	60,000	230	290	220
Do	80,000	178	219	172
Do	100,000	168	209	162
Machinery	60,000	247	290	233
Do	80,000	212	255	198
Do	100,000	202	245	188
Lumber	60,000	206	254	207
Do	80,000	171	219	172
Do	100,000	161	209	162
Ores and concentrates (southbound only) [3]	60,000	109	145	---
Do	80,000	92	128	---
Do	100,000	87	123	---
Petroleum and products	60,000	210	308	210
Do	80,000	175	273	175
Do	100,000	165	263	165

[1] Rates include all-risk insurance.
[2] Excess over 80,000-pound minimum when loaded in or on same car.
[3] Value not to exceed $60 per ton. Rate increases 25 percent for each additional $60 (or fraction) per ton valuation.
Source: Puget Sound-Alaska Van Lines.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Tonnage of coal increased 4 percent and value of production 14 percent compared with 1965 figures; value per ton was $7.50 in 1966 compared with $6.82 the previous year. The U.S. Armed Forces were again the chief consumers of Alaska coals. Military contracts for fiscal year 1967 totaled 668,000 tons compared with 638,578 tons for fiscal year 1966, Evan Jones Coal Co., a strip mine operator in the Matanuska field, was again the leading contractor, supplying 251,000 tons. In the Nenana (Healy River) field, Usibelli Coal Mine, Inc. and Vitro Minerals Corp., a joint venture of Vitro Corp. of America and Rochester & Pittsburgh Coal Co., each supplied 208,500 tons.

Except for minor quantities from small fields, all Alaska coal was strip-mined at four mines, two each in the Matanuska and Nenana fields. Of total tonnage mined, 42 percent was cleaned, the same as the figure for 1965. Heavy media separation was the treatment process used; only minor quantities were cleaned by jigging.

Golden Valley Electric Association, Inc., continued construction of its mine-mouth steam-generating plant at Healy in the northern coalfields. Major contracts were let for the generating units of the 22,000-kilowatt plant as well as for a 138,000-volt transmission line from Healy to Fairbanks. The new plant would slightly more than double the existing available power in the Fairbanks area; estimates were that wholesale cost of power would be reduced from 20 to 12 mills.

The long-controversial proposal to convert powerplants at Fort Richardson and Elmendorf Air Force Base from coal to natural gas continued to plague the Matanuska coalfield miners. In 1965, Defense Department officials had awarded a contract to Alaska Pipeline Co. to furnish natural gas to the bases, contingent upon the Congressional appropriations for conversion costs; no appropriations were made. The conversion proposal appeared to move closer to accomplishment when the House Armed Services Committee, sharply critical of the Department of Defense for failure to include conversion costs in its budget request, added $1.7 million to a military construction authorization bill to finance the conversion. The House Appropriations Committee, however, failed to provide funds; thus granting at least one more year of life to coal operations in the Matanuska fields.

Evan Jones Coal Co. (Matanuska fields) added four new 35-ton-capacity heavy-duty haulers to its equipment list. The new rigs were to be used to move strippings. In the Nenana fields, Usibelli Coal Mine, Inc., added a 60-ton tractor-trailer unit and had two more on order. Vitro Minerals, Inc. (Nenana), laid a new railroad spur and improved tipple and storage facilities. Thus Alaska coal operators, faced with extinction from the threat of natural gas, maneuvered to hold a share of the fuel market.

At the third Division of Lands competitive coal lease sale held in September, two parcels comprising the old Buffalo Coal Mine property between Palmer and Jonesville were sold. An 80-acre tract brought a bonus bid of $10.35 per acre while the remaining 880 acres brought $3.75 per acre. The lease contracts called for minimum expenditures of $1,000 per tract over a 3-year term. Rental was 25¢ per acre for the first year, 50¢ for the second through the fifth year, and $1 per acre thereafter.

The Bureau of Mines continued examination of coal deposits in the Kukpowruk River-Cape Beaufort area. Four diamond-drill holes along the Kukpowruk and one at Cape Beaufort were put down to obtain samples at depth. Kukpowruk surface samples had shown a suitable base coal in a blend to produce metallurgical quality coke; there was no improvement in coking characteristics with depth. The Cape Beaufort samples showed fair characteristics with depth where surface samples were nonagglomerating. An open-file report on these extensive Arctic coals was in process at yearend. No field work was scheduled for 1967.

Petroleum and Natural Gas.—Physical volume and value of both crude oil and natural gas increased substantially compared with results for 1965. With Middle Ground Shoal on a producing basis for a full 12 months of the year (compared with less than 1 month in 1965), oil produced increased to 14.4 million from 11.1 million

barrels; value increased to $44.0 million from $34.1 million. Although small increases resulted from operations in the established Swanson River and Soldotna Creek units, the gain belonged to full-year production from Middle Ground Shoal. Continuing development drilling of known offshore deposits gave assurance that crude production would increase further over the short term.

Although most of the established fields showed a slight increase of dry and/or associated gas production, the overall increase in gas production was due to greater amounts of dry gas produced from the Kenai field and transmitted to the Swanson River field for injection. Normal gas sales from the Kenai, Sterling, and Barrow fields showed a slight increase also, but the higher 1966 gas sales figure again reflected the Kenai gas going to Swanson River.

The Cook Inlet Basin, Copper River Basin, and the Arctic North Slope—all areas which had been exploration targets in the past—were again areas of wildcat or exploration drilling. With the exception of the Cook Inlet Basin, no new fields were discovered in these areas. Four new oil discoveries were reported for offshore Cook Inlet exploratory drilling. In other exploratory drilling, five dry holes were drilled in the Inlet waters north of the Forelands, and four dry holes were drilled offshore south of the Forelands. Single dry holes were drilled on the Alaska Peninsula, on the west side of Cook Inlet, in the Copper River Basin, and on the North Slope. Both the Kenai Peninsula and the upland Cook Inlet Basin had three dry holes each. A second wildcat well on the North Slope was under test at yearend.

In overall drilling, 69 wells were either completed, suspended, or drilling at the end of the year; of these, 60 were spudded in 1966. Among 47 well completions, four resulted in new oil discoveries, three gave new gas discoveries, 13 were oil or gas development wells, and 27 were dry holes. The remaining 22 wells were drilling as the year closed. Total footage drilled in 1966 more than doubled the 1965 figures. Of the 547,999 feet drilled, 369,872 feet was exploratory work compared with 157,823 feet in 1965. Development and step-out drilling increased to 178,127 feet from 110,548 feet. As late as 1964, development drilling totaled only 7,499 feet. The 23-fold increase over the 2-year period was an indicaton of the size of the offshore Cook Inlet deposits and of the rapidity with which the industry intended to exploit the new discoveries.

Native claims to huge land areas of Alaska posed a severe threat to the oil and gas industry, particularly in the effects on leasing. The Arctic Slope Native Association laid claim to approximately 96 million acres on the North Slope based on aboriginal rights. The claim, the largest ever made in Alaska, covered lands on which there was much activity in petroleum leasing and exploration. Included was all of the northern part of the State above 68th North Latitude from the Chukchi Sea to the 148th West Longitude and that section from 148° W to the Canadian border lying above 68°30′ N. In the Yukon-Kuskokwim Delta area, a claim on 77 million acres was filed. Other native groups made smaller claims in different parts of the State. As a result of the native action, Bureau of Land Management suspended new leasing on disputed lands until solution of the issues. Granting of patents on State selected lands was likewise suspended.

Early in the year Japanese interests announced plans to form the necessary business entities in order to bid for rights and to explore and develop Alaska oil and gas potentials. With Japanese Government approval, the parent Alaska Petroleum Development Co. was set up with an initial capitalization of $11 million. Teikoku Oil Co. (Imperial) and the Alaska Society were among the leading sponsors. A wholly owned subsidiary, Alasko, U.S.A., Ltd., was incorporated in Alaska. Initial Japanese interest was said to be in the Bristol Bay area. The Japanese also showed interest in a United States-Japanese joint venture to construct a methanol plant in Alaska; no firm commitments were announced.

Steps toward large-scale utilization of the huge gas reserves on the Kenai Peninsula and in offshore Cook Inlet deposits proceeded apace. Five major U.S. oil companies (Marathon Oil Co.; Pan American Petroleum Corp., a subsidiary of Standard Oil Co. of Indiana; Phillips Petroleum Corp.; Skelly Oil Co.; and Sinclair Oil and Gas Co.) reached an agreement with Japanese firms to supply liquefied natural gas to Japan. Shipments of 50 billion cubic feet of gas per year to Tokyo gas and electric utility firms were expected to begin in

Table 7.—Production of crude petroleum and natural gas

Year	Crude petroleum		Natural gas [1]	
	Thousand 42-gallon barrels	Value (thousands)	Million cubic feet	Value (thousands)
1958	W	W	50	$6
1959	187	$295	133	16
1960	559	1,230	246	30
1961	6,327	17,652	631	129
1962	10,259	31,187	2,184	467
1963	10,740	32,650	4,498	1,111
1964	11,059	33,627	6,238	1,719
1965	11,128	34,073	[2] 7,255	1,799
1966	14,358	44,007	11,267	2,794

W Withheld to avoid disclosing individual company confidential data.
[1] Comprises gas either sold or consumed by producers, including losses in transmission, quantities added to storage and increases of gas in pipelines.
[2] 1965 includes 653,538 Mc.f. sold (leased) from Kenai unit to Swanson River field, but does not include Swanson River gas produced and reinjected.

1968. Marathon, partner with Union Oil Co. of California in the Kenai unit, was to supply 30 percent of the gas and to operate transport of the liquefied gas to Japan. The four other companies, partners in the Cook Inlet gasfield, were to furnish 17.5 percent each. Phillips was scheduled to construct and operate the liquefaction plant on the Kenai Peninsula. Estimated capital costs for plants, tankers, and other needed facilities were put at $100 million.

Union Oil Co. of California began construction on two chemical plants in the Nikiski area of the Kenai Peninsula using natural gas as feedstock. Collier Carbon and Chemical Co., a Union subsidiary, was to operate a 1,500-ton-per-day ammonia plant, largest on the West Coast and using 60 million cubic feet of Kenai unit gas per day. Collier, associated with Japan Gas-Chemical Co., Ltd., was also slated to operate a 1,000-ton-per-day prilled urea plant. Capital costs for the two plants were put at $70 million; operations were expected to begin early in 1968. Union, with Marathon, had been party to the initial negotiations for shipments of liquefied Kenai unit gas to Japan but apparently found the petrochemical complex more attractive than shipment of liquefied gas.

A 5-year battle to open the Kenai Moose Range south of the Sterling Highway for oil and gas leasing ended in defeat when the U.S. Supreme Court refused to rule on the authority of the Secretary of the Interior to reject oil and gas lease offers in that area. On the State level, efforts to raise production taxes on oil and gas failed of passage. The State adopted a voluntary unitization policy covering leases on State lands whereby individual leases could be grouped into one unit under a single operator.

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

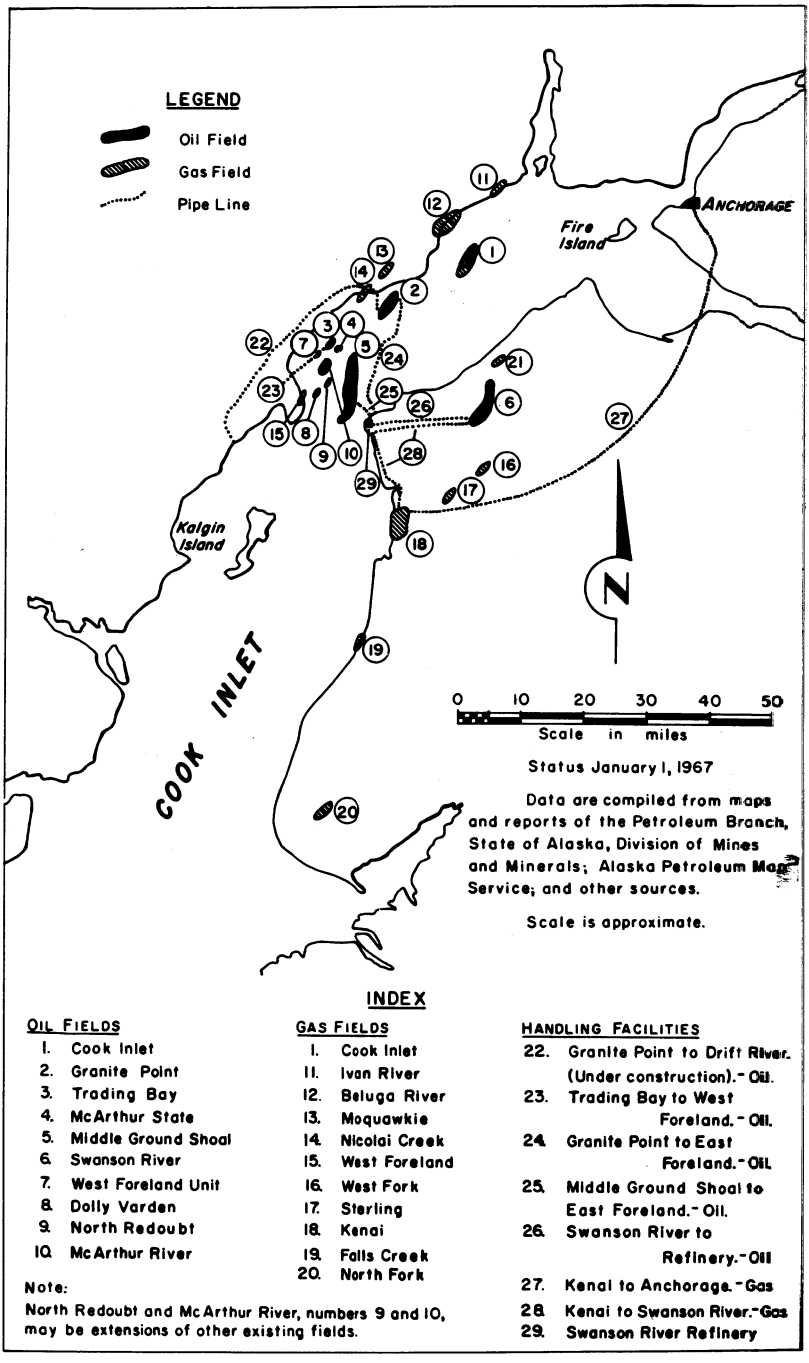
Year	Thousand acres
1957–61 (average)	25,755
1962	19,550
1963	14,053
1964	11,600
1965	10,184
1966	9,275

Source: 1954–58 Bureau of Land Management and 1959–66 Geological Survey, U.S. Department of the Interior.

Alaska's 16th competitive lease sale brought in $7 million in bonuses. The bulk of the bids came from tracts in the Middleton Island area, a small island in the Gulf of Alaska. Highest bid, $761 per acre for a 1,086-acre tract, was by Tenneco Oil Co.; average for the 134,067 acres offered was $52.54 per acre. At the State's 17th competitive lease sale, 18,590 acres in scattered upland tracts on the Kenai Peninsula and in the Susitna Valley drew a disappointing $136,280. Four offshore tracts at Katalla, scene of Alaska's early oil production, were withdrawn from the sale because of protests by native groups. Highest bid, in a joint venture of Colorado Oil and Gas Corp. and Newmont Mining Co., was $21.65 per acre on a 640-acre tract.

METALS

Antimony.—No shipments of antimony ore or concentrate were made in 1966. At the Stampede mine north of Mount McKinley in the Kantishna district, Yukon



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Note:
North Redoubt and McArthur River, numbers 9 and 10, may be extensions of other existing fields.

Figure 2.—Cook Inlet oil and gas fields and handling facilities.

River region, Earl R. Pilgrim milled some 45 tons of ore stockpiled in previous years. Fourteen short tons of concentrates containing 55 percent antimony were produced and added to inventory. Assessment work was done at the Klem mine and the K and D Lode in Southeastern Alaska, at the Judy Ann Lode in the Chulitna district, Cook Inlet-Susitna region, and at the Eagle Creek deposit north of Fairbanks.

Beryllium.—Activity in beryllium exploration on the Seward Peninsula decreased. U.S. Steel Corp. reported surrender of leases at Lost River and Camp Creek. United States Smelting Refining and Mining Co. reported assessment work only on its Lost River claims. Except for assessment work, there was no activity on the Prince of Wales Island deposits in Southeastern Alaska.

Copper.—An appreciable increase in interest in Alaska copper potentials by major mining companies was evident throughout the 1966 field season. Besides Kennecott Copper Corp.'s Ruby Creek deposit, where exploration and development proceeded over the full year, examination or exploration of copper showings were under way in many parts of the State. Deposits were diamond drilled at or near Denali and Drift River (Cook Inlet-Susitna region), Gravina Island and Prince of Wales Island (Southeastern Alaska), Muir Inlet (Glacier Bay, Southeastern Alaska), Lake Iliamna (Bristol Bay region), and Ruby Creek (northwestern Alaska region).

The State Division of Mines published reports on stream sediment examinations in different parts of the State. Anomalous quantities of copper (among other metals), thought sufficiently interesting to warrant further investigation, were found at the following places: the Old Rampart placer district northwest of Fairbanks; the Hollis-Twelvemile Arm area at Kasaan Bay, Prince of Wales Island; and a 60-mile area between Nenana and Fairbanks.

Production of copper during the year was minor; small quantities were produced as byproduct metal from other ores and one producer mined ores for copper in the Chitina area, Copper River region. The latter did not give permission to release figures on the operation.

Gold.—Output and value of gold continued the sharp declines of recent years, decreasing 35 percent from the low figures for 1965. Value fell just below $1 million, a 77-year low; physical volume was the lowest since 1886. With activity in placer mining continuing the decline in evidence for more than 10 years, and no significant lode activity underway, prospects for Alaska's gold industry appeared dim indeed.

United States Smelting Refining and Mining Co. (USSR&M) continued dredging operations on the Hogatza River in the Hughes district, Yukon River region and at Chicken Creek in the Fortymile district, and also in the Yukon River region. The Hogatza River operation was just below the Arctic Circle.

Table 9.—Mine production of gold, silver, and other metals[1] in terms of recoverable metals[2]

Year	Mines producing		Material sold or treated[3] (short tons)	Gold (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)
1957–61 (average)	5	93	2,635	172,647	$6,043
1962	1	66	162	165,259	5,784
1963	4	72	914	99,573	3,485
1964	4	87	2,493	58,416	2,045
1965	6	69	3,305	42,249	1,479
1966	4	55	7,346	27,325	956

Year	Silver (lode and placer)		Other		Total value (thousands)
	Troy ounces	Value (thousands)	Short tons	Value (thousands)	
1957–61 (average)	23,629	$21	46	$24	$6,088
1962	22,199	24	------	------	5,808
1963	14,010	18	5	1	3,504
1964	7,336	9	11	7	2,061
1965	7,673	10	41	26	1,515
1966	7,193	9	W	W	965

W Withheld to avoid disclosing individual company confidential data.
[1] Includes copper, lead and zinc produced.
[2] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings or slimes retreated, and ore shipped to smelters during calendar year indicated.
[3] Does not include gravel washed.

Table 10.—Placer production of gold

Year	Mines producing [1]	Material treated (thousand cubic yards)	Gold recovered		
			Troy ounces	Value	Average value per cubic yard
1957–61 (average)	93	14,859	171,975	$6,019,132	$0.405
1962	66	8,846	164,966	5,773,810	.653
1963	72	6,264	98,362	3,442,670	.550
1964	87	3,314	56,284	1,969,940	.595
1965	69	1,785	38,686	1,354,010	.758
1966	55	1,828	26,532	928,620	.508

[1] Excludes itinerant prospectors, "snipers," "highgraders," and others, who gave no evidence of legal right to property.

Other small dredging operations were carried out on the Sewart Peninsula at Bluff. Basin Creek, and Fairhaven; in the Kuskokwim River region on Marvel Creek; and in the Yukon River region at Flat. Goodnews Bay Mining Co., operator of placer platinum deposits at Platinum in the extreme southwestern corner of the Kuskokwim region, produced a small quantity of byproduct gold.

An appreciable increase in activity in the offshore placer deposits of the State was in evidence throughout the year. New State regulations liberalizing prospecting permits and leading of offshore lands were enacted. Government agencies, particularly the Bureau of Mines and the Geological Survey made extensive preparations for aiding the industry in establishing the potentials in offshore placers and for developing tools and techniques for their evaluation and exploitation. The Bureau of Mines scheduled the Research Vessel Virginia City for work off Nome and Bluff in Norton Sound in the 1967 field season. Research and investigations in these areas, and possibly in other northern submerged deposits, was to be done in cooperation with the Geological Survey; the program was expected to continue over a number of years. Under another program, the University of Washington was to investigate the mineral wealth of the Continental Shelf of the Bering Sea. Initial work was to be on the shelf between St. Lawrence Island and the Seward Peninsula.

Private interest in offshore potentials continued strong. Shell Oil Co. again had a prospecting crew operating off the Nome coast. Shell was reported to have under development a sonic drill, operating on somewhat the same lines as the sonic pile drivers, for coring of underwater sediments. Hawaiian Dredging & Construction Co., a subsidiary of Dillingham Corp. of Hawaii, sent representatives to the Seward Peninsula to investigate offshore dredging possibilities. Martin Dredging Co. operated an experimental "hydro-cone" dredge offshore at Nome. Results were reported to have established the feasibility of the equipment; plans to build commercial-sized equipment capable of operating to depths of 128 feet were underway at yearend.

Activity in lode mining was not significant. Two operators in the Fairbanks district reported production. Exploration was done at properties in the Chandalar, Willow Creek, Kantishna, and Valdez districts, and in the Southeastern Alaska region.

Figures compiled by the Alaska Division of Mines and Minerals showed 660 gold lode and placer claims staked compared with 409 in 1965. Affidavits of annual assessment work were filed on 4,447 claims compared with 4,723 claims in 1965. The figures did not indicate any appreciable increase in gold mining activity.

Iron Ore.—Exploration of iron deposits continued in 1966. In the Southeastern Alaska region, United States Steel Corp. tested further the huge titaniferous magnetite deposits the corporation held at Klukwan, some 23 miles northwest of Haines. Outlying sections of the Klukwan placers were drilled. The corporation also held large lode iron deposits in the same area. At the Union Bay (Cleveland Peninsula) deposit, the corporation reported assessment work only. Assessment work was done also on other Southeastern Alaska iron deposits, mainly on Prince of Wales Island; some of these were valuable chiefly for their copper content.

In the Cook Inlet-Susitna and Bristol Bay regions, Pan American Petroleum Corp., an exploration subsidiary of Standard Oil Co. of Indiana, continued exploration and examination of the Chenik Mountain-Iliamna Lake iron deposits discovered in 1964. The company reported surface sampling, geophysical and geochemical investigations. Atlantic Richfield Co. reported assessment work only on deposits 70 miles northwest of Chenik Mountain; the deposits were discovered in 1965.

Mercury.—Despite good prices for mercury, production of the liquid metal increased only slightly. Prospectors and mining scouts were active in the Kuskokwim province, however, giving some hope of increased activity in 1967. At yearend, negotiations were in process for reopening the Red Devil mine near Sleetmute on the Kuskokwim River. Previous operations at the Red Devil had enabled Alaska to rank third among the mercury producing States of the Nation.

Preparations for working or exploring other Kuskokwim mercury deposits during the 1967 field season were underway. Included were the Parks property, the Willis group, and the Egnaty Creek deposits. The Bureau of Mines had a field crew examining the Egnaty Creek deposits; further work was scheduled for the 1967 season. Disseminated cinnabar in sandstone occurring over a widespread area gave some promise of important, if low-grade, mineralization.

Nickel.—Except for the assessment work necessary to hold unpatented mining claims, there was no significant activity in nickel.

Platinum Group Metals.—Goodnews Bay Mining Co. continued dredging operations on the Salmon River in the extreme southwestern part of the Kuskokwim River region. The company, a platinum producer from the Goodnews Bay deposits for more than 30 years, did not release operating figures for publication. Physical volume of production and value of production were relatively unchanged from 1965. The company also produced appreciable quantities of other platinum-group metals. Goodnews Bay was the only United States operation in which platinum was the primary metal recovered.

Scrap Metals.—Shipments of nonferrous scrap, stimulated by high copper prices and the effect of the Viet-Nam War, increased considerably, although still of no great significance in national totals. Shipments from Fairbanks, Anchorage, and Juneau were consigned mostly to Seattle, with small quantities going to other United States points. There was no record of nonferrous scrap exports. A small lot of ferrous scrap from Anchorage was shipped to Japan.

Silver.—Alaska silver production, in line with the decrease in gold output, remained well below 10,000 ounces. Silver in Alaska had been almost entirely a byproduct from gold operations. Small quantities of lode silver were shipped in concentrates from the Fairbanks and the Nizina districts. The Nizina (Copper River region) shipments were copper concentrates with silver a byproduct.

Uranium.—Alaska's Bokan Mountain uranium deposit on Prince of Wales Island was inactive throughout the year because of lack of a market. The mine, near Kendrick Bay, was closed down in 1964. With the reawakening interest in uranium manifest in 1966, prospects to reactivate the Bokan Mountain mine were considered good. Appreciable reserves were said to exist when the mine was shut down.

NONMETALS

Barite.—Alaska Barite Co. installed crushing and loading facilities at the Red Cliff barite holdings on Castle Island, 25 miles west of Petersburg. The company had the deposits under lease from A. J. Industries, Inc., successor to the old Alaska Juneau Gold Mining Co. Alaska Juneau diamond drilled the deposits before World War II. Reserves at that time were reported to be 60,000 tons above high tide plus 160,000 tons below high tide to a depth of 40 feet. At yearend approximately 50,000 tons of barite had been shipped to New Orleans and other Gulf Coast ports for chemical uses and for manufacture of oil-well drilling muds.

Gem Stones.—Raw jade was produced from Dahl Creek and other places in the Shungnak River-Ambler River area in northwestern Alaska. Mentasta marble for sale as mineral specimens was produced about 10 miles west of Mentasta Lake in the Slana River area (Copper River region). Soapstone, for carving and for sale

as mineral specimens was mined on Grubstake Gulch, Willow Creek district (Cook Inlet-Susitna region). Small quantities of agate, jasper, chalcedony and other gem-type quartz were produced in other sections including the Seward area, Livengood, Chicken (Yukon River region), and Iliamna Lake. An appreciable increase in natural gold and gold nuggets sold for specimens and jewelry was noted.

Sand and Gravel.—Both physical volume and value of sand and gravel decreased sharply compared with 1965 totals. The decreases reflected less demand as construction and rehabilitation arising from the 1964 earthquake approached completion. Also involved were shifts in highway construction patterns showing increased emphasis on resurfacing and paving with less sand and gravel being used for fill on primary road construction. Average unit value, in line with the shifting use patterns, increased from $1.14 to $1.25.

Twenty-six commercial producers accounted for 6 percent of output and 6 percent of value. Average value of commercial production was $1.17 per ton. Commercial operators washed 312,000 tons (29 percent) of output valued at $864,000 or $2.77 per ton. Unwashed product was 763,000 tons valued at $0.52 per ton. Commercial producers included The Alaska Railroad, an agency of the U.S. Department of the Interior. The railroad was classed as a commercial producer to permit comparability with data published for other States.

Fourteen Federal, State, and municipal agencies (or their contractors) produced sand and gravel. For the Government agencies, output was 16.4 million tons valued at $20.5 million or $1.25 per ton. Washed or otherwise prepared product was 1.6 million tons with a unit value of $3.17. Untreated product amounted to 14.8 million tons at $1.04 per ton. The Alaska Department of Highways, the U.S. Army Corps of Engineers, and Mt. McKinley National Park were the major producers. The Alaska Department of Highways furnished 76 percent of the tonnage and 82 percent of the value credited to Government agencies.

Of total production, 86 percent was used as fill, 12 percent for paving, and 2 percent for building construction. There was no recorded production of industrial sand.

Stone.—Physical volume of stone decreased 3 percent while value of output increased 2 percent. Unit value was $1.98 compared with $1.88 in 1965. Commercial producers accounted for 6 percent of volume and 4 percent of value compared with 21 and 14 percent, respectively, in 1965.

Table 11.—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	1965		1966	
	Quantity	Value	Quantity	Value
Construction:				
Building:				
Sand	157	$440	57	$201
Gravel	168	528	84	268
Paving:				
Sand	110	333	404	1,408
Gravel	1,340	4,089	1,634	4,192
Fill:				
Sand	21	14	3,532	3,775
Gravel	28,443	29,019	11,444	11,560
Railroad ballast: Gravel	18	29	16	27
Other:				
Sand	4	4	44	85
Gravel	------	------	242	277
Total	30,261	34,456	17,457	21,793
Miscellaneous gravel	5	11	------	------
Grand total	30,266	34,467	17,457	21,793
Commercial:				
Sand	190	493	301	403
Gravel	5,066	5,107	774	860
Government-and-contractor: [1]				
Sand	102	298	3,736	5,066
Gravel	24,908	28,569	12,646	15,464

[1] Approximate figures for operations by the State, counties, municipalities, and other Government agencies under lease.

The Alaska Railroad was classed as a commercial producer. Railroad figures were included in commercial production to make stone figures for Alaska comparable with those of the other States.

Among the Government-and-contractor producers, the Bureau of Public Roads was the leader in volume and value of product. Other important Government-and-contractor producers included the Alaska Department of Highways and the Forest Service, U.S. Department of Agriculture.

REVIEW BY REGIONS

Alaska Peninsula.—Great Basins Petroleum Co., associated with Mobil Oil Co. and Elwerath Oil Co., Inc. (a West Germany firm), drilled a dry hold south of Ugashik Bay on the Bristol Bay side of the Peninsula. The well, drilled to 9,462 feet before being abandoned, was the first exploration on the Peninsula since 1959. Great Basins used a huge Hercules C–130 airfreighter of Alaska Airlines to ship equipment and supplies to the drilling location. Almost 1 million pounds of gear was flown in from Anchorage in less than 5 days, with loads averaging 43,000 pounds. Cost of barging the equipment to the site was estimated as six times that of airtransport.

Exploration and examination of lead, zinc, silver, and gold bearing deposits at Chignik Bay continued. The deposits were staked in 1965.

Bristol Bay.—St. Eugene Mining Corp., Ltd., an affiliate of Falconbridge Nickel Mines, Ltd., continued examination of the Kasna Creek copper deposits near the south shore of Lake Kontrashibuna some 160 miles southwest of Anchorage. The company ran geophysical and geochemical surveys on the large low-grade copper-iron deposits occurring in the Iliamna-Lake Clark area.

Pan American Petroleum Corp. made further investigations of the Chenik Mt.-Iliamna Lake titaniferous iron deposits discovered in 1964.

Cook Inlet-Susitna.—Petroleum, for the first time in the Cook Inlet-Susitna region, was the leading mineral commodity followed by sand and gravel and coal. Minor quantities of stone, gold, and gem stones were produced.

The offshore Middle Ground Shoal oilfield, from which the first oil flowed shoreward in December 1965, produced 2.6 million barrels of oil from 11 wells and was still under development at yearend. For comparison, the established Swanson River-Soldotna Creek operations (Kenai Peninsula), rated as a major oilfield, produced 11.7 million barrels.

Pan American Petroleum Corp. and Shell Oil Co., both operators in the Middle Ground Shoal field, continued drilling of development wells from their respective de-

Table 12.—Value of mineral production in Alaska, by regions [1]

(Thousands)

Region	1965	1966	Minerals produced in 1966 in order of value
Alaska Peninsula	$20	------	
Aleutian Islands	64	------	
Bristol Bay	2	$198	Sand and gravel.
Cook Inlet-Susitna	11,631	19,745	Petroleum, sand and gravel, coal, stone, gold, gem stones, silver.
Copper River	7,154	2,513	Sand and gravel, stone, copper, silver, gem stones.
Kenai Peninsula	41,952	39,385	Petroleum, natural gas, sand and gravel, stone.
Kodiak	19	14	Sand and gravel.
Kuskokwim River	1,049	1,032	Platinum-group metals, mercury, gold, gem stones, silver.
Northern Alaska	215	219	Natural gas, sand and gravel.
Northwestern Alaska	25	69	Sand and gravel, gem stones, gold, silver.
Seward Peninsula	1,633	1,488	Sand and gravel, tin, gold, gem stones, stone, silver.
Southeastern Alaska	4,159	3,777	Stone, sand and gravel, barite, gold, silver.
Yukon River	15,532	14,243	Sand and gravel, coal, gold, stone, gem stones, peat, silver, antimony, lead.
Total	83,455	82,683	

[1] No production reported in Bering Sea region.

velopment platforms. At the end of the year a total of 13 wells had been drilled from the two platforms. Minor interruptions to production occurred when pipelines transporting the oil to onshore facilities developed leaks under the severe winter conditions of Cook Inlet. Pan American positioned a second drilling platform in the southern portion of the field and planned a separate pipeline from it to East Foreland shore facilities. Shell announced plans for an additional platform about 2½ miles from their existing installation. With the new development facilties, and development drilling scheduled to continue from the original platforms, a substantial increase in Middle Ground Shoal output seemed assured.

Four new oil discoveries, all offshore, were recorded for the region in 1966. Union Oil Co. of California brought in Kustatan No. 1–A in the Dolly Varden field at 1,400 barrels per day from 10,660 to 10,875 feet in Hemlock Tertiary sands. The discovery was 9 miles south of the Trading Bay field and 4½ miles south of McArthur River. Union planned to erect a permanent drilling and production platform in 1967.

Atlantic Richfield Co. completed West Forelands Unit No. 3, near the west side of Cook Inlet and some 6 miles west of the Middle Ground Shoal field. The well tested at more than 1,600 barrels per day from the Hemlock formation between 9,486 and 9,600 feet. The discovery unit was made up of both State and Federal lands. The same company also brought in McArthur State No. 1, about 2½ miles northeast of West Forelands No. 3, at 1,440 barrels per day. The McArthur State well flowed from the same Hemlock formation found in West Forelands No. 3 with the pay zone from 9,660 to 9,790 feet. There was a question whether McArthur State was a new discovery or an extension of a known field.

Also in the Inlet, approximately 3 miles west of the Pan American permanent platform, the latter tested North Redoubt State 175779 No. 1 at a rate in excess of 1,500 barrels per day. The well produced from the interval 10,662 to 10,824 feet. As with the McArthur State well, the North Redoubt discovery was questioned; with additional information, North Redoubt could prove to be a southeast extension of the McArthur River field.

In wildcatting, dry holes were drilled just below the mouth of the Drift River (Atlantic Richfield) and midway on the west side of Kalgin Island (Hunt Oil Co.). Placid Oil Co. suspended drilling at 12,405 feet at the northern tip of Kalgin Island, and Pan American did likewise at 11,968 feet on the Redoubt Shoals well 2 miles south of West Forelands.

Two new gasfield discoveries for the Cook Inlet-Susitna region were reported. At Nicolai Creek near Trading Bay on the west shore of the Inlet, Texaco, Inc., received a discovery certification on Nicolai Creek State No. 1–A. Standard of California tested Ivan River No. 44 A–1 at 5,600 thousand cubic feet per day. The well, north of the Beluga gasfield, was the northernmost field in the Cook Inlet Basin.

In coal mining, Evan Jones Coal Co. was again the leading producer in the Matanuska field. The company strip-mined coal at the East mine. Operations were on a 6-day-a-week basis with slightly more than 100 men producing 1,200 to 1,300 tons per day of washed coal. Stripping was on a two-shift basis, washing on three shifts, and hauling on a single 9-hour shift. Alaska Matanuska Coal Co., operating the Premier mine, was the only other producer of record in the Matanuska field.

In other mineral activity, Pan American Petroleum Corp. and Atlantic Richfield Co. continued examining iron deposits in the Chenik Mountain, Iliamna Bay areas. Bear Creek Mining Co., Kennecott's exploration subsidiary, prospected a copper showing at Drift River on the west side of Cook Inlet below West Forelands. Tennessee Corp., associated with Dome Mines, Ltd., Moneta Porcupine Mines, Ltd., and Sunshine Mining Co., continued exploration of the Pass Creek copper showing in the Denali area. The deposit was found by geologists of the State Division of Mines and Minerals in 1963.

Some activity, largely assessment work or maintenance, occurred on gold lode properties in the Willow Creek and Valdez Creek districts and in other scattered parts of the region. Kaiser Cement & Gypsum Corp. improved and added to the road system at their Kings River Limestone holdings. Cemco, Inc., of Anchorage accomplished mapping, sampling, and geological surface studies on limestone deposits at Long Creek in the Chulitna area.

Copper River.—Sand and gravel, stone, and copper were the leading mineral commodities; total mineral production of the region was minor.

The Alaska Department of Highways completed the final drafts of the proposed routes of the Copper River Highway and of the economic impact on the areas traversed. The studies were in process of publication at yearend. The Copper River bridge at Chitina was under design. Location surveys for road sections from Slana River to Bartell Creek, Gulkana Junction to Paxton, and East Bank of the Copper River to McCarthy were underway.

At the State's 16th competitive oil and gas lease sale held in July, offshore tracts near Middleton Island some 80 miles south of Cordova in the Gulf of Alaska drew high interest. Tenneco Oil Co. bid $761 per acre on a 1,086-acre tract off the east side of Middleton. Bids submitted by other major oil companies and a few small independents brought the total of the sale to more than $7 million.

In other State sales, 10 foreclosed patented mining claims in the Chitina-McCarthy area were sold at public auction. Private ownership of the lands, coupled with the anticipated benefits from the Copper River highway program, was expected to stimulate renewed interest in this formerly highly productive copper area.

Kenai Peninsula.—Oil production from the Swanson River-Soldotna Creek complex set a new record, up 600,000 barrels from the 11.1 million barrel output of 1965. The small increase was attributed to completion of repressuring facilities needed to maintain optimum producing rates. Standard of California, operator at Swanson River, began injecting increased volumes of gas during the first part of the year. At midyear, an additional well in the Soldotna Creek unit was converted to injection and, for the first time, gas was injected through three wells into the Swanson River unit. At the end of the year the Soldotna Creek unit had five gas injection wells in operation, and the Swanson River unit had three. In April, the last month prior to fieldwide injection, monthly production was 916,000 barrels. By December the rate was 1.17 million, a 28-percent increase.

Developments to exploit the Peninsula's natural gas resources proceeded apace. Union Oil Co. of California began construction of two chemical plants in the Nikiski area. Collier Carbon and Chemical Co., a Union subsidiary, and Japan Gas-Chemical Co., Ltd., a major Japanese chemical firm, were associated in a $70 million complex to consist of a 1,500-ton-per-day ammonia plant using 60 million cubic feet per day of Kenai Unit gas as feedstock and a 1,000-ton-per-day prilled urea plant. The urea plant was to be a joint venture with Japan Gas-Chemical. The ammonia plant, rated the largest on the West Coast, and the urea plant as the largest in the world, were scheduled to go on stream early in 1968.

In initial proposals and negotiations, Union Oil Co., with its Kenai unit partner Marathon Oil Co., had explored shipment of Kenai gas to Japan as liquefied methane. With the Union decision to build the giant chemical complex on the Peninsula, Marathon joined with Phillips Petroleum Co., Skelly Oil Co., Sinclair Oil Co., and Pan American Petroleum Corp. to ship liquefied gas from the Kenai unit and from offshore Cook Inlet fields to Japan. The five firms reached an agreement to supply 50 billion cubic feet per year to Tokyo Gas Co., Ltd., and Tokyo Electric Power Co., Ltd. on a 15-year contract. Phillips was to operate a liquefaction plant near Nikiski; Marathon was to negotiate construction of tankers and subsequently operate them. Approval of the governments of both the United States and Japan was needed before the arrangements could be implemented.

Kuskokwim River.—Platinum from the Salmon River dredging operations of Goodnews Bay Mining Co. was the leading mineral commodity of the region. Physical volume and value of output were nominally comparable with the figures for 1965. The company did not release figures for publication. A Yuba electric dredge equipped with 8-cubic-foot buckets was used in dredging operation with a 6-yard dragline stripping ahead of the dredge.

Value of gold output remained at the depressed level of 1965. Only minor quantities of mercury were produced, but some evidence of renewed interest in the region's mercury resources was seen. Prospectors and mining company scouts were active in areas known to contain mercury mineralization. Efforts to finance the reopening of the Red Devil mercury mine, a major past producer, were in process during the year;

at yearend no firm arrangements had been announced.

The Bureau of Mines continued its program of examinations and sampling of the region's mineral resources. Mercury, gold, and other mineral deposits were under investigation. Open-file reports on deposits of lode gold (Nixon Fork), lead-silver (near Mount McKinley National Park), and copper (Willow Creek district) were made available to the public.

Northern Alaska.—Gas wells at the South Barrow field in Naval Petroleum Reserve No. 4 produced 435 million cubic feet of gas, an increase of 11 percent compared with the 1965 figure. Of this, 71 million cubic feet valued at $36,000 was sold to Barrow Utilities, Inc., for consumption in the city of Barrow. The remainder was used by the contractor to service buildings and to generate power for government installations at Point Barrow.

In petroleum drilling, Sinclair Oil & Gas Co. plugged and abandoned Colville No. 1 at 9,930 feet as a dry hole. Atlantic Richfield Co. drilled Susie Unit No. 1 to 13,517 feet. The well was under test at yearend. South of the Colville River Delta, Union Oil Co. of California spudded Kookpuk No. 1 late in the year and drilled to 718 feet. All three wells were classed as wildcats.

Northwestern Alaska.—At the new camp of Bornite, Kennecott Copper Corp. reached target depth below 1,000 feet in its vertical shaft. The company was proceeding with lateral exploration and development openings on the Ruby Creek copper property. Late in the year the operation encountered a serious water problem with a reported 11,000 gallons per minute flooding laterals and the lower section of the shaft. Preparations for increasing pumping capacity were underway. The company estimated that at least 2 years were needed for vertical and horizontal exploration and development before production. Preliminary projections indicated a 500- to 1,000-per-day mill for the deposit.

Seward Peninsula.—Sand and gravel, tin, and gold were the leading mineral commodities with sand and gravel accounting by far for the bulk of the $1.4 million production. Minor values were recorded for gem stones, stone, and silver. Value of gold production was less than $49,000. The region was sixth in the State in value of mineral production.

Increased activity in offshore placer deposits was noted. The largest concentration of offshore permits in the State was in the gold and tin mining areas of the Peninsula. Six applications to convert Nome area permits to leases were filed. Shell Oil Co. and Martin Dredging, Inc., among others, were engaged in research on drilling, submersible dredges, and other projects to promote exploitation of underwater placers. The Bureau of Mines and the Geological Survey made preparations to join in the research work in the 1967 field season.

At Bluff, the Bureau of Mines examined and sampled lode gold deposits near Daniels Creek. Gold was found in a relatively thin series of schists and schistose graphitic limestones. The Daniels Creek, Swede Creek, and Koyona Creek placers all appeared to have been derived from this series. Evaluation of the examination data was in process at yearend.

In tin mining, two placer operations were active. At Lost River, L. Grothe and C. Pearson produced tin concentrates using a bulldozer bucking into sluice boxes. Combined tin and tungsten concentrates were shipped to the Wah Chang plant at Texas City, Tex. The tungsten was not deemed commercially recoverable. At Tin City, Lee Bros. Dredging Co. used a bulldozer for stripping with a front-end loader loading trucks for haulage to a washing plant. Concentrates from this operation were shipped to Texas City also.

Southeastern Alaska.—Stone, sand and gravel, and barite were the leading mineral commodities. Minor quantities of gold and silver were recovered from a mill cleanup of the old Alaska Juneau Gold Mining Co. operation in the Juneau district. Dismantling of the steel skeleton of the old AJ mill which burned in the summer of 1965 was underway. Following dismantlement, plans were to sluice off the hillside of the millsite.

Bonanza Gold, Inc., of Spokane, Wash., reported diamond drilling on a copper-iron deposit near the old Jumbo Basin copper mine on Hetta Inlet, Prince of Wales Island. Cambridge Mining Corp., Ltd., drilled a copper prospect on the south end of Gravina Island at Seal Cove. Other

claim holders reported assessment work or maintenance.

Yukon River.—Sand and gravel, coal, and gold were the leading mineral commodities. Minor quantities of stone, gem stones, and peat were recorded.

Busty Belle Mines, Inc., received approval of an Office of Minerals Exploration loan for work on the Silvertone and Cottonwood claims in the Fairbanks district. The silver-lead lode had been an intermittent small producer in past years. In the Chandalar, Frank Birch had a small crew working on mill construction for the Chandalar lodes. Birch held the deposits under an agreement with Little Squaw Mining Co., a subsidiary of Grandview Mines, Inc., of Spokane. In the Bonnifield district, a Portland, Oreg., firm drilled the old Liberty Bell gold mine. The Buzby copper prospect on Wood River was reported under option to Hanna Mining Co.

The Mineral Industry of Arizona

This chapter has been 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 Leonard P. Larson [1] and William C. Henkes [2]

Producing more copper than the other 49 States combined, Arizona mine owners and operators continued to increase capacity. Chiefly because of increased copper production, the total value of mine output in 1966 was 7 percent higher than in 1965. During the year, active development continued at The Anaconda Company Twin Buttes project south of Tucson. Kennecott Copper Corp. and Pima Mining Co. announced plans to expand production.

Increasing by $40.5 million, the value of mineral production in Arizona for 1966 totaled $620.6 million. Copper production accounted for 86 percent of the total value and 91 percent of the increase in total value. Construction materials—cement, sand and gravel, stone, and pumice—increased 15 percent in value; road building and residential and nonresidential construction rose.

[1] Mining engineer, Bureau of Mines, Denver, Colo.
[2] Petroleum engineer, Bureau of Mines, Denver, Colo.

Table 1.—Mineral production in Arizona [1]

Mineral		1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Asbestos	short tons	3,469	$441	W	W
Clays [2]	thousand short tons	129	164	89	$121
Copper (recoverable content of ores, etc.)	short tons	703,377	497,991	739,569	535,004
Diatomite	do.	295	8	1,353	36
Gem stones		NA	120	NA	120
Gold (recoverable content of ores, etc.)	troy ounces	150,431	5,265	142,528	4,988
Gypsum	thousand short tons	103	540	75	394
Iron ore (usable)	thousand long tons, gross weight	8	51	W	W
Lead (recoverable content of ores, etc.)	short tons	5,913	1,845	5,211	1,575
Lime	thousand short tons	204	3,543	218	3,721
Mercury	76-pound flasks	158	90	363	160
Molybdenum (content of concentrate)	thousand pounds	9,399	15,880	10,161	17,812
Natural gas (marketed)	million cubic feet	3,106	376	3,161	436
Petroleum (crude)	thousand 42-gallon barrels	97	W	132	370
Pumice	thousand short tons	r 1,161	r 1,515	1,103	1,674
Sand and gravel	do.	14,918	16,621	18,730	20,448
Silver (recoverable content of ores, etc.)	thousand troy ounces	6,095	7,881	6,339	8,196
Stone	thousand short tons	2,474	4,171	2,271	4,091
Tungsten concentrate (60-percent WO_3 basis)	short tons	3	5	2	5
Uranium ore	do.	117,898	3,918	64,195	1,978
Vanadium	do.	W	381	W	453
Zinc (recoverable content of ores, etc.)	do.	21,757	6,353	15,985	4,636
Value of items that cannot be disclosed: Cement, clay (bentonite) feldspar, helium, mica (scrap), perlite, pyrites, and values indicated by symbol W		XX	12,933	XX	14,347
Total		XX	r 580,092	XX	620,565

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.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes bentonite; included with "Value of items that cannot be disclosed."

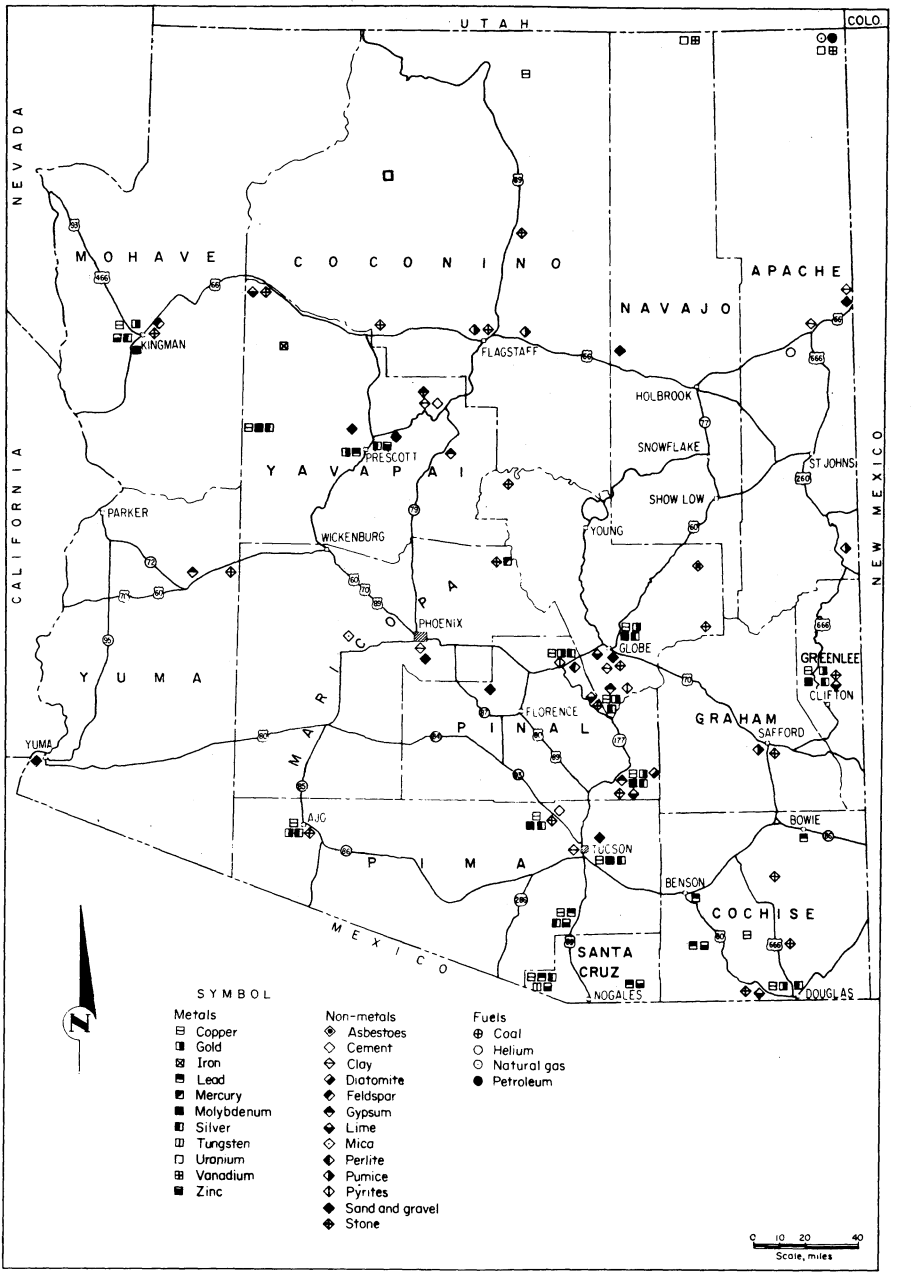

Figure 1.—Mineral production areas in Arizona in 1966.

Table 2.—Value of mineral production in constant 1957–59 dollars
(Millions)

Year	Value[1]
1957	$ 358
1958	342
1959	315
1960	383
1961	415
1962	458
1963	461
1964	477
1965	480
1966	510

[1] Data for 1957–65 revised.

The greatest declines in values among the State's nonmetallic mineral industries were $146,000 in gypsum production and $80,000 in stone. The drop in gypsum occurred primarily because of a lower demand for calcined gypsum products; the lower value of stone output resulted mostly from a decline in the output of basalt, crushed granite, and crushed sandstone used in highway construction.

Employment and Injuries.—Final 1965 statistics of employment and injuries in the mineral industries, excluding the petroleum and natural gas industries, and preliminary date for 1966 compiled by the Bureau of Mines are given in table 3.

Employment[3] in the mining and quarrying sector in the Arizona economy increased substantially during the year, reaching 16,500 in December, up 4 percent (600) from the corresponding period of the previous year. Employment in the State copper industry rose 400. With increased employment and earnings, industrial payrolls were substantially higher; weekly earnings in the State rose from $151.39 to $154.47. Average hourly earnings rose from $3.32 per hour in December 1965 to $3.38 per hour in December 1966. The average number of hours worked per week remained nearly constant.

Legislation and Government Programs.—Office of Minerals Exploration (OME), U.S. Geological Survey, contracted to assist Big Treasure Mining and Development Co., a California corporation, to explore for silver at the Little Treasure-Adjust group of claims in Pinal County. The property was to be explored by surface drilling for silver-bearing ore occurring along veins in volcanic and sedimentary rocks. Total cost of the work was estimated at $112,000, of which the Government participation was 75 percent.

Table 3.—Employment 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
1965:								
Coal	4	130	1	4	-----	-----	-----	-----
Metal	11,208	304	3,409	27,263	11	652	24.32	4,066
Nonmetal	293	226	66	530	1	19	37.72	11,769
Sand and gravel	1,178	201	237	1,905	-----	36	18.90	530
Stone	498	288	143	1,097	1	14	13.67	5,880
Total	13,181	293	3,856	30,799	13	721	23.83	4,044
1966: p								
Coal	5	125	1	4	-----	-----	-----	-----
Metal	10,650	313	3,330	26,628	9	588	22.42	3,180
Nonmetal	250	222	56	450	-----	17	37.78	773
Sand and gravel	1,250	215	268	2,147	-----	41	19.10	758
Stone	430	278	120	953	-----	17	17.84	256
Total	12,585	300	3,775	30,182	9	663	22.26	2,879

p Preliminary.

OME also contracted to assist Donald C. Gilbert of San Diego, Calif., to explore for silver on the Royal and Deer Horn claims in Santa Cruz County. The property was to be explored by crosscutting and drifting in search of silverbearing ores in and along veins near the contacts of granite and sedimentary rocks.

[3] Unemployment Compensation Division, Employment Security Commission of Arizona. Arizona's Current Employment Developments. The Employment Picture. Jan. 16, 1967, 4 pp.; Feb. 15, 1967, 4 pp.

REVIEW BY MINERAL COMMODITIES

METALS

Copper.—Demand for copper remained high throughout the year; deliveries to fabricators were augmented by releases of 350,000 tons from the U.S. stockpile. Continuing its upward growth begun in 1960, production of primary copper from mines in Arizona reached 740,000 tons. About 60,000 short tons of new capacity came on stream, or was under construction during the year. Except for the strike from September 20 to October 10 at mines operated by Inspiration Consolidated Copper Co., no serious work stoppages occurred at the major mines in the State during the year.

Domestic and foreign consumers of copper depend on mines in Arizona as a major source of supply. Fifty-two percent of the total domestic primary production and 19 percent of the free world production came from Arizona mines. Output from the 16 largest mines, 12 open pit and 4 underground properties, accounted for 721,000 tons; 79 percent was derived from open-pit and 21 percent from underground mines.

Table 4.—Fifteen leading copper-producing mines in 1966, in order of output

Rank in 1966	Rank in 1965	Mine	District	County	Operator	Source of copper in 1966
1	1	Morenci	Copper Mountain	Greenlee	Phelps Dodge Corp.	Copper ore, copper precipitates, gold-silver ore.
2	2	San Manuel	Old Hat	Pinal	Magma Copper Co.	Copper ore.
3	3	Ray	Mineral Creek	do.	Kennecott Copper Corp.	Copper ore, copper precipitates.
4	4	New Cornelia	Ajo	Pima	Phelps Dodge Corp.	Copper ore, gold-silver ore.
5	5	Copper Queen, Lavender Pit.	Warren	Cochise	do.	Copper ore, copper precipitates.
6	7	Inspiration	Globe-Miami	Gila	Inspiration Consolidated Copper Co.	Do.
7	6	Mission	Pima	Pima	American Smelting and Refining Co.	Copper ore.
8	14	Pima, Northeast	do.	do.	Pima Mining Co.	Do.
9	13	Mineral Park	Wallapai	Mohave	Duval Corp.	Copper ore, copper precipitates.
10	11	Copper Cities	Globe-Miami	Gila	Miami Copper Co.	Do.
11	9	Silver Bell	Silver Bell	Pima	American Smelting and Refining Co.	Do.
12	8	Esperanza	Pima	do.	Duvall Corp.	Do.
13	10	Bagdad	Eureka	Yavapai	Bagdad Copper Corp.	Do.
14	12	Magma	Pioneer	Pinal	Magma Copper Co.	Copper ore, gold-silver ore.
15	15	Miami	Globe-Miami	Gila	Miami Copper Co.	Copper precipitates.

Most of the productive capacity of Arizona's copper industry is in the hands of a relatively few firms. Nine of the State's largest copper mines were controlled by four of the copper industry's largest producers: Kennecott Copper Corp., Phelps Dodge Corp., American Smelting and Refining Co. (Asarco), and Magma Copper Co. These four companies accounted for 72 percent of the State output of primary copper.

Phelps Dodge Corp., with three open pits and one underground mine in Cochise, Greenlee, and Pima Counties, contributed more than 36 percent of the total State output, accounting for 17 percent of the growth within the State. Magma Copper Co., with two underground mines in Pinal County, accounted for about 74 percent of the underground production and 16 percent of the State total. Ray Mines Division, Kennecott Copper Corp., and Asarco, with mines in Pinal and Pima Counties, respectively, each contributed about 10 percent. The Inspiration Consolidated Copper Co. operations in Gila County contributed approximately 8 percent. Other major producers were Duval Corp., Miami Copper Co., Bagdad Copper Corp., and Pima Mining Co. One percent, 8,000 tons, of the total output was produced from 59 smaller mines.

Producers, to assure a greater portion of the world and domestic markets, modernized and expanded existing plants and pursued new developments. Phelps Dodge Corp. expanded the annual copper productive capacity at Morenci by about 25,000

tons: 10,000 tons from the beneficiation of pit-run material and 15,000 tons from the leaching of waste dumps. Asarco expanded mine and mill capacity at Mission, mill capacity at Silver Bell, and smelting capacity at Hayden. Kennecott Copper Corp. announced plans to increase the annual copper capacity at Hayden by 24,000 tons. The increased output was to be derived from the treatment of copper silicate ore at a new vat leaching plant to be constructed at the site.

Table 5.—Ore mined, waste and leach material removed, and total copper production at principal copper open-pit and underground mines

Mine	Ore mined (thousand short tons)		Waste and leach material removed (thousand short tons)		Total copper produced from all sources [1] (short tons)	
	1965	1966	1965	1966	1965	1966
Open pit:						
Morenci	19,089	19,325	29,601	28,808	127,566	141,178
Ray	8,595	8,758	22,061	17,826	72,153	70,820
New Cornelia	10,655	10,487	15,889	14,920	70,905	68,297
Inspiration	5,799	6,447	9,491	8,404	53,436	48,917
Mission	6,646	5,969	29,282	29,179	[2] 56,237	[2] 47,941
Daisy-Pima, Northeast [3]	2,646	6,024	[4] 9,243	[4] 13,405	[2] 18,000	[2] 39,300
Lavender	5,661	6,107	21,886	25,154	35,687	34,729
Mineral Park	4,914	5,379	4,822	9,016	[5] 19,039	[5] 25,565
Copper Cities	3,200	4,354	11,668	8,468	[5] 20,184	[5] 24,897
Silver Bell	3,185	3,564	6,951	8,844	[5] 21,479	[5] 24,393
Esperanza	4,232	4,207	8,253	9,477	[5] 21,691	[5] 23,364
Bagdad	2,091	2,092	10,568	8,548	[5] 20,376	[5] 20,310
Underground:						
San Manuel	13,504	14,391	-----	-----	93,767	101,390
Copper Queen	766	721	-----	-----	30,948	26,964
Magma	440	432	-----	-----	19,452	19,631
Miami	[6]	[6]	-----	-----	[7] 9,111	[7] 8,736

[1] Includes copper recovered from leaching of material in place and in dumps.
[2] Gross metal in concentrate shipped.
[3] Daisy-Pima in 1965.
[4] Thousand cubic yards.
[5] Gross metal in concentrates and precipitates shipped.
[6] All production from in-place leaching.
[7] Gross metal in precipitates shipped.

Source: Company-published annual reports or Bureau of Mines data.

Table 6.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1957–61 (average)	109	5	62,002	141,816	$4,964	4,751	$4,320
1962	83	5	79,583	137,207	4,802	5,454	5,917
1963	90	4	81,214	140,030	4,901	5,373	6,873
1964	85	1	86,742	153,676	5,379	5,811	7,518
1965	92	2	93,466	150,431	5,265	6,095	7,881
1966	92	1	102,168	142,528	4,988	6,339	8,196
1890–1966	NA	NA	NA	13,463,569	358,720	393,505	318,678

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1957–61 (average)	511,530	$305,663	9,752	$2,370	33,032	$7,663	$324,980
1962	644,242	396,853	6,966	1,282	32,888	7,564	416,418
1963	660,977	407,162	5,815	1,256	25,419	5,846	426,038
1964	690,988	450,524	6,147	1,611	24,690	6,716	471,743
1965	703,377	497,991	5,913	1,845	21,757	6,353	519,335
1966	739,569	535,004	5,211	1,575	15,985	4,636	554,399
1890–1966	21,221,597	9,361,415	644,830	127,241	1,001,024	243,719	10,409,773

NA Not available.
[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings or slimes retreated, and ore, old tailings, or copper precipitates shipped to smelters during the calendar year indicated.
[2] Does not include gravel washed or tonnage of precipitates shipped.

Table 7.—Mine production of gold, silver, copper, lead, and zinc in 1966, by counties, in terms of recoverable metals

County	Mines producing [1]		Material sold or treated [2] (short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
Cochise	7	-----	6,843,627	41,221	$1,442,735	905,149	$1,170,358
Coconino	[3] 4	-----	7,032	55	1,925	20,631	26,676
Gila	11	-----	13,188,237	3,995	139,825	229,806	297,139
Graham	1	-----	89	-----	-----	-----	-----
Greenlee	3	-----	19,331,635	11,802	413,070	626,953	810,650
Maricopa	6	-----	640	7	245	5,202	6,726
Mohave	8	-----	5,381,748	111	3,885	571,285	738,672
Pima	13	-----	30,296,347	34,030	1,191,050	2,265,332	2,929,074
Pinal	15	-----	23,633,813	37,541	1,313,935	1,044,964	1,351,138
Santa Cruz	3	-----	3,852	26	910	19,097	24,692
Yavapai	15	-----	3,339,701	13,716	480,060	648,760	838,847
Yuma	6	1	41,669	24	840	1,517	1,962
Total:							
1966	92	1	102,068,390	142,528	4,988,480	6,338,696	8,195,934
1965	92	2	93,466,081	150,431	5,265,085	6,095,248	7,881,156

	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Cochise	62,023	$44,867,438	3	$1,013	382	$110,751	$47,592,295
Coconino	545	394,108	-----	-----	-----	-----	422,709
Gila	95,563	69,130,564	-----	-----	-----	-----	69,567,528
Graham	3	2,315	-----	-----	-----	-----	2,315
Greenlee	141,197	102,141,729	-----	-----	-----	-----	103,365,449
Maricopa	12	8,970	-----	-----	-----	-----	15,941
Mohave	24,876	17,995,118	10	3,083	145	42,152	18,782,910
Pima	200,258	144,866,818	35	10,611	1,268	367,676	149,365,229
Pinal	192,547	139,288,174	4	1,134	-----	-----	141,954,381
Santa Cruz	30	21,774	301	90,826	585	169,635	307,837
Yavapai	22,309	16,138,512	4,804	1,452,294	13,604	3,945,218	22,854,931
Yuma	206	148,695	54	16,324	1	218	168,039
Total:							
1966	739,569	535,004,215	5,211	1,575,285	15,985	4,635,650	554,399,564
1965	703,377	497,990,916	5,913	1,844,856	21,757	6,353,044	519,335,057

[1] Operations at miscellaneous cleanpus not counted as producing mines.
[2] Does not include gravel washed, tonnage of precipitates shipped, or uranium ore milled.
[3] Excludes count of uranium mine from which copper was recovered as a byproduct.

South of Tucson, open-pit mine and mill expansion was scheduled to increase annual productive capacity at Pima by 38,000 tons of copper. Stage 1, completed during the year, increased capacity from 6,000 to 18,000 tons of crude ore per day; stage 2, to be completed in 1967, was to raise the daily output to 30,000 tons. In the same general area, The Anaconda Company continued development at its Twin Buttes project. By the end of 1967, annual productive capacity in the State was to increase about 107,000 tons.

Copper contributed significantly to the economy of 7 of the 14 counties in the State. Pima County, with 5 of the 16 largest operations, accounted for 200,250 tons, or 27 percent of the State output; Pinal County, with 3 large properties, 192,500 tons or 26 percent. Substantial production was derived from ores mined in Cochise, Gila, Greenlee, Mohave, and Yavapai Counties.

Total gross valuation of all copper-mining property rose from $280.2 million in fiscal 1965 to $318.4 million in fiscal 1966. The major increases in gross valuation occurred in the value of productive (patented and unpatented) mining claims and in the gross value of smelters, concentrators, and mining machinery, and mining and smelting supplies.[4] Mining property represented 14.2 percent of the net assessed valuation of all taxable property in Arizona in 1966, compared with 13.2 percent in 1965.

Eight primary smelters were operated in the State during the year, primarily on ores produced by the company operating the smelter. Three of the smelters—Phelps Dodge Corp. smelter at Douglas, Inspiration Consolidated Copper Co. smelter at Inspiration, and Asarco smelter at Hayden —also treated ores on a custom or toll ba-

[4] State Tax Commission of Arizona. Twenty-eighth Biennial Report, December 1966. pp. 88, 92.

Table 8.—Mine production of gold, silver, copper, lead, and zinc in 1966, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Dry gold	2	21	[2] 32	[2] 35	300	-----	-----
Dry gold-silver	4	103,572	213	6,936	1,702,800	-----	-----
Dry silver	15	19,576	39	72,227	104,000	3,100	-----
Total	21	123,169	284	79,198	1,807,100	3,100	-----
Copper	45	101,558,298	127,431	5,595,644	1,359,481,200	5,400	2,586,000
Copper-zinc and uranium[3]	[4] 4	[5] 19,426	75	28,335	2,065,500	10,600	2,214,500
Lead	7	556	16	4,720	9,100	90,700	7,500
Lead-zinc	4	320,674	13,627	589,841	564,500	10,136,800	26,641,500
Zinc	2	1,623	4	4,812	58,400	67,100	519,000
Total	61	101,900,577	141,153	6,223,352	1,362,178,700	10,310,600	31,968,500
Other "lode" material:							
Gold tailings	1	5	2	-----	-----	-----	-----
Gold-silver tailings and silver tailings [3]	3	42,813	1,058	34,070	86,700	-----	-----
Copper cleanup	(6)	474	30	684	99,700	-----	-----
Copper precipitates	19	82,684	-----	-----	114,965,800	-----	-----
Lead assay office cleanup	(6)	2	-----	-----	-----	2,000	-----
Lead tailings	2	1,350	1	1,392	-----	106,300	1,500
Total	25	127,328	1,091	36,146	115,152,200	108,300	1,500
Total "lode" material	92	102,151,074	142,528	6,338,696	1,479,138,000	10,422,000	31,970,000
Placer	1	-----	(2)	(2)	-----	-----	-----
Total all sources	93	102,151,074	142,528	6,338,696	1,479,138,000	10,422,000	31,970,000

[1] Detail will not necessarily add to totals because some mines produce more than one class of material.
[2] Dry gold and placer combined to avoid disclosing individual company confidential data.
[3] Combined to avoid disclosing individual company confidential data.
[4] Copper-zinc mines only.
[5] Excludes uranium-ore tonnage.
[6] From properties not classed as mines.

Table 9.—Mine production of gold, silver, copper, lead, and zinc in 1966, 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 (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Concentration and smelting of concentrates: Ore [1]	132,471	5,995,790	[2] 1,329,735,200	10,327,900	31,962,500
Direct-smelting:					
Ore	[3] 8,969	[3] 308,152	24,834,600	92,100	7,500
Cleanings	30	684	99,700	2,000	-----
Precipitates	-----	-----	114,965,800	-----	-----
Old tailings	1,058	34,070	86,700	-----	-----
Total	10,057	342,906	139,986,800	94,100	7,500
Other: Leaching of copper ore	-----	-----	9,416,000	-----	-----
Placer	(3)	(3)	-----	-----	-----
Grand total	142,528	6,338,696	1,479,138,000	10,422,000	31,970,000

[1] Includes uranium ore concentrate.
[2] Includes copper recovered from leaching of ore at operations that employ "dual-process" treatment of leaching followed by flotation concentration.
[3] Placer production combined with "direct-smelting ore" gold and silver production to avoid disclosing individual company confidential data.

sis. With smelters operated at Douglas, Ajo, and Morenci, Phelps Dodge Corp. controlled 57 percent of total smelting capacity within the State. Magma Copper Co., with smelters at San Manuel and Magma, accounted for 13 percent of the capacity. The smelters of Kennecott Copper Corp. and Asarco at Hayden and Inspiration Consolidated Copper Co. at Inspiration, each accounted for 10 percent.

Approximately 3.3 million tons of ore, concentrates, and precipitates were shipped

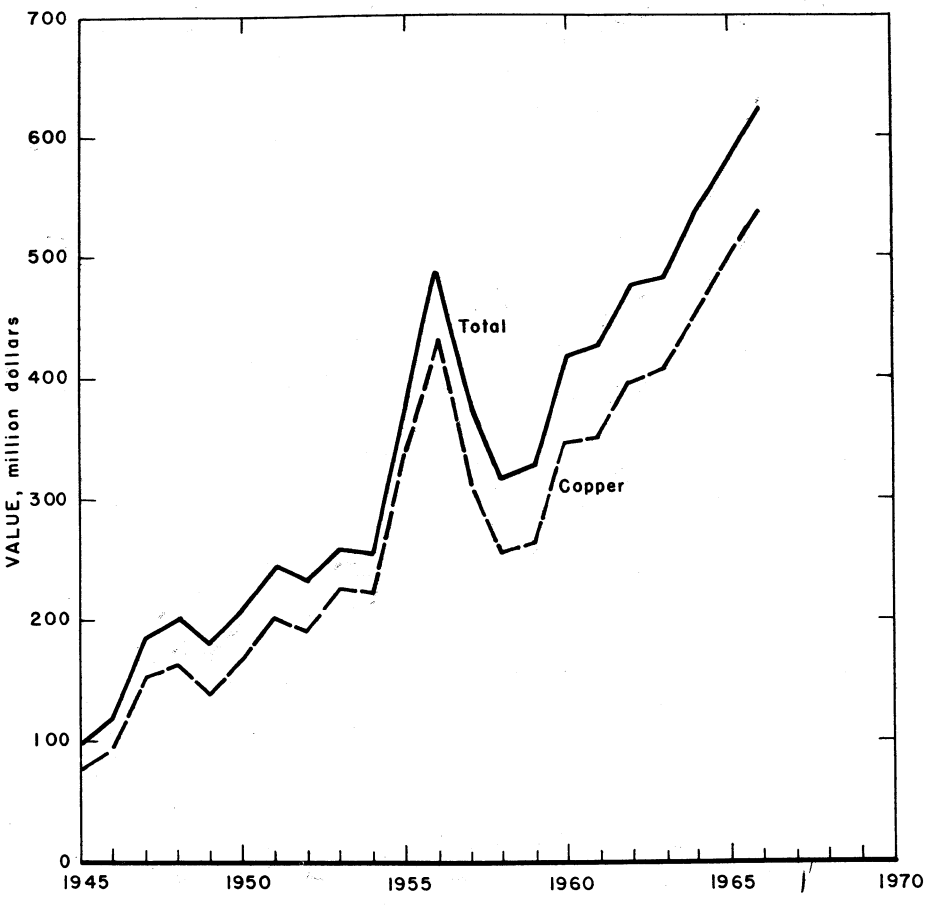

Figure 2.—Value of mine production of copper, and total value of mineral production in Arizona.

to smelters in or outside the State. These shipments consisted of 2.9 million tons (86 percent) of concentrates obtained from milling porphyry copper ores; 87,819 tons (3 percent) of precipitates from the leaching of ores in dumps, in place, and in heaps; and 382,112 tons (11 percent) of direct shipping ores.

Porphyry copper ores were mined at open-pit and underground mines in Cochise, Gila, Greenlee, Mohave, Pima, Pinal, and Yavapai Counties. The copper content of 82.7 million tons of porphyry ores mined at the 12 large open-pit mines averaged 0.628 percent; it ranged from a low of 0.417 percent to a high of 0.786 percent, compared with a range from 0.381 to 0.855 percent copper, averaging 0.651 percent in 1965. Porphyry ores with a low copper content generally contained molybdenum as a byproduct; molybdenum content offset the lower copper values.

Ores from underground mines contained from 0.708 to 4.460 percent copper: The lower analysis represented the copper content of ores obtained from block-caving operations at San Manuel; the higher analysis represents the copper content of the ore from the Magma mine where sand-fill methods were used. The copper content of the concentrates recovered from the milling of copper ores averaged 22 percent.

The Copper Queen mine, operated by Phelps Dodge Corp. near Bisbee, was the

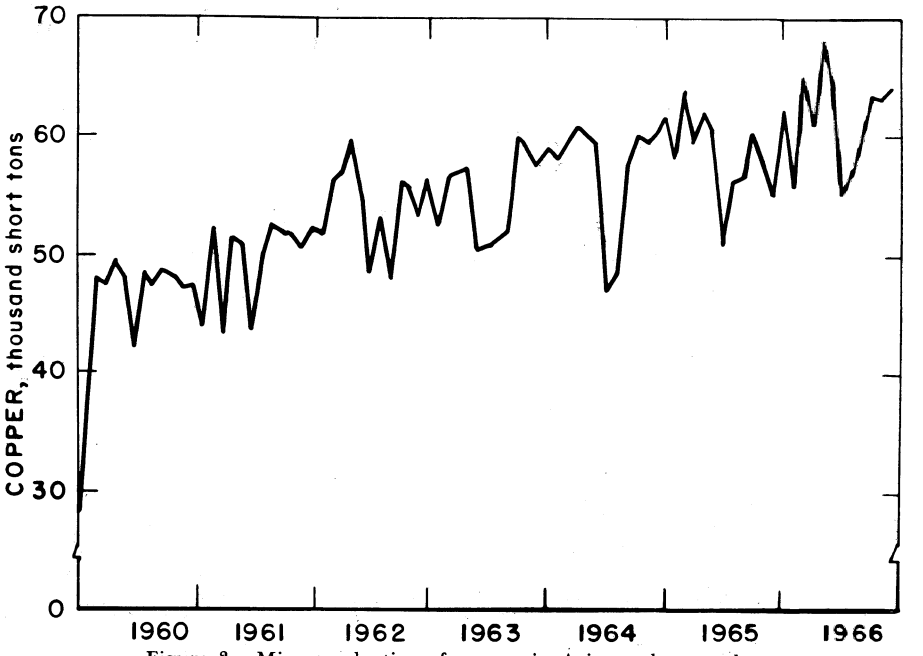

Figure 3.—Mine production of copper in Arizona, by months, in terms of recoverable metal.

major source of direct-shipping ores. In 1966, 235,900 tons of direct-shipping ores from five underground mines contained 9,850 tons of copper, 8,600 ounces of gold, and 219,200 ounces of silver.

With increased quantities of water available at certain mining properties and improvements in leach methods, output of copper from the leaching of low-grade dump material increased from 44,600 tons in 1965 to 57,483 tons. The copper content of the precipitates averaged 70 percent. With the completion in July of the new precipitation plant at Morenci and continued developments at other operations in the State, output was to be significantly increased. Heap leaching recovered an additional 5,135 tons of cement copper containing 4,708 tons of recoverable metals.

The average domestic refinery price for copper in 1966, as reported by Engineering and Mining Journal, was 36.17 cents compared with 35.01 cents in 1965.

Gold.—Output of gold from 46 lode and 1 placer deposit in Arizona totaled 143,000 troy ounces: 127,000 ounces, 89 percent, was recovered as a byproduct of copper refining; 14,000 ounces, 10 percent, from the smelting of lead-zinc ores; and the balance from gold, gold-silver, silver and other base metal ores, and miscellaneous lode material.

Accounting for 61 percent of the total output, Phelps Dodge Corp. was the major producer. In its annual report the company stated that the combined output of byproduct gold at the Morenci, New Cornelia, and Copper Queen branches totaled 87,000 troy ounces.

Magma Copper Co., the second largest gold producer in the State, accounted for 25 percent of the total output. According to its annual report, 35,200 troy ounces of gold was recovered from ores produced by the company at the Magma (12,800 ounces) and San Manuel (22,400 ounces) mines.

Shattuck Denn Mining Corp., Iron King mine, the fourth largest producer of gold in the State, was the largest producer of gold from lead-zinc ores.

Iron Ore.—Production and shipments of usable iron ore declined. Direct-shipping magnetite ore was produced and shipped by Cline & Seitz from the Margaret-Howard mine in Gila County and by Westchester Mining Co. from the Red Rock mine in Pinal County. CF&I Steel

Corp. mined hematite at the Apache mine in Navajo County, and continued test drilling at the 36,000-acre iron-ore deposit on the Fort Apache Indian Reservation. Sponge iron was produced from pyrite by Ray Mines Division, Kennecott Copper Corp., at Hayden and by Phelps Dodge Corp. at Douglas from iron oxides recovered by the smelting process.

Westchester Mining Co., a subsidiary of Sovereign Resources of Dallas, Tex., operated the Arkota steel mill at Coolidge. The firm also recovered iron concentrate from ores produced at the Red Rocks claims which was sold for use as ballast, in farm equipment tires, and for sand blasting.

Lead.—Output of lead declined 12 percent, to a 32-year low. Most of the production was recovered by Shattuck Denn Mining Corp. from the beneficiation of lead-zinc ores produced at the Iron King mine, 20 miles east of Prescott. The concentrate was shipped to the Asarco smelter at El Paso, Tex.; zinc concentrate recovered was sent to the Asarco smelter at Amarillo, Tex. The Glove mine, operated by Arivaca Mining Corp. in the Tyndall mining district, Santa Cruz County, was the second largest producer.

Mercury.—A small quantity of mercury was produced from seven mines in the Mazatzal Mountains in Gila and Maricopa Counties. Production rose from 158 flasks valued at $90,000 to 363 flasks valued at $160,000. Mercury content of the ore ranged from 0.05 to 0.25 percent, averaging 0.10 percent. All but 4 percent of the production was recovered by treatment in Gould rotary or Shutte furnaces.

Molybdenum.—Output of molybdenum, contained as molybdenum sulfide (MoS_2) in concentrate form, continued upward, but at a decreasing rate. In 1964 and 1965, production increased 743,000 and 3,103,000 pounds, respectively; in 1966, the increase was 762,000 pounds. Arizona mines accounted for 11 percent of the total U.S. molybdenum production.

More than 61.3 million tons of copper ore containing 0.002 to 0.048 percent MoS_2 was processed to recover 1.5 million tons of copper-molybdenum concentrates. The molybdenum concentrates recovered ranged from 39.44 to 55.95 percent molybdenum, and averaged 54.33 percent for the 10.1 million pounds produced. Lower output of molybdenum at six of the nine properties reporting production in 1966 was offset by increased output at the San Manuel and Mineral Park operations.

Shipments of molybdenum concentrates from eight mines, in six counties, contained 10.2 million pounds of molybdenum valued at $17.8 million. Exports of concentrates contained 2.4 million pounds of molybdenum and represented approximately 24 percent of the total shipments. Stocks, on hand December 31, 1966, were 160,331 pounds, compared with 255,217 pounds in the previous year. The average price for molybdenum in concentrate form was $1.75 per pound, compared with $1.69 in 1965. Groundbreaking ceremonies were held July 28 for the new molybdenite flotation plant under construction at Hayden, by Ray Mines Division, Kennecott Copper Corp. The plant was designed for a daily capacity of 900 tons of copper concentrate. Production was expected to total about 900,000 pounds of molybdenum annually. The concentrate was to be processed into molybdic oxide at the Kennecott Copper Corp. molybdic oxide plant in Salt Lake City, Utah.

Silver.—Arizona's silver production was 6.3 million troy ounces, a 4-percent increase. Of the total silver produced in 1966, 88 percent was recovered from copper ore mined at 22 properties in 7 counties, 9 percent from lead-zinc ores from mines in 2 counties, 1 percent from dry silver ores, and 2 percent from miscellaneous ores and material. The five leading silver-producing companies—Phelps Dodge Corp., Asarco, Magma Copper Co., Duval Corp., and Shattuck Denn Mining Corp.—accounted for 80 percent of the State total. In 1966, the ratio of silver to copper was about 8.2 ounces of silver for each ton of copper produced from copper ores, the same as that reported for the previous year.

Tungsten.—Tungsten concentrate (65.51 percent WO_3) was recovered by Fernstrom Mining Co. from the processing of ore mined at the Carboloy mine in Pima County.

Uranium Ore.—Arizona was ranked sixth in the Nation in uranium production. Thirty operations in Apache, Coconino, Navajo, and Yavapai Counties were active in 1966 compared with 26 in 1965. Shipments of uranium ore to processing plants at Tuba City; Grand Junction, Rifle, and Uravan, Colo.; Shiprock and Grants, N.

Mex.; and Moab, Utah, totaled 64,195 tons, valued at $2 million. The 46-percent reduction in output from the 117,898 tons produced in 1965 resulted primarily from the closing of the Orphan Lode mine of Westec Corp., formerly Western Equities, Inc., on the south rim of the Grand Canyon. This property, largest producer in the State in 1965, was closed in July as ore production exceeded scheduled deliveries under its U.S. Atomic Energy Commission (AEC) allocation. By negotiated agreement and special legislation, Westec Corp. was given the right to continue mining until 1986, when title to the 20-acre claim was to pass to the National Park Service.

The f.o.b. mine value of production ranged from $2.56 for crude ore containing 0.08 percent uranium oxide (U_3O_8) to $131.50 for crude ore containing 1.37 percent U_3O_8. The average grade of ore shipped from mines during the year was 0.36 percent U_3O_8, 0.02 below that reported for the previous year. The average value of mine shipments was $2.42 per ton below that reported for the previous year.

Vanadium.—Vanadium was recovered from uranium-vanadium ores mined in Apache and Navajo Counties that were processed at plants in Colorado and New Mexico having vanadium recovery circuits. The value of the recovered vanadium was credited to the county and State of origin.

Zinc.—Primarily because of the lower yield from the Copper Queen, Old Dick, and Iron King mines in Yavapai County, output of zinc was 27 percent below that of the previous year. More than 80 percent of the recoverable zinc came from lead-zinc ores produced at the Iron King underground mine operated by Shattuck Denn Mining Corp. The remainder came from 17 other properties in six counties. The Old Dick and Copper Queen underground mines and the mill, operated by Cyprus Mines Corp. near Bagdad, were closed about the middle of the year because of depletion of proven ore reserves. Exploration work was started in mid-1966 near the present Old Dick shaft. The new shaft was expected to be finished by late 1967, thus permitting development of the new ore body, with production possibly extending for several years and exploration of the ore zone at deeper levels than heretofore practicable.

NONMETALS

Asbestos.—Asbestos was shipped from four underground mines in the Salt River Valley north of Globe. Nearly all the output was classified as sand and waste, floats, or other short fiber material for use in manufacturing asbestos cement, and other asbestos building products; 28 percent was classified as filter fiber and 2 percent as spinning grade. The leading producer, Jacquays Mining Corp., selectively mined and hand sorted chrysotile ore at the Regal and Chrysotile mines for shipment to the company mill at Globe. Production also was reported by Western Asbestos Manufacturing Co. from the Phillips mine and Metate Asbestos Corp. from the Lucky Seven.

Cement.—Production of portland and masonry cements increased 8 percent and 3 percent, respectively. The average value per barrel of portland and masonry cements increased. A gain in shipments of portland and masonry cements reflected an upturn in construction activity in the State.

Portland cement capacity remained at the 1965 level. The entire output of the two plants—one in Pima and one in Yavapai County—was derived by the dry process. Electrical energy consumed totaled 72.8 million kilowatt-hours; all was purchased. With shipments higher than production, stocks were reduced. Portland cement shipments were to ready-mixed concrete companies, concrete-products manufacturers, building-material dealers, and highway contractors. The balance was shipped to other contractors, government agencies, and miscellaneous consumers.

Of the total shipments, 69 percent was by truck and 31 percent by rail. Most of the shipments were in bulk form; 13 percent was in containers.

Raw materials consumed in producing cement included limestone, clay, gypsum, and blast-furnace slag; resin, lime, asbestos, and other compounds also were used.

Clays.—The quantity of all types of clays sold or used decreased 29 percent. A 31-percent reduction in the output of miscellaneous clay used in manufacturing building brick and portland and masonry cements accounted for most of the decline. Ball clay mined by McKusick Mosaic Co. was used in manufacturing stoneware, art pottery, and floor and wall tile. The quan-

tity of bentonite clay for use in filtering and decolorizing mineral and vegetable oils, as reservoir lining, and as a binder for taconite pellets declined 10 percent.

Clays were produced in Apache, Gila, Maricopa, Pima, and Yavapai Counties.

Diatomite.—Arizona Gypsum Corp. produced a small quantity of diatomaceous earth from the White Cliffs mine near Mammoth in southeastern Pinal County. The material—dried, ground, and classified to 325 mesh—was used as filler.

Feldspar.—The Taylor mine operated by Industrial Minerals Division, International Minerals & Chemical Corp. (IMC), was the only producer of feldspar. All of the hand cobbed potash feldspar was ground and sized for use in manufacturing pottery.

Gypsum.—Production of crude gypsum from five mining operations—three in Pinal and one each in Yavapai and Yuma Counties—totaled 75,000 tons, 27 percent less than that reported for the previous year. The lower output was primarily attributed to a reduction in the demand for gypsum products that accompanied the 5-percent decline in residential construction and a reduced demand for agricultural gypsum. Increased demand for portland and masonry cements resulted in a high output of gypsum used as a cement retarder. National Gypsum Co., from its open pit near Winkelman (Pinal County), mined crude gypsum which was calcined at the company's Phoenix plant for use in manufacturing gypsum wallboard, lath, and other plaster products. Gypsum mined by Arizona Gypsum Co. from deposits near Winkelman and Camp Verde in Pinal and Yavapai Counties was sold uncalcined for use as a cement retarder and as a soil conditioner. Crude gypsum mined by Garcia Gypsum Co. at an open pit near Mammoth and by Harquahala Gypsum Co. at an underground mine near Salome was sold for use as a soil supplement.

Lime.—Continued high demand for primary copper effected a 13-percent rise in the quantity of quicklime used in concentrating copper ores. This curtailed shipments of quick lime to the steel industry. Sales to the construction industry also were below those of the previous year. Of the quantity sold or used, 95 percent was quicklime, 5 percent hydrated lime, used mostly in chemicals.

Most of the lime was used within the State; a small quantity was shipped to California, New Mexico, and Mexico. Morenci, Ray Mines, and San Manuel used their entire production for concentrating copper ores. Lime was produced and sold by Paul Lime Plant, Inc.; Hoopes & Co.; and U.S. Lime Division, The Flintkote Co.

Approximately 450,000 tons of crushed limestone was calcined in five shaft and eight rotary kilns. Seven of the rotary and the five shaft kilns were fired by gas; one rotary was fired by fuel oil.

Mica.—A small quantity of scrap mica, produced by Buckeye Mica Co. at its mine near Buckeye in Maricopa County, was dry-ground at the company mill in Buckeye. The ground mica was sold for use in manufacturing roofing material and for other uses.

Perlite.—Arizona Perlite Roofs, Inc., operated the Adams and Iberri mines near Superior in Pinal County. Crude perlite mined by the company was shipped to the Supreme Perlite, Inc., expanding plant at Phoenix, Maricopa County, and to an expanding plant outside the State. Expanded perlite produced by Supreme Perlite, Inc., was used as concrete aggregate, an aggregate replacing sand in plaster, loose-fill insulation, and a soil conditioner. Harborlite Corp., operating the Harborlite mine in Pinal County, shipped crude perlite to company-owned plants and other expanding plants outside the State. Production and value of crude perlite increased 15 and 43 percent, respectively. Output of expanded perlite doubled; the average sales value declined.

Pumice.—Accounting for more than 34 percent of the U.S. output, Arizona led the Nation in the production of pumice and pumicite materials. Total sales of pumice, pumicite, scoria, and volcanic cinder from deposits in Apache, Coconino, Graham, and Yavapai Counties were 5 percent lower in quantity and 10 percent higher in value than in 1965. The average sales value of prepared material (crushed, screened, and blended) was $1.60 per short ton; crude material was marketed at about $1.01 per ton. The material produced at the 11 mines was used principally as railroad ballast. Other reported uses for the material were fill for road construction and as a concrete aggregate.

The Atchison, Topeka & Santa Fe Railway Co., the principal producer, obtained volcanic cinder from the Darling pit near Winona, Coconino County, for use as a railroad ballast. Pumice and pumicite materials, for use as road base and surfacing material, was produced at county highway department projects in Apache and Coconino Counties.

Pyrites.—Pyrite from the Magma mine of Magma Copper Co. was sold to Ray Mines as supplemental feed for its sulfuric acid and sponge-iron plant. Primary feed for the acid plant was copper sulfide ores from the Ray pit. The sulfuric acid was used in leaching waste dumps and, with sponge iron, in the leach-precipitation-flotation (LPF) process. Output of byproduct pyrite was 23 percent in quantity and 22 percent in value below that reported for the previous year.

Sand and Gravel.—Production of sand and gravel totaled 19 million tons, the second highest output in State history. Sand and gravel was produced in all of the State's 14 counties, from a total of 78 commercial and 104 Government-and-contractor operations. All but a small tonnage was processed in 60 stationary and 47 portable plants. Of the 8 million tons shipped by commercial carrier, 99 percent was by truck and 1 percent by rail.

Output of construction sand and gravel rose 26 percent, from 14.8 million tons in 1965 to 18.6 million tons in 1966. Road construction utilized 65 percent of the total output of construction sand and gravel; material used as fill accounted for 7 percent. Rising 20 percent, nonresidential construction in the State effected an increased demand for building sand and gravel. However, residential construction in the State was 5 percent less than that of the previous year. The output of paving sand and gravel rose 9 percent as Interstate and State highway department construction continued at record rates. Of the 12.1 million tons of paving sand and gravel produced, 10.2 million tons was Government-and-contractor output; 1.9 million tons was classified as commercial.

State highway construction contracts awarded totaled $80.1 million, up from $69.9 million; 63 percent of this total was for construction of roads in the National System of Interstate and Defense Highways.[5] Of the 1,167.3 miles of Interstate Highways in Arizona, 712.1 miles was open to the public at yearend; 448.3 miles was under construction, engineering, or right-of-way phase; and 6.9 miles had not been started.[6]

Table 10.—Sand and gravel production in 1966, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value
Apache	554	$761
Cochise	1,465	1,474
Coconino	W	W
Gila	246	292
Graham	W	W
Greenlee	113	112
Maricopa	6,654	7,474
Mohave	1,553	1,612
Navajo	1,116	1,108
Pima	1,437	1,581
Pinal	596	841
Santa Cruz	496	496
Yavapai	1,756	1,819
Yuma	1,835	1,952
Undistributed	909	926
Total	18,730	20,448

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

Industrial sand production was appreciably below that of 1965. Most of the output was unground sand used in oil formation fracturing; a small quantity was sold for use as engine and blast sand.

Stone.—Production of stone declined from 2.5 million tons valued at $4.2 million in 1965 to 2.3 million tons valued at $4.1 million in 1966. Crushed limestone produced in 7 counties at 10 operations accounted for 70 percent of the total quantity and 55 percent of the total value. Of the crushed limestone, 26 percent was used in manufacturing lime for copper ores benefication, 13 percent as a flux in the smelting of copper ore, and 57 percent by the cement industry. Major producers included Arizona Portland Cement Co. Division, California Portland Cement Co.; Paul Lime Plant, Inc.; and Phelps Dodge Corp.

Crushed sandstone was quarried mainly in Cochise and Greenlee Counties. Crushed miscellaneous stone quarried in 13 counties accounted for 15 percent of the total stone output. All of the crushed miscellaneous stone was used in road construction.

[5] Engineering News-Record. State Highway Department's Construction Contracting Plans for 1967 . . . and Budgets for Maintenance: Highway Construction Spending Will Reach For a Record This Year. V. 178, No. 12, Mar. 23, 1967, pp. 24–25.

[6] Bureau of Public Roads. Quarterly Report on The Federal-Aid Highway Program, Dec. 31, 1966. Press Release BPR 67–5, Feb. 1, 1967.

Table 11.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	1,207	$1,601	2,849	$3,382
Paving	491	591	439	573
Fill	153	105	234	200
Other	11	9	[1] 24	[1] 208
Industrial:				
Blast	[2] 51	[2] 76	(1)	(1)
Engine	(2)	(2)	1	8
Oil (hydrafrac)	18	196	(1)	(1)
Other	12	16	-----	-----
Total	1,943	2,594	3,547	4,371
Gravel:				
Construction:				
Building	1,553	2,056	2,213	2,945
Paving	3,409	3,945	1,468	1,784
Railroad ballast	[3] 54	[3] 36	-----	-----
Fill	548	535	722	554
Other	(3)	(3)	-----	-----
Miscellaneous	47	63	74	83
Total	5,611	6,635	4,477	5,366
Total sand and gravel	7,554	9,229	8,024	9,737
Government-and-contractor operations:				
Sand:				
Paving	1,274	1,429	1,380	1,373
Fill	92	84	211	182
Total	1,366	1,513	1,591	1,555
Gravel:				
Building	-----	-----	75	62
Paving	5,924	5,827	8,845	8,912
Fill	66	48	195	182
Other	8	4	-----	-----
Total	5,998	5,879	9,115	9,156
Total sand and gravel	7,364	7,392	10,706	10,711
All operations:				
Sand	3,309	4,107	5,138	5,926
Gravel	11,609	12,514	13,592	14,522
Total	14,918	16,621	18,730	20,448

[1] Blast, oil (hydrafrac), and "Other (construction)" sand combined to avoid disclosing individual company confidential data.
[2] Blast and engine sand combined to avoid disclosing individual company confidential data.
[3] Railroad ballast and other gravel combined to avoid disclosing individual company confidential data.

MINERAL FUELS

Coal (Bituminous).—The Navajo Tribal Council approved a contract with Peabody Coal Co. of St. Louis, Mo., for strip mining 150 million tons of coal from the Black Mesa area on the Hopi and Navajo Indian Reservations, Navajo County. The contract called for delivery of coal by slurry pipeline to a $188 million, 1.5-megawatt powerplant to be built on the Colorado River in Clark County, Nev., by Southern California Edison Co. Under terms of the contract, Peabody was to pay a royalty of 25 cents per ton—12.5 cents per ton each to the Hopi and Navajo Indians—and, in addition, 12.5 cents per ton to be deposited in an escrow account. Over a 35-year period, Peabody Coal Co. was to supply a minimum of 17 million tons of coal to the utility. The first unit of the powerplant was scheduled for completion in October 1970. The plant was to serve southern Nevada, southern California, and parts of Arizona.

Helium.[7]—Grade A Helium (99.995-percent purity) was produced throughout the year at the Kerr-McGee Corp. Navajo

[7] Prepared by Office of Assistant Director—Helium, Washington, D.C.

Table 12.—Stone production in 1966, by counties

County	Short tons	Value
Apache	16,765	$58,538
Cochise	W	W
Coconino	145,702	409,489
Gila	187,100	307,506
Greenlee	W	W
Maricopa	9,351	19,218
Mohave	48,342	104,472
Navajo	6,519	18,040
Pima	W	W
Pinal	90,483	188,430
Santa Cruz	3,216	4,825
Yavapai	450,222	578,228
Yuma	36,791	241,763
Undistributed	1,276,045	2,160,672
Total	2,270,536	4,091,181

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

plant. The helium was extracted from naturally occurring, non-hydrocarbon gas produced from the Pinta Dome and Apache Springs fields in Apache County.

Based on Arizona Oil and Gas Commission reports, it was estimated that the Navajo plant produced for sale about 63.5 million cubic feet of grade A helium during the year, an increase of about 9 percent over the estimated 1965 production of 58 million cubic feet. The 1966 production was valued at approximately $2.2 million. Although the Navajo plant had facilities for liquifying large quantities of the produced helium, no data were available on the relative volumes of gaseous and liquid helium produced and sold.

Table 13.—Stone sold or used by producers, by kinds

Year	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
	Basalt and related rocks (traprock)		Granite		Limestone		Marble	
1962	586,323	$879,482	113,274	$117,424	1,986,091	$2,430,203	12,528	$104,929
1963	80,816	208,716	20,705	32,738	1,771,114	2,307,107	22,713	287,042
1964	40,814	36,370	W	W	1,800,623	2,483,623	[1] 22,476	[1] 275,787
1965	W	W	236,735	362,186	1,601,867	2,146,626	W	W
1966	10,347	31,226	-----	-----	1,590,470	2,261,527	21,164	278,708
	Sandstone		Slate		Other stone		Total	
1962	601,532	1,486,902	84	837	1,033,310	1,596,130	4,333,142	6,615,907
1963	714,897	1,574,782	-----	-----	646,370	658,765	3,256,615	5,069,150
1964	788,171	1,675,194	-----	-----	[2] 1,107,096	[2] 1,811,973	3,759,180	6,282,947
1965	460,152	1,233,788	-----	-----	175,287	428,575	2,474,041	4,171,175
1966	318,444	883,907	-----	-----	330,111	635,813	2,270,536	4,091,181

W Withheld to avoid disclosing individual company confidential data; included with "Other stone."
[1] Excludes dimension marble; included with "Other stone."
[2] Includes dimension marble.

Table 14.—Stone sold or used by producers, by uses

Use	1965		1966	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction, short tons	3,037	$22,428	1,357	$12,985
Rubble, do	496	11,293	283	3,260
Rough architectural, cubic feet	31,822	26,419	16,159	14,524
Dressed architectural, do	13,252	27,174	7,999	20,570
Curbing and flagging, do	52,744	52,542	55,892	54,590
Total (approximate, in short tons)	10,900	139,856	7,729	105,929
Crushed and broken stone:				
Riprap, short tons	286,073	413,228	130,026	195,048
Metallurgical, do	530,658	1,138,903	502,006	1,086,688
Concrete and roadstone, do	362,684	731,568	235,673	548,251
Lime, do	391,835	717,420	450,016	896,545
Other, do	[1] 891,890	[1] 1,030,200	[2] 945,086	[2] 1,258,720
Total, do	2,463,140	4,031,319	2,262,807	3,985,252
Total stone (approximate in short tons)	2,474,000	4,171,175	2,270,500	4,091,181

[1] Includes stone used in abrasives, animal feed, cement, landscaping, mineral food, roofing granules; in making book ends, clocks, etc.; and for unspecified use.
[2] Includes stone used in abrasives, agriculture, animal feed, cement, landscaping, mineral food, paper, polyester filler, precasting, roofing granules, signs, stucco, terrazzo, walls, and for unspecified use.

The Kerr-McGee Navajo plant was operated entirely independently of the Government helium program.

Natural Gas.—Marketed natural gas, all from Apache County, totaled 3.2 billion cubic feet, up 2 percent from the 1965 figure.

On July 26 the Federal Power Commission (FPC) ruled that El Paso Natural Gas Co. and Transwestern Pipeline Co. should supply natural gas to the southern California market from the Four Corners area and the Permian basin. This ruling indirectly affected Arizona's natural gas industry in that not only would larger markets be made available to producers of the Four Corners area—including Arizona—but new facilities would be built in the State. El Paso was to build 130.4 miles of 30-inch line paralleling the three existing 24-inch, 30-inch, and 34-inch pipelines in the State. New compressor stations were to be added at Franconia and Hackberry; the latter was to have two 8,000-horsepower, gas-turbine compressor units. Transwestern was to build 67 miles of new pipeline and add 98,400 horsepower in new compression—most of it in the State.

Petroleum.—Output of petroleum from the five producing fields was 36 percent higher than in 1965. Yield from the East Boundary Butte field was up 63 percent to 70,923 barrels; the Dry Mesa field was ranked second with 33,774 barrels, a 23-percent increase.

Exploratory drilling declined from 29 wells in 1965 to 15, all dry. Two dry field wells were drilled.

At a lease sale held August 10, at the Fort Apache Indian Agency, 42,229 acres was leased for a total bonus of $54,244. Average bid per acre was $1.35; the highest bid was $2.53 per acre. The bids were much below that of 1965, when the average bid was slightly above $17 per acre.

Table 15.—Drilling for petroleum in 1966, by counties

County	Dry	Total	Footage
Exploratory completions:			
Apache	8	8	26,004
Coconino	1	1	3,178
Mohave	1	1	4,031
Navajo	3	3	7,111
Pinal	1	1	797
Yavapai	1	1	2,327
Total	15	15	43,448
Development completions:			
Apache	2	2	2,700
Total all drilling	17	17	46,148

Source: Committee on Statistics of Drilling, American Association of Petroleum Geologists.

REVIEW BY COUNTIES

Apache.—The county was the source of all helium, natural gas, and petroleum produced in the State and accounted for 59 percent of all the oil and gas well drilling. Mineral fuels comprised more than half of the total value of mineral production in the county.

Paving sand and gravel was the principal nonmetallic mineral produced in the county during the year. Production reported from nine operations—one commercial and eight operated by contractors or crews of State and Federal agencies—was twice the quantity produced the previous year, reflecting the higher rate of road construction. Arizona Silica Sand Co., the only commercial operator, produced a small quantity of sand from a deposit near Houck largely for use in hydrofracting oil wells with a small quantity used for sand blasting.

Volcanic cinders, from a deposit near Springerville in the southeastern part of the county, was used by the Apache County Highway Department as base material in road construction. Filtrol Corp.—a manufacturer of catalysts, absorbents, and decolorizing agents—produced bentonitic clay from the Cheto clay deposit near Sanders for use in filtrating vegetable and mineral oil. The largest producer of bentonite in the State, the company accounted for all of the clay output in Apache County.

Carnotite-type uranium ores, mined from 22 deposits on the Colorado Plateau in the northern part of the county, were shipped to processing plants in Colorado, New Mexico, and Utah. Output was at approximately the same level as in the previous year when 18 operators reported production. Principal producers were Vanadium Corporation of America (VCA); Gilbert Shumway; Climax Uranium Co., Climax Molybdenum Co. Division, American Metal Climax, Inc.; and Pioneer Drilling Co.

Table 16.—Value of mineral production in Arizona, by counties

County	1965	1966	Minerals produced in 1966 in order of value
Apache	r $4,307,906	$5,208,819	Helium, sand and gravel, uranium ore, vanadium, natural gas, petroleum, pumice, clays, stone.
Cochise	W	51,094,213	Copper, sand and gravel, gold, silver, lime, stone, zinc, lead.
Coconino	W	4,153,689	Pumice, uranium ore, sand and gravel, stone, copper, silver, gold.
Gila	70,389,453	72,186,623	Copper, lime, molybdenum, asbestos, stone, silver, sand and gravel, gold, mercury, iron ore, clays.
Graham	W	148,568	Sand and gravel, pumice, copper.
Greenlee	93,809,251	105,583,016	Copper, lime, silver, stone, gold, molybdenum, sand and gravel.
Maricopa	6,004,733	7,739,805	Sand and gravel, mercury, clays, mica (scrap), stone, copper, silver, gold.
Mohave	19,586,739	24,412,574	Copper, molybdenum, sand and gravel, silver, stone, feldspar, zinc, gold, lead.
Navajo	1,468,466	1,231,436	Sand and gravel, uranium ore, stone, iron ore, vanadium.
Pima	149,153,395	162,020,777	Copper, cement, molybdenum, silver, sand and gravel, gold, stone, zinc, clays, lead, tungsten concentrate.
Pinal	141,730,125	151,631,186	Copper, molybdenum, silver, gold, sand and gravel, gypsum, lime, perlite, stone, pyrites, diatomite, iron ore, lead.
Santa Cruz	377,323	808,662	Sand and gravel, zinc, lead, silver, copper, stone, gold.
Yavapai	33,054,812	31,860,510	Copper, cement, zinc, sand and gravel, lead, molybdenum, silver, stone, gold, lime, pumice, gypsum, clays, uranium ore.
Yuma	1,290,738	2,364,802	Sand and gravel, stone, copper, lead, gypsum, silver, gold, zinc.
Undistributed [1]	r 58,919,163	120,320	
Total	r 580,092,000	620,565,000	

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

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

From the uranium-vanadium ores produced in the county, vanadium concentrates were recovered as a coproduct at mills in Grand Junction, Colo., and Shiprock, N. Mex.

Cochise.—Copper, gold, silver, zinc and lead, recovered primarily from porphyry copper ore, accounted for $47.6 million (93 percent) of the total value of county mineral production. Lime, sand and gravel, and stone accounted for the remainder. The county was ranked first in the State in production of gold, third in production of silver, fourth in production of zinc, and fifth in the production of copper.

Copper Queen Branch, Phelps Dodge Corp., at Bisbee—consisting of the Copper Queen underground and Lavender open-pit mines—accounted for most of the mine production and mine employment in the county. This property, the largest gold and silver producer in the State, yielded 6.8 million tons of ore; 6.1 million tons from the open pit and 721,000 tons from the underground mine according to the company annual report.

In addition, approximately 31.2 million tons of waste and leach material were removed. The ratio of waste and leach material to ore moved in 1966 was approximately 5.1 to 1, compared with 3.87 to 1 in 1965. The increase in the stripping ratio resulted primarily from development work in relocating U.S. Highway 80 along the north side of the pit. The recovered copper content of the open-pit ores mined during the year was 0.57 percent. The concentrator treated approximately 6 million tons of ore at an average rate of 19,500 tons per operating day; the open-pit mine and concentrator were operated the equivalent of a 6.5-day week; and the underground mine was operated a 6-day week. Part of the ore from the underground mine was shipped to the company smelter at Douglas. Automatic controls installed to adjust the quantity of ore fed to each of eight ball mills at Lavender concentrator resulted in an increase in productive capacity.

Underground exploration continued during the year; however, no important discoveries were made. The tonnage of ore developed was again, as in 1965, somewhat less than the quantity mined. Further work was done on the application of continuous automatic X-ray analysis of process streams at the Lavender Pit concentrator.

The company smelter at Douglas, 41 miles east of the Copper Queen Branch operations treated ores from the under-

ground mine at Bisbee, concentrates from the Lavender Pit plant, and precipitates from the leaching of Lavender Pit dump material. The smelter also treated copper scrap and other materials on a custom or toll basis. An experimental adaptation of the mechanical tuyere puncher developed at Morenci was installed and tested. A study was underway to adapt this device for the company smelter at Ajo.

Interstate Accounting & Office Service of Phoenix operated the Mame mine of Hope Mining and Milling Co. in the Turquoise mining district.

Some gold, silver, copper, lead, and zinc were recovered from several small properties.

The $3.5 million of nonmetals produced was substantially above that of 1965 and resulted from increased output of lime and sand and gravel. Limestone produced by Paul Lime Plant, Inc., was used primarily for lime manufacture at the company plant and as a flux in smelting copper ores. Hydrated lime and quicklime produced at this plant was used primarily in copper-ore concentration, with small quantities sold to the construction industry, for soil stabilization, and in manufacturing mortar and masonry cements. Sandstone quarried and crushed by Andrew J. Gilbert Construction Co. from the Gilbert silica pit near Elfrida was used as smelter flux by Phelps Dodge Corp. at Douglas. Contractors and crews of the Arizona Highway Department quarried a small quantity of miscellaneous stone for riprap.

Coconino.—Uranium production by Westec Corp. at the Orphan Lode and Orphan Lode Park mines on the south rim of the Grand Canyon declined substantially. The mines were closed in July upon completion of allocated deliveries to AEC. The county, however, continued as the leading uranium ore producer in the State but at a drastically reduced rate. Also reduced was the quantity and value of silver and copper recovered from the processing of Orphan mine uranium ores at the Tuba City mill, operated by El Paso Natural Gas Co.

Construction materials—pumice, sand and gravel, and stone—were the principal mineral commodities produced in the county. Sand and gravel from 11 operations, 4 commercial and 7 Government-and-contractor, decreased as road construction projects were completed. The output of paving sand and gravel by crews and contractors of the Arizona Highway Department accounted for 93 percent of the total production of sand and gravel; four commercial companies produced the balance. Pumice and pumicite from seven quarries in the Flagstaff-Winona area were used, primarily, as concrete aggregate, railroad ballast, and in road construction. Companies operating quarries in the Williams-Ash Fork-Drake area quarried and prepared dimension sandstone for use as building stone and flagging. Flagstaff Service and Materials Co. quarried and crushed miscellaneous stone from the Gray Mountain quarry for use in road construction.

Gila.—An expanding mining industry increased the value of mineral production to a new high in 1966 despite a 3-week strike which closed operations of Inspiration Consolidated Copper Co., a major copper source. Output of copper and associated metals, primarily from mines in the Globe-Miami area, furnished 97 percent of total value of mineral production. Nonmetallic minerals and mineral products, together with iron ore and mercury, accounted for the remainder. Inspiration Consolidated Copper Co., according to its annual report, shipped 114.2 million pounds of copper during 1966, 8.2 percent less than in 1965. The lower output resulted from a strike that began late in September and closed all company operations for approximately 3 weeks, and the collapse in March of a new leaching-plant ore excavator. The excavator was a key item in a project to increase the treatment capacity of the Inspiration Division from 16,500 tons to 20,000 tons per day.

Inspiration Division mined and treated 6.4 million tons of ore at a daily average rate of 19,073 tons. The ore contained 0.829 percent copper (0.358 percent oxide copper and 0.471 percent sulfide copper), slightly lower in grade than the 0.894 percent copper ores (0.416 percent oxide copper and 0.478 percent sulfide copper) mined in 1965. The ratio of waste to ore in 1966 was 1.30 compared with 1.64 the previous year, indicating a reduction in stripping rates of about 21 percent. The lower overall ratio of waste to ore resulted from near completion of preproduction stripping at the Thornton-West extension.

Copper also was recovered by acid leaching of waste dumps and mined-out areas, followed by precipitation of copper from solution by scrap iron. Recovery by leaching resulted in the 6.9 million pounds of copper, compared with 7.7 million pounds in 1965.

The Inspiration smelter treated 217,739 tons of concentrates, precipitates, and other material: 119,097 tons was from company operations and 98,642 was custom or toll-intake material. The new suspended-arch reverberatory furnace (with inside length 110 feet and width 32 feet) completed in May was operated at capacity. The new furnace replaced two smaller units that were dismantled to accommodate the new construction. Further improvement and expansion of the smelter facilities was planned.

Refinery operations were conducted at capacity. All of the company output plus part of smelter toll-intake was refined. The remaining unrefined copper was shipped elsewhere for refining. Overall recovery through the refinery was 82.07 percent compared with 87.66 percent the previous year. At its Thornton and Live Oak pits Inspiration Consolidated Copper Co. selectively mined three types of ore: A mixed oxide-sulfide ore that was leached and concentrated; a high-sulfide ore that was concentrated; and late in the year, a high-oxide ore that was leached.

Planned plant modificiations or additions included the following:

Extension of open-pit coarse-crusher bins and substitution of belt conveyors for rail haulage to the secondary crushing plant.

Modification of bin storage beyond the secondary crusher to permit efficient segregation of the three types of ore.

Replacement of existing tertiary crushers.

Underground operations at the firm's Christmas mine, 10 miles north of Hayden, remained closed following settlement of the strike. The small open-pit operation which was started in 1965 to provide back fill for the underground mine was expanded. Drilling indicated sufficient quantity and grade to utilize fully the existing mill. Metallurgical testing indicated that a better than 90-percent recovery of the sulfide fraction and about 50-percent recovery of the oxide fraction of the mixed ores found in the pit could be obtained. The ores were not suitable for leaching.

The mine was being developed in stages to make ore readily available for the mill in quantity; this phased development was used because no advanced stripping of overburden was completed before the decision to expand open-pit activity. The initial waste to ore ratio was expected to be as high as 6 to 1, decreasing as development proceeded. The percent of overall recovery of copper was 76.87 in 1966 compared with 85.48 percent in 1965.

In 1966, production was 934,813 tons of ore containing 1.140 percent copper; in 1965, 715,671 tons of ore containing 1.413 percent copper was produced mainly from the underground part of the property. Concentrates were trucked 36 miles to Miami and discharged into rail cars for transportation over the Inspiration railroad to the company smelter at Inspiration.

The "Ox Hide Mine" near Inspiration was being developed as an open pit with extraction of copper by heap leaching and precipitation.

Miami Copper Co. Division, Tennessee Corp. (a subsidiary of Cities Service Co.), recovered copper from its Copper Cities mining, milling, and leaching operation. Ore was leached in place at the Miami underground mine and low-grade dump material was leached at Castle Dome.

In a plant northwest of Miami, Ranchers Exploration and Development Corp. recovered copper precipitates and in 1966 shipped more than 7 million pounds of copper in that form. The quantity of low grade oxide ore, tractor ripped and scraper hauled to prepared leach sites, increased. Screen analysis indicated that 93 percent of the material from the Bluebird open pit was minus 4-inch material and 2 percent was plus 10-inch material.

Dilute sulfuric acid solution (1 to 5 percent H_2SO_4) used for leaching was distributed over the heap through 3-inch plastic pipelines 8 feet apart; needle valves, at 2-foot intervals controlled the rate of flow. An average heap of 125,000 tons received about 185 gallons per minute of 5 percent sulfuric acid initially with the acid content gradually reduced to between 2 and 3 percent. Leach time varied from 1 to 2 months. About 20,000 pounds of 85- to 90-percent copper precipitates were produced daily from the pregnant solution by use of scrap iron. The precipitate was drawn from the leach tanks in slurry form and

transferred to drying pads before storage and shipment.

Six other operations yielded ore or material from which copper, gold, or silver was recovered.

Mercury output came from the Cypress, Mercuria, Ord, Valley Assay, and one unnamed property. The mercury content of the 1,111 short tons of crude ore produced ranged from 0.05 percent to 0.25 percent, averaging 0.09. Most of the ore was furnaced; only 26 percent was retorted. Cane Springs Milling & Mining Co., operator of the Cypress mine, was the largest producer in the county. A small quantity of magnetite ore was mined and shipped by Cline & Seitz from the Margaret-Howard mine for use as a processing agent.

Nonmetals production, principally asbestos and lime, accounted for 3 percent of the total value of county mineral output. All of Arizona's asbestos mining was in Gila County. Jacquays Mining Corp. (Regal and Chrysotile mines), Western Asbestos Manufacturing Co.—formerly Asbestos Manufacturing Co.—(Phillips mines), and Metate Asbestos Corp. (Lucky Seven mine), produced filter fiber, waste plaster and shorts, paper fiber, floats, and sand and waste material.

Crushed limestone produced at quarries operated by Hoopes & Co. near Miami and by Ray Mines near Hayden was used in manufacturing quicklime and as a flux in smelting copper ores. Miscellaneous stone was quarried from deposits on the San Carlos Indian Reservation for use as concrete and road metal. George O. Gould shipped a small quantity of sandstone from the Yellow Stone quarry near Pine in the northwestern part of the county for use as flagging. McKusick Mosaic Co. mined ball clay from the Weary Lode No. 2 near Globe for use in manufacturing stoneware art pottery, and floor and wall tile.

Graham.—In the Lone Star mining district, east of Safford, Hecla Mining Co. discontinued exploration of the Copper Flat group of 240 unpatented mining claims, owned by Winkler-Faulkner. The property was held under terms of a lease with purchase option by Newmont Exploration, Ltd., and Hecla Mining Co. Pumice and volcanic cinders produced by Gila Valley Block Co. from the Pumice, Blue Bird, and Triangle claims were sold for use as a concrete aggregate.

Greenlee.—Copper accounted for 97 percent of the total county mineral output value. Greenlee County was the third largest source of copper in Arizona, contributing 19 percent of the State output. The county index of economic activity averaged about 11 percent higher than in 1965. The Morenci open-pit mine operated by the Morenci Branch, Phelps Dodge Corp., contributed most of the county mineral output value. The mine was the largest producer of copper in the State and the second largest producer in the Nation. According to the company annual report, copper production totaled 141,178 short tons, compared with 127,566 tons in 1965, reflecting the increased capacity resulting from the expansion and modernization program begun in 1962. The mine was operated 318 days, the equivalent of 6.5 days per week. Operations were continuous throughout the year, except for a regular 3-week vacation shutdown.

Ore and waste material were mined at an average rate of 151,400 tons per day: 60,800 tons was ore and 90,600 waste and leach material. The ratio of waste and leach material to ore was 1.49 to 1, the lowest reported since 1960. About 40 percent of the total material moved was ore.

Construction of a new precipitation plant for recovering copper by leaching low-grade material was completed. The plant began limited operations in April, reaching full operation in July. On a full-year basis, these facilities were to increase Morenci copper production by 15,000 tons per year.

At the new leach-precipitation-flotation (LPF) system for recovering part of the nonsulfide content of the Morenci ores, problems were encountered with equipment performance and process control. They were partly overcome during the year and further improvement was expected in 1967. The $18.7 million system when operating at designed capacity was expected to increase the annual copper output of the mine by 10,000 tons.

During the year a system for continuous X-ray analysis of feed, concentrate, and tailings at the Morenci concentrator was installed and put into operation.

Significant quantities of byproduct gold, silver, and molybdenum also were recovered from copper ores at the Morenci concentrator. Limestone mined by the com-

pany at the Morenci quarry was used as a smelting flux and in manufacturing quicklime used for metallurgical purposes. Sandstone was quarried by the company near Morenci for use as smelter flux.

Maricopa.—Mineral production in Maricopa County, the State's largest metropolitan area, centered about nonmetallic mineral products for construction. The value of residential building contracts was up 13 percent; nonresidential building contracts rose by more than 35 percent. Sand and gravel from 38 operations accounted for 97 percent of the county mineral output value, other nonmetals 1 percent, and metals the remainder. The leading source of sand and gravel in the State, the county accounted for 36 percent of the total output. Eighteen commercial operators at 20 pits, principally in the Phoenix metropolitan area, processed 5.2 million tons of sand and gravel valued at $6.1 million. Sixty-four percent of the product was construction sand and gravel used by the building industry.

Mercury was recovered from the furnacing of ores at two mines. Output from the National (Big Sam) and the Pine Mountain cinnabar deposits in the Mazatzal Mountains, in the northeastern part of the county, comprised most of the State output. Ores from the Big Sam mines operated by Big Sam Mercury Mines were processed in a 100-ton Shutte furnace; ore from the Pine Mountain property, operated by United Nuclear Corp., was processed in a 50-ton Gould rotary furnace.

Apache Building Stone quarried rough architectural-dimension sandstone at the Sunflower quarry and Baine Stone Co. quarried rubble at a quarry in the Tonto National Forest. At the Harquahala quarry, Agnes D. Mick produced marble for use as a decorative exterior stone. Miscellaneous stone quarried by contractors for the Arizona Highway Department was used for riprap.

Buckeye Mica Co. ground scrap mica from the Buckeye mine at its mill near Buckeye and sold the product primarily for use in manufacturing construction materials.

Miscellaneous clay mined from deposits near Phoenix by Phoenix Brick Yard and Wallapai Brick and Clay Products, Inc., was used by the companies for manufacturing building brick.

Small quantities of gold, silver, and copper were recovered from copper and silver ores mined by small producers.

Mohave.—Originally a gold- and silver-mining center dating from a rich silver strike in 1870, Mohave County was once again becoming one of Arizona's significant mining areas. Duval Corp. operated a large copper-molybdenum mine and concentrator in the Mineral Park district (Ithaca Peak), about 15 miles north of Kingman. It was reported the company acquired patent to 56 mining claims, 961 acres, in the Mineral Park district.

General Cable Corp., a large manufacturer of electric wire and cable, announced plans for a $10 million copper rod and wire plant to be built at Kingman. Construction began in December; manufacture of copper rod and wire was scheduled to begin in October 1967.

Metals production (gold, silver, copper, lead, zinc, and molybdenum) came from mines located in the Bentley, Cedar Valley, and Wallapai mining districts. Plans were announced by El Paso Natural Gas Co. for an open-pit copper operation at the old Emerald Isle mining claim 15 miles northwest of Kingman and 3 miles from the Duval Corp. Mineral Park operation. The mine and mill, scheduled for production by mid-1967, was to have a daily capacity of 800 to 900 tons of ore; about 1.5 million cubic yards of overburden was to be removed before production. Chico Mining & Milling Corp. core drilled an area south of the old Jamison mine in Cerbat Mountains.

Potash feldspar and quartz, obtained from pegmatite dikes at the Taylor mine by a contractor for IMC, was processed by IMC at its mill in Kingman and shipped to California, Illinois, Texas, Mexico, and the Philippines. Quartz produced by C. F. Weeks at the White Spar quarry near Kingman was sold for abrasive use.

Miscellaneous stone was quarried by contractors and crews of the Arizona Highway Department for use in highway construction. Apache Building Stone quarried dimension sandstone near Sunflower for rough architectural use.

Six plants processed 1.6 million tons of sand and gravel. Of the total 88 percent was processed by contractors and crews of Federal, State, and county agencies for use

in road construction and 12 percent by commercial operators for use by the construction industry.

Navajo.—Uranium ores from five operations provided 14 percent of the State production of this commodity and accounted for 7 percent of the total value of county mineral output. Industrial Uranium Co., the largest producer, operated the Moonlight mine and shipped its output to the Atlas Minerals Division, Atlas Corp., mill at Moab, Utah. Uranium ore, produced from the Alma and Seegan mines by Grant L. Shumway, and from the Bootjack mine operated by Atlas Minerals, also was processed at the Atlas mill. Crude ore from the Mitchell Mesa property was shipped to the VCA mill at Shiprock, N. Mex., for recovery of uranium and vanadium concentrates.

Sand and gravel produced at 15 Government-and-contractor operations and at 3 commercial operations totaled 1.1 million tons. Of this total, 932,000 tons was used for road construction—864,000 tons was used on Government projects and 68,000 tons was sold commercially.

CF&I Steel Corp. shipped to Pueblo, Colo., a test quantity of hematite ore from a deposit northwest of Young, held under lease from the Fort Apache Indian Tribe. In 1964, the company signed a 10-year lease with the White Mountain Apache Tribal Council for development of certain known iron deposits. The company had been drilling on the 36,000-acre iron ore deposit since 1960.

Pima.—Expanded mine production, coupled with increased construction and development activities, stimulated a rise in the county economy. Nonresidential building contracts were up 17 percent; residential contracts, however, dropped 21 percent below the levels of the previous year. Employment by the mining and quarrying industries in the Tucson area rose 14 percent (500) over the 3,700 reported employed at the end of 1965.

Contract construction industry payrolls increased by 300 employees during the year. Average weekly earnings of employees in the copper industry was $156.24, down from $156.46 in 1965; average hourly earnings however rose from $3.28 in 1965 to $3.36 an hour in 1966. The number of hours worked per week in the copper industry was 1.2 hours lower.[8]

Production of copper from county mines was 14,531 tons above the 1965 level, and 1,686 tons above the 1964 output, the previous high. The higher output resulted from increased yield, primarily from the Pima mine supplemented by increased production from the Esperanza and Silver Bell mines. The quantity and value of byproduct molybdenum sulfide recovered from copper ores declined.

Anaconda continued development work at Twin Buttes located at Sahuarita, near Tucson. According to the company annual report, preproduction stripping for the open pit, begun in 1965, was accelerated to a daily rate in excess of 300,000 tons. By yearend, more than 50 million tons of alluvial overburden had been removed. Ore was encountered at an average depth of 460 feet below the surface.

Mining operations in ore and bedrock were to begin in 1968, and during 1969, the mine was to be sufficiently developed to provide feed to a 30,000- to 40,000-ton-per-day flotation concentrator. Excavation for the concentrator was begun; and metallurgical testing reached the point where the milling flow sheet neared completion. Nine belt conveyors more than 20,000 feet in total length were to transport crushed ore and rock from the pit to the concentrator, waste dumps, or low-grade ore stockpile. A standard-gage railroad, 7.4 miles long, was built from the Southern Pacific Railroad at Sahaurita to the projected millsite at Twin Buttes.

Phelps Dodge Corp. in its annual report stated that production of copper from the New Cornelia Branch Ajo open-pit mine totaled 68,297 tons. The property was worked the equivalent of 6.5 days per week, with an average daily combined output of ore and waste material of 80,000 tons. Operations were continuous except for a 3-week vacation shutdown. The ratio of waste to ore mined at the Ajo open pit was 1.42:1, slightly lower than the 1.49:1 reported in 1965. Productive capacity at Ajo was expected to continue at about the present level until the latter part of 1970, when output was expected to fall off.

Pima Mining Co. (50 percent owned by Cyprus Mines Corp.) reported that 30.2 million tons of ore and waste was moved from the open pit at an average daily rate of 83,000 tons. The ratio of waste to ore

[8] Work cited in footnote 3.

was 4.01:1 compared with 6.13:1 in 1965. Copper concentrates were shipped to Asarco and Phelps Dodge Corp. for smelting and refining. In 1966, concentrates produced contained 78.6 million pounds of copper, compared with 36 million in 1965. This major increase resulted from completion in mid-1966 of a $20.5 million expansion project which increased daily ore productive capacity from 6,000 to 18,000 tons. In Auugst, a new $16.5 million project to further expand capacity to 30,000 tons per day, was started with completion scheduled for mid-1967.

In mid-1966, the company installed equipment at its mill to recover low-grade molybdenum concentrate. Additional equipment to upgrade the concentrate to a marketable product was to be installed in 1967. The plant, scheduled for completion in October 1967, was expected to recover 650,000 pounds of molybdenum per year.

Gold and silver produced in the county were recovered as byproducts of copper refining. The New Cornelia Branch at Ajo was the largest producer of gold and the third largest producer of silver. The Mission mine was ranked first in the yield of silver and second largest in zinc. The small quantity of lead produced came from ores mined at Mission and from six small lode mines.

Fernstrom Mining Co. sold Kennametals, Inc., Fallon, Nev., a small quantity of tungsten concentrates recovered from ores mined and milled at the Carboloy mine.

From crushed limestone produced at the company quarry and purchased slag and gypsum, Arizona Portland Cement Co. manufactured portland and masonry cements at its dry process plant near Rillito. The cement was shipped to consumers in and out of the State.

The entire production of miscellaneous clays produced by Phoenix Brick Yard, Grabe Brick Co., Inc., and Tucson Pressed Brick Corp. from the Pantano clay deposit near Tucson, was used in manufacturing building brick.

A small quantity of marble from the Andrada quarry was crushed and sold for use as roofing granules, landscaping, and animal feed. Crushed sandstone produced by San Antonio Mine Co. was sold to the copper industry for use as a flux. Crews and contractors of the Arizona Highway Department quarried miscellaneous stone for use as riprap.

Fourteen commerical operators produced 1.3 million tons of sand and gravel, valued at $1.4 million, for building, paving, fill, and miscellaneous uses. Contractors and crews of the Arizona Highway Department and Pima County Highway Department accounted for 178,000 tons, valued at $175,000.

Pinal.—Increased output of copper from the San Manuel and Ray Mines operated by Magma Copper Co. and Kennecott Copper Corp. respectively, was the primary factor in the county maintaining its 25-percent share of the total State mineral output. Copper supplied $139.3 million (92 percent) of the $151.6 million value of county mineral production; byproduct gold, silver, and molybdenum, accounted for most of the remainder. Nonmetallic minerals produced were sand and gravel, gypsum, lime, perlite, stone, pyrites, and diatomite. A small quantity of lead and iron ore was produced.

The 1966 annual report of Kennecott Copper Corp. stated that the Ray Mines Division near Hayden mined and milled 8.8 million tons of ore, compared with 8.6 million in 1965. Copper production from all sources totaled 70,820 short tons, compared with 72,153 tons in 1965. The decline resulted from lower grade ore mined. The average grade of the ore produced in 1966 was 0.84 percent copper, compared with 0.86 in 1965.

Pyrites purchased from Magma Copper Co., and recovered from the Ray Mines mill tailings were used for manufacturing sulfuric acid and the production of sponge iron. The acid was used in the LPF system and for leaching waste dumps. Sponge iron obtained by roasting pyrite in a fluidized-bed reactor was used as a precipitant in the LPF system.

The productive capacity of the Ray concentrator was to be increased 24,000 tons to approximately 100,000 tons of copper annually by 1969. The additional output was expected from the daily treatment of 10,000 tons of copper silicate ore. A $35 million vat-leaching system, using sulfuric acid to dissolve the copper in the ore, was to be constructed. Copper was to be recovered from solution by electrolysis. Key feature of the project was the construction of a 750-ton-per-day sulfuric acid production

complex. Sulfuric acid was to be produced by converting about 87 percent of the sulfur dioxide contained in smelter gas. About 100 pounds of acid was to be required for the leaching of 1 ton of ore. The copper silicate deposits to be mined lie east of Mineral Creek, partly within the present pit limits. Expansion of the pit to permit mining deeper ore and adjacent ore bodies required the relocation of surface facilities, shops, and office. A large primary-crushing plant was to be constructed south of the final pit boundaries and a precipitation plant constructed nearby.

The Magma and San Manuel underground mines were operated throughout the year. According to the Magma Copper Co. annual report, production of all metals increased at the San Manuel Division. An increase in the quantity of ore mined and improvement in recovery resulted in greater copper production. Molybdenum sulfide output rose because of a higher average molybdenum content and improved recovery. During the year, the San Manuel Division mined 14.4 million tons of ore containing 0.772 percent sulfide copper, compared with 13.5 million tons of ore containing 0.773 percent sulfide copper in 1965. Ore mined per operating day increased from 37,791 tons in 1965 to 40,312 tons in 1966. The increase resulted from the completion in July 1965 of a $10 million expansion program to enlarge plant capacity 12 percent.

The San Manuel concentrator treated 14.3 million tons of ore at an average rate of 40,091 short tons per operating day. Approximately 89 percent of the total copper and 92 percent of the sulfide were recovered. Ore mined during 1966 contained approximately 14.09 pounds of recoverable copper per ton, compared with 13.89 pounds per ton in 1965. The San Manuel smelter processed 339,652 tons of concentrates containing 29.95 percent copper—compared with 314,750 tons containing 30.24 percent copper in 1965—to recover 101,390 tons of copper, 22,396 ounces of gold, and 311,699 ounces of silver. Seven million pounds of molybdenum sulfide was also recovered from the processing of these ores. The quarry operated by the company produced 67,230 tons of limestone and 19,128 tons of quartzite for metallurgical purposes.

The Magma mine near Superior, operated by the Superior Division, Magma Copper Co., produced 19,631 tons of copper, compared with 19,452 tons in 1965. The 431,913 tons of ore mined during the year contained 4.70 percent copper, 0.032 ounce of gold, and 1.13 ounces of silver per ton, compared with 439,911 tons assaying 4.65 percent copper, 0.031 ounce of gold, and 0.99 ounce of silver per ton in 1965. Gold and silver recovered from the processing of these ores totaled 12,802 and 466,334 ounces, respectively.

A replacement ore body in limestone strata, 410 feet stratigraphically above the east replacement bed currently under production, was diamond drilled during the year to further outline the deposit. Drilling indicated that mineralization extended up dip from the 3,600 to the 2,800 level and that 3.5 million tons of 6 percent copper ore may exist within that area. Diamond drilling to determine the extent of mineralization below the 3,600 level was planned for 1967.

Nonmetals accounted for 1 percent of the total counties mineral-production value. In quantity and value, sand and gravel was the most important. Seven commercial operators produced 342,000 tons of sand and gravel valued at $608,000 from eight operations; 98 percent of this output was processed for use in building construction. Contractors and crews of the Arizona Highway Department and the Pinal County Highway Department processed 207,000 tons of paving sand and gravel valued at $212,000.

Crude gypsum produced by Arizona Gypsum Co., National Gypsum Co., and Garcia Gypsum Co., Inc., from mines near Winkelman and Mammoth was sold for use as a portland cement retarder and as a soil supplement, and used in manufacturing plaster products. Arizona Gypsum Co. also produced a small quantity of diatomite from the White Cliffs mine near Mammoth for use as a filler. Perlite produced by Arizona Perlite Roofs, Inc., from the Iberri mine was expanded at the Supreme Perlite Co., Inc., plant at Phoenix; that produced by the company from its Adams mine and by Harborlite Corp. from the Harborlite mine was shipped to out-of-State expanding plants.

Santa Cruz.—Sand and gravel produced by a commercial operator and contractors

and crews of the Arizona Highway Department accounted for 62 percent of the total value of mineral production in the county. Gold, silver, copper, lead, and zinc recovered from ores produced by four small operators comprised most of the remainder.

Yavapai.—The value of mineral production was 4 percent lower than the previous year primarily because of the decline in output of copper and zinc. However, the county was the leading producer in the State of lead and zinc; fourth in gold, silver, and molybdenum; and seventh in copper. The combined value of the production of these metals was $23.8 million, 75 percent of the total value in the county.

In its annual report, Bagdad Copper Corp., the principal copper producer in the county, reported that the Bagdad copper mine, 50 miles west of Prescott, produced 10.3 percent more copper than that reported for the previous year. The average grade of ore mined contained 0.94 percent copper compared with 0.83 percent in 1965. The higher grade ore was the chief reason for the increased production.

Output of copper from the leaching of low-grade ores was 17.7 percent below that of 1965. Molybdenum shipments in 1966 were 418,325 pounds compared with 453,364 pounds in 1965.

Stripping on the present ore body was nearly completed. The quantity of material removed during the year was 19 percent less than that removed during 1965. Costs per ton of material moved declined 10 percent.

The refinery, constructed by the company as a joint venture with Chemetals Corp., was completed in May and initial production was begun in June. Corrosion problems, caused by hot-acid solutions, were largely solved by changing the chemical makeup of the liquids. Copper powder produced by the process commanded a 15-percent premium over copper metal.

The company reported that drilling in the vicinity of the present pit disclosed an ore body that may contain 17 million tons of additional ore with an average grade of 0.71 percent. Stripping ratio over this ore was estimated at less than 2.5:1.

The Iron King mine operated by Iron King Branch of Shattuck Denn Mining Corp., 20 miles east of Prescott, was the leading producer of lead and zinc in the State. The company reported that 318,600 tons of crude ore was mined and milled for the recovery of 14,200 tons of lead concentrates and 24,600 tons of zinc concentrates. The lead concentrates contained 12,200 ounces of gold, 548,000 ounces of silver, 605,000 pounds of copper, 9,446,000 pounds of lead, and 2,103,000 pounds of zinc. The zinc concentrates contained 2,100 ounces of gold, 48,000 ounces of silver, 99,800 pounds of copper, 538,000 pounds of lead, and 26,900,000 pounds of zinc.

Cyprus Mines Corp. stated in its annual report to the stockholders that proven ore reserves at the Old Dick and Copper Queen underground mines near Bagdad were depleted and that the flotation mill was shut down. The last of the ore was produced during the first 6 months.

In mid-1966, the company began construction of a new shaft (J. L. Bruce) to explore and develop a small ore body between the 950- and the 2,150-foot levels near the Old Dick shaft. The shaft, 40 percent complete at yearend, would permit development of the new ore body and exploration of the ore zone at deeper levels.

American Cement Corp. produced portland and masonry cements by the dry process at its plant near Clarkdale. Raw materials, limestone and clay, were obtained from the nearby company-owned Redwall limestone quarry and the Lakebed clay deposit. Other raw materials: asbestos, gypsum, lime, and resin were purchased. The company shipped cement in bulk and in containers by truck and rail to Arizona and out-of-State customers.

Verde Division, Arizona Gypsum Corp., operated gypsum (including gypsite and anhydrite) and clay deposits near Camp Verde in the east-central part of the county. Uncalcined gypsum mined by the company was sold for use as a portland cement retarder; a small quantity was sold for use on soils deficient in sulfate sulfur and as a soil conditioner. Yavapai Block Co. obtained a small quantity of scoria from the Crews pit near Ashfork and prepared it for use as a lighweight aggregate in manufacturing lightweight building blocks.

Quicklime and hydrated lime were produced by U.S. Lime from limestone quarried and crushed by the company at the Nelson quarry.

Crews and contractors for the Arizona Highway Department produced a small

quantity of miscellaneous stone used as riprap. Additional quanities of stone were produced by commercial operators, dimension sandstone for building purposes and flagging.

Sand and gravel was produced and processed by commercial producers, contractors for the Bureau of Public Roads, crews and contractors for the Arizona Highway Department, and crews of the Yavapai County Highway Department. Most of the material was noncommercial paving sand and gravel produced by contractors for the Arizona Highway Department; a small quantity of building sand and gravel, road construction sand, and fill sand was produced by commercial operators.

Yuma.—Accounting for 83 percent of the total value of mineral output, sand and gravel was the principal mineral commodity produced. Sand and gravel was mined by commercial operators, contractors and crews for the Arizona Highway Department, and crews of the Yuma County Highway Department. More than 62 percent was paving sand and gravel produced by contractors for the Arizona Highway Department; 21 percent was sand and gravel for building and road construction and for fill produced by commercial operators.

Stone production consisted of crushed marble used for cattle feed, polyester filler, roofing granules, stucco, and in precasting; dimension sandstone was used by the construction industry and miscellaneous stone by contractors and crews of the Arizona Highway Department.

The Mineral Industry of Arkansas

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

By Raymond B. Stroud [1]

The diversified mineral output of Arkansas attained a record high value of $190.1 million, an increase of 6.2 percent over that of 1965. The value increase of $10 million marked the fifth successive year of gain and expressed the increasing impact that mineral output has on Arkansas economy. Value of bauxite production was the second highest recorded since 1943. Bromine, clay (including kaolin), lime, natural gas, abrasive stone, sand and gravel, and cement reached new records in production value.

Production of natural gas liquids and gem stones gained in value but failed to exceed past records. Spurred by the high market price, mercury output was registered for the first time since 1946. The remaining nine mineral commodities produced in 1966 had a net value decrease of about $8 million compared with 1965 data; lower petroleum production accounted for about 70 percent of the decrease. Iron ore was not produced in 1966, ending a productive period from 1962 to 1965.

U.S. Army Corps of Engineers construction projects, comprising 12 locks and dams

[1] Geologist, Bureau of Mines, Bartlesville, Okla.

Table 1.—Mineral production in Arkansas [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	249,233	$2,379	232,856	$2,266
Bauxite—long tons dried equivalent	1,593,085	17,974	1,718,390	19,439
Bromine—thousand pounds	32,254	7,171	42,307	10,467
Clays—thousand short tons	866	1,890	[2] 775	[2] 776
Coal—do	226	1,643	236	1,640
Gem stones	NA	31	NA	35
Lime—thousand short tons	192	2,776	207	3,004
Natural gas—million cubic feet	82,831	12,922	105,174	16,407
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	27,787	1,578	32,050	1,923
LP gases—do	69,752	3,139	64,664	3,233
Petroleum (crude)—thousand 42-gallon barrels	25,930	68,974	23,824	63,372
Sand and gravel—thousand short tons	12,806	15,836	16,056	21,038
Stone (includes slate and shell)—do	21,241	26,778	19,109	24,588
Value of items that cannot be disclosed: Abrasive stone, cement, clay, gypsum, iron ore (1965), mercury (1966), phosphate rock, soapstone, and tripoli	XX	16,019	XX	21,939
Total	XX	179,110	XX	190,127

NA Not available.
XX Not applicable.
[1] Production as measured by mine shipments, sales, or maketable production (including consumption by producers).
[2] Excludes certain clays; included with "Value of items that cannot be disclosed."

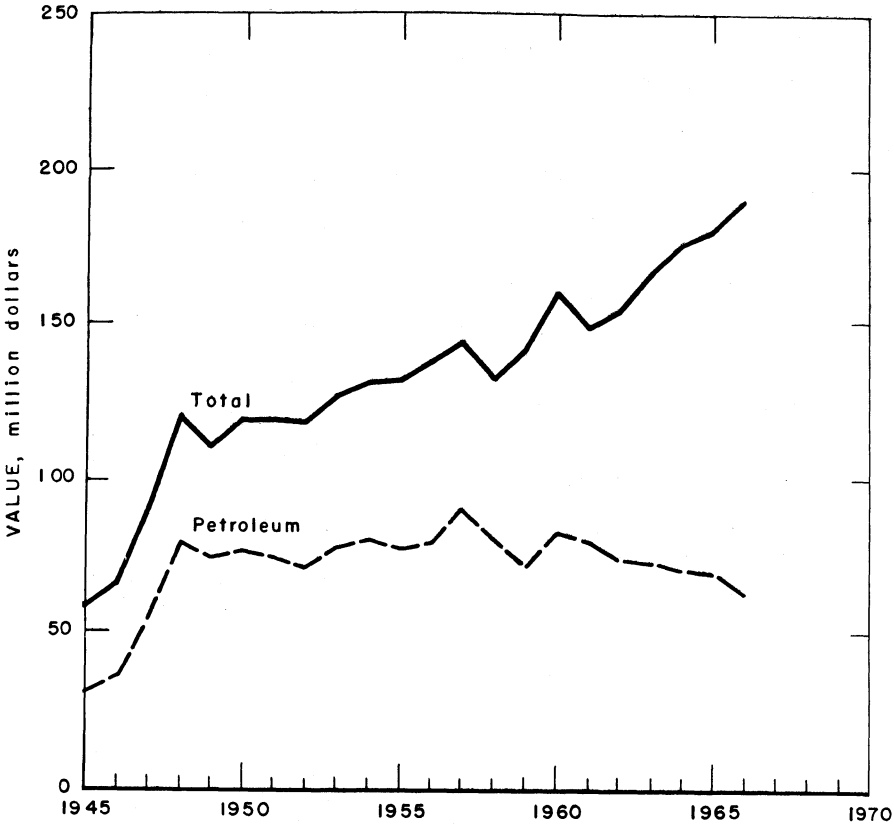

Figure 1.—Value of petroleum and total value of mineral production in Arkansas.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Millions)

Year	Value [r]
1957	$141
1958	132
1959	142
1960	160
1961	149
1962	153
1963	166
1964	174
1965	179
1966	187

[r] Revised.

on the Arkansas River, dams on Cossatot (Gillham) and Caddo (De Gray) Rivers, and extensive stabilization and revetment construction along the Arkansas River, provided a principal market for stone production.

Arkansas State Highway Department construction awards exceeded $60 million during 1966 and accounted for a substantial share of the increased outputs of cement and sand and gravel, and a major part of stone production.

Union Carbide Corp. began constructing its vanadium oxide extraction plant in Garland County. The company simultaneously began mining operations to supply vanadium ore at a rate of 1,600 tons per day, the plant's announced capacity. Plant operation was expected to start about mid-1967.

Arkansas Cement Corp., a division of Arkansas-Louisana Gas Co., completed installations at its Foreman plant, thereby increasing cement capacity to 5 million barrels annually. The new facilities featured a 500-foot cement kiln and a 13 by

46-foot, 115-ton ball mill rated as one of the three largest ball mills in the United States.

Arkla Chemical Corp., a subsidiary of Arkansas-Louisiana Gas Co., continued construction of its Big River chemical fertilizer complex at Helena. The operation, when complete, will produce eight types of fertilizer from natural gas, water, sulfur, and phosphate rock.

The Dow Chemical Co. began constructing a bromine extraction plant that will utilize brines associated with oilfields in Columbia County. This operation, the fourth bromine plant in the State, will raise total annual bromine capacity in Arkansas to more than 100 million pounds.

Continental Oil Co. completed its 1,000 ton per day (347,000 tons annually) anhydrous ammonia plant at Blytheville. The $20 million plant utilized natural gas at a daily rate of about 40 million cubic feet.

Arkansas Electric Co-operative Corp. began operating its new Carl E. Bailey generating station near Augusta. The 125,000-kilowatt plant utilized natural gas as fuel. The company also announced plans for constructing a new $15 million power generating station at Camden.

Arkansas Power and Light Co. continued expansion of electric facilities in Arkansas with announcement of plans for a $41 million addition to its Lake Catherine (Hot Spring County) steam electric station. Construction of the new generator and steam boiler unit, scheduled to start in 1967, would increase capacity from 500,000 to 725,000 kilowatts; the additional electric power will be available in 1969. The company will also be a participant with four other private power companies in a $32 million expansion program consisting of construction of a 450-mile, 345,000-volt electric transmission line extending from El Dorado, Ark., to Oklahoma City, Okla., via Shreveport, La. The project, begun in 1966, was scheduled for completion in 1970.

Construction of a fast-breeder atomic reactor plant near Fayetteville was continued. The $25 million project, initiated by Southwest Atomic Energy Associates (comprised of 17 U.S. private power utilities, U.S. Atomic Energy Commission, European Atomic Energy Community, and A West Germany corporation), will be an experimental program to increase efficient use of nuclear energy in providing electric power. The plant also is designed to produce fissionable nuclear fuel which would improve economy of operation.

Employment.—Mineral industry payroll totaled nearly $29.0 million, an 11-percent increase over 1965 figures. Weekly wages compared with 1965 data, averaged $140.49 in metal mining, a 7.3-percent increase; $104.07 in coal mining, a 7.4-percent increase; $113.64 in production of crude oil and natural gas, a 4.3-percent increase; and $103.97 in nonmetallic mining and quarrying, a 5.4-percent increase. An average of 4,954 workers was employed each month by the mining industry.

Table 3.—Employment 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
1965:								
Coal	123	179	22	175	---	7	39.95	765
Metal	1,948	300	585	4,681	1	35	7.69	1,463
Nonmetal	667	255	170	1,372	---	47	34.26	819
Sand and gravel	938	278	261	2,149	---	41	19.08	420
Stone	2,017	261	526	4,436	1	102	23.22	2,659
Total	5,693	275	1,564	12,813	2	232	18.26	1,624
1966: p								
Coal	110	182	20	151	---	5	33.11	629
Metal	1,985	300	595	4,757	---	34	7.15	434
Nonmetal	900	259	234	1,870	1	68	36.90	3,870
Sand and gravel	920	272	250	2,142	---	61	28.48	517
Stone	1,820	262	477	4,006	2	118	29.96	3,833
Total	5,735	275	1,576	12,926	3	286	22.36	2,001

p Preliminary.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

A major increase (27 percent) in value of natural gas production, coupled with a 9-percent increase in value of natural gas liquids, failed to offset losses sustained by decreased output of petroleum and a decrease in value of Arkansas coal production. Total value of the four mineral commodities was $86.6 million, compared with $88.3 million in 1965. The year was the first time in which total mineral fuels value dropped below nonmetallic mineral output value.

Coal (Bituminous). — Four underground mines in two counties and four strip mines in three counties produced 1,000 or more tons each. Total output was nearly 10,000 tons more than in 1965. The largest mine (strip) had an output of 113,357 tons, whereas only 63,545 tons of coal were ascribed to underground mines. Strip coal was valued at $6.72 per ton, and coal from underground mines was valued at $7.60 per ton. Strip mines accounted for 73 percent of the total coal output and 71 percent of the total value. Johnson County, with five mines, led in coal output with 49 percent of the State's total; Franklin and Sebastian Counties accounted for the remainder.

Table 4.—Coal (bituminous) production [1]

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	423	$3,241
1962	256	1,809
1963	221	1,505
1964	212	1,503
1965	226	1,643
1966	236	1,640

[1] Data from mines producing 1,000 tons or more.

Oil and Gas Exploration and Development. —A substantial gain in total holes drilled for oil and gas failed to increase the State's oil reserves despite the fact that 156 new wells were oil productive. Oil reserves decreased at a more rapid rate than in the period January 1965 to January 1966. Reserves of natural gas liquids and natural gas were greater than at the end of 1965. Fifty-eight wells were successful in discovery of new sources of natural gas.

Of the 466 wells drilled, 80 percent were in 14 south Arkansas counties; nine new oilfields—five in Union and one each in Hempstead, Lafayette, Miller, and Nevada Counties—were discovered. The new Patmos field in Hempstead County was discovered by a well drilled to a total depth of 5,909 feet. An 11-foot productive zone in

Table 5.—Oil and gas drilling in 1966, by counties

County	Development			Exploratory			Total
	Oil	Gas	Dry	Oil	Gas	Dry	
Arkansas	---	---	---	---	---	1	1
Ashley	---	---	---	---	---	1	1
Bradley	7	---	1	---	---	2	10
Calhoun	---	---	---	---	---	3	3
Columbia	7	---	5	---	---	4	16
Crawford	---	7	2	---	---	---	9
Desha	---	---	---	---	---	1	1
Faulkner	---	---	---	---	---	1	1
Franklin	---	14	7	---	1	1	23
Greene	---	---	---	---	---	1	1
Hempstead	---	---	---	1	---	---	1
Johnson	---	11	7	---	---	1	19
Lafayette	22	---	42	1	---	17	82
Little River	---	---	---	---	---	6	6
Logan	---	8	1	---	3	2	14
Miller	1	---	5	1	---	11	18
Nevada	10	---	6	1	---	11	28
Ouachita	40	1	22	---	---	12	75
Pope	---	2	7	---	---	---	9
Scott	---	2	---	---	---	---	2
Sebastian	---	7	3	---	1	4	15
Sevier	---	---	---	---	---	1	1
Union	60	---	39	5	---	25	129
Yell	---	---	---	---	1	---	1
Total: 1966	147	52	147	9	6	105	466
1965	99	45	95	5	1	92	337

Source: Arkansas Oil and Gas Statistical Bulletin, v. 25, No. 12, December 1965, through v. 27, No. 1, January 1967.

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

	Proved reserves, Dec. 31, 1965	Changes in proved reserves, due to extensions and new discoveries in 1966	Proved reserves, Dec. 31, 1966 (production was deducted)	Change from 1965 percent
Crude oil—thousand barrels	201,026	−19,699	181,327	−10
Natural gas liquids [1]—do	14,756	1,418	16,174	+10
Natural gas—million cubic feet	2,269,012	330,617	2,599,629	+15

[1] Includes condensate, natural gasoline, and LP gases.
Source: American Gas Association, American Petroleum Institute, and Canadian Petroleum Association. Proved Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas. Published in The Tulsa Daily World, 66th yr., No. 201, Apr. 3, 1967, p. 27.

the Smackover Limestone was rated at 60 barrels per day. Although no production had been recorded at yearend, the field made Hempstead County the State's 10th county having known oil-productive capability.

In north Arkansas, six new gasfields were discovered in four counties; all were in previous gas-producing counties with the exception of one field, the Waveland Field. This field, in Yell County was discovered by a well drilled to a total depth of 9,337 feet. A 30-foot zone in the Atoka Formation had an initial production rating of 6.1 million cubic feet per day.

In the State, as a whole, 204 wells were oil or gas productive with an overall success ratio of 44 percent. Drilling in north Arkansas attained a 61-percent success ratio, whereas in south Arkansas the success ratio was only 42 percent. Union County, with 129 wells drilled, accounted for 35 percent of the total wells drilled in south Arkansas.

Natural Gas.—Production of natural gas soared to a record high of 105.2 billion cubic feet. At yearend, 53 productive gasfields in north Arkansas contributed to the 10th consecutive year of overall gain. Franklin County led the nine gas producing counties in north Arkansas with 27 percent of the total value; the nine counties accounted for more than two-thirds ($10.1 million) of the total production value of natural gas. Columbia County led a six-county area in south Arkansas with natural gas output valued at $2.4 million. Five of the State's 15 counties, registering natural gas production, exceeded $1 million output values. The increased output combined with consecutive years of high success ratios in natural gas discoveries marked the Arkoma Basin as one of the most important gas productive areas in the Nation. Six exploratory wells drilled in four north Arkansas counties resulted in successful discoveries.

Natural Gas Liquids.—Value of natural gas liquids was 9 percent over that of 1965. Average value, of the 96.7 million gallons of LP gases, natural gasoline, and cycle products was 5.3 cents per gallon. Four processing plants in four counties—Columbia, Lafayette, Union, and Miller—account-

Table 7.—Gross withdrawals and disposition of natural gas

(Million cubic feet)

Year	Gross withdrawals [1]			Disposition			
				Marketed production [2]			
	From gas wells	From oil wells	Total	Quantity	Value (thousands)	Repressuring	Vented and wasted [3]
1957–61 (average)	32,900	41,000	73,900	43,978	$4,619	25,020	4,902
1962	62,000	41,600	103,600	66,213	9,866	35,315	2,072
1963	57,700	41,500	99,200	76,101	11,796	19,191	3,908
1964	57,900	42,900	100,800	75,753	11,806	21,411	3,636
1965	57,500	46,500	104,000	82,831	12,922	20,155	1,014
1966	63,100	58,479	121,579	105,174	16,407	15,196	1,209

[1] Marketed production plus quantities used in repressuring, vented, and wasted.
[2] Comprises gas sold or consumed by producers, including losses in transmission, quantities added to storage, and increases in gas in pipelines.
[3] Includes direct waste on producing properties and residue blown to air.

Table 8.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline and cycle products		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	36,049	$2,239	62,338	$2,982	98,387	$5,221
1962	29,415	1,673	69,452	2,432	98,867	4,105
1963	26,219	1,466	66,377	2,497	92,596	3,963
1964	30,082	1,678	61,616	2,460	91,698	4,138
1965	27,787	1,578	69,752	3,139	97,539	4,717
1966	32,050	1,923	64,664	3,233	96,714	5,156

ed for the total Arkansas output. Above 71 percent of the State's total output was assigned to Columbia County.

Petroleum.—Production and value of crude oil decreased for the sixth consecutive year, but the value was sufficient to comprise 33.3 percent of the State's total mineral value, more than any other single mineral commodity. An eight-county area in south Arkansas, led by Columbia with more than 9 million barrels of oil production, had 6,372 producing wells at yearend. Fifty-five secondary recovery projects utilized water injection, steam injection, and in-situ combustion methods to recover 56 percent of the State's total crude oil output. More than 50 million barrels of water was injected into reservoirs for pressure maintenance, and 185 million barrels of salt water was injected into 362 operating salt water disposal wells.[2]

Magnolia field in Columbia County was the State's most productive oilfield and contributed 23 percent of the total value.

The State's five refineries processed an average of 78,783 barrels of crude oil per day during the year.

NONMETALS

Production of 13 nonmetallic mineral commodities, paced by stone, sand and gravel, cement, and bromine, listed in order of value, accounted for the major part of the State's total mineral value. Other nonmetals contributing $1 million or more included clays (all types), lime, and barite.

Major markets for stone, sand and gravel, and cement were provided by the Arkansas State Highway Department because of its many road construction and road improvement programs. An estimated 25 percent of the stone output and 42 percent of the sand and gravel production was directly attributable to highway construction projects.

U.S. Army Corps of Engineers construc-

[2] Arkansas Oil and Gas Commission, Annual Oil and Gas Report, 1966.

Table 9—Crude petroleum production by fields

(Thousand 42-gallon barrels and thousand dollars)

Field[1]	1965		1966	
	Quantity	Value	Quantity	Value
Champagnolle	567	$1,508	538	$1,431
Dorcheat-Macedonia	406	1,080	368	979
El Dorado	367	976	388	1,032
Fouke	777	2,067	701	1,865
Irma	547	1,455	492	1,309
Magnolia	6,990	18,593	5,510	14,657
McKamie-Patton	1,292	3,437	1,121	2,982
Midway	2,436	6,480	2,506	6,666
Sandy Bend	506	1,346	461	1,226
Schuler	1,416	3,767	1,320	3,511
Smackover	3,226	8,581	3,213	8,547
Stephens	1,250	3,325	1,275	3,392
Village	388	1,032	---	---
Wesson	1,003	2,668	910	2,421
Other fields[2]	4,759	12,659	5,021	13,354
Total	25,930	68,974	23,824	63,372

[1] Breakdown of individual fields as reported in "The Oil and Gas Journal."

[2] Includes oil consumed on leases and net change in stocks held on leases for the State. Bureau of Mines figures.

Table 10.—Crude petroleum production, indicated demand, and stocks in 1966, by months

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Arkansas
January	1,856	1,855	710
February	1,903	1,872	741
March	2,032	1,996	777
April	2,056	2,095	738
May	2,076	2,063	751
June	1,982	1,974	759
July	2,009	2,028	740
August	1,995	1,912	823
September	1,914	1,832	905
October	1,954	1,941	918
November	1,883	1,691	1,110
December	2,164	2,387	887
Total: 1966	23,824	23,646	XX
1965	25,930	r 26,165	XX

r Revised.
XX Not applicable.

tion activities, including the Little Rock, Tulsa, and Vicksburg Districts, furnished markets for 17 percent of the stone output.

At yearend, construction was underway or nearing completion on 12 lock and dam projects along the Arkansas River to provide navigation facilities. Construction work progressed during the year at the sites of De Gray Dam on Caddo River in Clark County and Gillham Dam on Cossatot River in Howard County. A major part of Arkansas stone output was utilized in channel rectification and bank stabilization projects along the Arkansas River.

Other Federal, State, and private construction and building projects continued expansions and accounted for much of the remaining stone and sand and gravel outputs. Out-of-State markets for stone and sand and gravel increased substantially during the year.

Abrasive Stone.—Norton Pike Division of Norton Co., and Arkansas Oilstone Co. produced a record tonnage of Arkansas novaculite for whetstone manufacture. Combined value of the two companies products represented more than a twofold increase over that of 1965. Arkansas Oilstone Co. processed a part of its crude novaculite into finished stones within the State. All of Norton Co.'s crude ore was shipped to Eastern States for processing.

Barite.—Barite output and value declined 6.6 percent in quantity and 4.7 percent in value compared with 1965 data. National Lead Co., Baroid Division, and Dresser-Magcobar (formerly Magnet Cove Barium Corp.) mined and processed barite ore in Hot Spring County. The major part of the output was ground and used in drilling mud manufacture. The Milwhite Co. processed Missouri barite for several industrial uses at its plant in Saline County. The State maintained second ranking in the United States in barite production.

Table 11.—Primary barite sold or used by producers

Year	Short tons	Value (thousands)
1957–61 (average)	310,870	$2,902
1962	258,691	2,232
1963	236,077	2,161
1964	233,455	2,202
1965	249,233	2,379
1966	232,856	2,266

Bromine. — Three companies — Michigan Chemical Corp., Arkansas Chemicals, Inc., and Great Lakes Chemical Corp.—processed oilfield brines for bromine recovery at plants in Union County. Two of the three companies converted substantial parts of the elemental bromine to ethylene dibromide, which in turn is used in formulating antiknock gasoline compounds and fumigants. Combined output of elemental bromine and bromine compounds increased 31 percent in gross weight over that recorded in 1965. Much of the increase was attributable to full-time operation of the Great Lakes Chemical Corp. plant.

The Dow Chemical Co. will become Arkansas' fourth bromine producer in 1967, when its plant in Columbia County, under construction in 1966, is completed. Bromine content of oilfield brines in Columbia County is reportedly as high (4,300 to 4,600 parts per million) as brines in Union County.

Table 12.—Shipments of portland cement to consumers

Year	Thousand barrels
1957–61 (average)	2,401
1962	3,053
1963	3,556
1964	3,807
1965	4,519
1966	4,903

Cement.—Combined production of portland and masonry cements by two cement plants increased substantially, and at year-end cement shipments to Arkansas consumers showed an 8-percent increase over comparable 1965 data. Both cement producers reported gains in output. Arkansas Cement Corp. began utilizing its expanded plant capacity to meet market demands. More than half of the total shipments of both cement plants went to ready-mix concrete companies and highway construction contractors, attesting to the continued high rate of building and construction activity. About 94 percent of the total comprised bulk shipments, of which most was transported by truck.

Clays.—Combined output of kaolin, fire clay, and miscellaneous clay set a new production record in 1966. Most of the increase was attributable to greatly expanded output of kaolin and a moderate increase in production of miscellaneous clay. Value of the combined clay production was more than twice that recorded in 1965. Clay production was registered in 16 counties by 14 companies. The U.S. Forest Service produced some clay for road construction projects in one county. Kaolin was produced in two counties; fire clay in two counties; and miscellaneous clay in 15 counties. Most of the kaolin was used in firebrick. Clays were also used in making cement, lightweight aggregates, heavy structural products, and chemicals. Pulaski, Hot Spring, Johnson, and Lonoke Counties, ranked in order of production, accounted for 67 percent of the State's total output.

Gypsum.—Output of gypsum increased slightly over that produced in 1965. The State's two producing companies—Dulin Bauxite Co., Gypsum Division, and Dierks Forests, Inc.—mined and processed gypsum for use in cement and wallboard manufacture, respectively. Both companies conducted land-reclamation projects following open pit operations to restore mined-out land to useful purposes.

Lime.—Six companies converted limestone to lime for various uses during the year; only one company produced its own supply of limestone. Combined output and value of lime production increased over comparable 1965 data. Four paper manufacturing companies reported output of regenerated lime substantially above those in 1965. Two alumina producers—Aluminum Company of America and Reynolds Metals Co.—processed limestone to lime for use in converting bauxite ores to alumina. This use of lime was more than twice that used for other purposes. Part of Arkansas lime production was used for sugar refining, water purification, agricultural, and building purposes. Limestone used in lime manufacture was produced in only one county in the State.

Phosphate Rock.—Peyton Creek Phosphate Rock Mining Co., the State's only producer, reported a greatly reduced output of ground phosphate rock. The company mine and crushing plant was idle much of the last 6 months of 1966. The entire output was sold for direct application to soils as a fertilizer.

Sand and Gravel.—The State's sand and gravel industry registered increases of 3.2 million tons in quantity and $5 million in value over that of 1965. About 73 percent of the total output was classified as commercial production and had an average unit value of $1.34 per ton. Sand and gravel sold to Government-and-contractor markets had an average unit value of $1.23 per ton. Arkansas State Highway Department was the largest single user of sand and gravel in 1966.

Sand and gravel was produced in 67 counties by 279 operators. Nine Arkansas counties had sand and gravel outputs that exceeded 625,000 tons; three of the counties reported outputs of more than 1.25 million tons. Miller County, with a production of 1.9 million tons by eight producing companies, led in the State. The wide distribution in productive areas indicated that Arkansas is well endowed with abundant sand and gravel resources.

Soapstone.—Production and value of soapstone, a talcose rock, decreased slightly in 1966. The Milwhite Co. quarried soap-

Table 13.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	6,118	$6,444	3,186	$2,592	9,304	$9,036
1962	6,717	7,946	4,130	2,060	10,847	10,006
1963	7,699	9,096	4,400	4,493	12,099	13,589
1964	8,637	10,990	3,157	3,846	11,794	14,836
1965	9,559	12,001	3,247	3,835	12,806	15,836
1966	11,677	15,656	4,379	5,382	16,056	21,038

stone and ground the output to supply markets for filler in insecticides and roofing compounds. The soapstone deposits in Saline County have been productive for 14 consecutive years.

Stone.—Combined production and value of all varieties of stone mined in Arkansas decreased about 10 and 8 percent, respectively compared with 1965 figures. Despite the lower output, it was the second most important mineral commodity produced in the State in terms of value. Sandstone was the most widely produced stone in terms of tonnage, but the value of syenite output was higher. Stone value totaled $24.6 million, of which $8.3 million was credited to syenite production; sandstone value (crushed and dimension) was $7.6 million; and limestone value (crushed and that used for cement and lime manufacture) was $6.7 million. Slate, valued at $824,000, shell, valued at more than $1 million, and dimension marble, valued at $110,000, contributed the remaining tonnage. Thirty-nine of the State's 75 counties reported stone output. Four producers in three counties accounted for the slate output. Dimension marble was produced in two

Table 14.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	1,734	$1,990	1,443	$1,616
Paving	1,599	1,803	3,047	3,076
Fill	324	202	372	334
Other [1]	390	1,128	340	1,128
Total	4,047	5,123	5,202	6,154
Gravel:				
Building	1,928	2,823	1,696	2,733
Paving	3,444	3,985	4,751	6,751
Fill	108	54	21	10
Other [2]	32	16	7	8
Total	5,512	6,878	6,475	9,502
Total sand and gravel	9,559	12,001	11,677	15,656
Government-and-contractor operations:				
Sand:				
Building	---	---	10	10
Paving	1,241	1,091	1,963	1,817
Total	1,241	1,091	1,973	1,827
Gravel:				
Building	---	---	83	123
Paving	2,006	2,744	2,323	3,432
Total	2,006	2,744	2,406	3,555
Total sand and gravel	3,247	3,835	4,379	5,382
Grand total	12,806	15,836	16,056	21,038

[1] Includes other construction sand and industrial sand (ground and unground).
[2] Includes other construction gravel, railroad ballast, and miscellaneous gravel (1965).

Table 15.—Stone sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1962	20,611	$19,866
1963	18,913	22,727
1964	20,241	26,172
1965	21,241	26,778
1966	19,109	24,588

counties, and dimension sandstone was produced by five operators in Logan County. All syenite output was credited to Pulaski County. Limestone was produced in 15 counties and crushed sandstone in 21 counties. A total of 140 companies contributed to the combined output.

Stone uses included limestone for cement and lime; mussel shell for growing cultured pearls; syenite for roofing granules, riprap, concrete aggregate, and roadstone; dimension marble and sandstone for buildings; slate for roofing granules and filler; and crushed sandstone and limestone for roadbase construction, buildings, riprap, concrete aggregate, fill, and paving. Average value of commercial stone was $1.37 per ton; stone production classified as Government-and-contractor was valued at $0.91 per ton.

Sulfur (Recovered Elemental).—Tonnage of byproduct sulfur from plants treating sour natural gas in three Arkansas counties was about 28 percent lower than in 1965. Olin Mathieson Chemical Corp. was the principal producer, and Arkla Chemical Corp. and Monsanto Chemical Co. recovered the remaining tonnage.

Tripoli.—Caddo Minerals Co. mined and processed less tripoli than in 1965. The tripoli, an altered product of Arkansas novaculite, was mined by open pit methods, air-dried, then passed through a crusher and rotary kiln for further drying. The ground product was bagged and shipped to consumers for use as abrasive material.

METALS

Bauxite continued to be the State's most important metal commodity. A small output of mercury was registered for the first time in 20 years. Union Carbide Corp. began mining and stockpiling vanadium ore in Garland County for later processing in a company plant under construction at year-end. No iron ore was produced as the iron mining operation in Nevada County was idle throughout the year.

Aluminum.—The two aluminum reduction plants in the State operated at increased rates of production. Greater quantities of alumina chemicals, tabular alumina, and related materials were produced at Arkansas alumina plants. Aluminum Company of America doubled its capacity to produce tabular alumina at its plant near Benton. Reynolds Metals Co. added sodium aluminate (an alumina chemical) at its Arkansas operation near Bauxite. The company also acquired control of foundry facilities at Jones Mills, formerly operated by General Motors Corp. Reynolds began conversion of the plant for production of transmission cable. Cable production is scheduled for early in 1967 with initial plant capacity of about 12,500 tons annually.

Bauxite.—Production and value of bauxite increased 8 percent over that of 1965. The mineral value of $19.4 million was the third highest since bauxite production began in 1899. Aluminum Company of America (Alcoa), American Cyanamid Co., and Reynolds Mining Corp. mined and processed bauxite for alumina production and chemical applications. Porocel Corp. and Stauffer Chemical Co. processed bauxite to produce activated bauxite. Calcined bauxite was produced by American Cyanamid Co., Norton Co., and Stauffer Chemical Co.

Table 16.—Bauxite mine production and shipments from mines and processing plants to consumers

(Thousand long tons and thousand dollars)

Year	Mine production			Shipments		
	Crude	Dry equivalent	Value	As shipped	Dry equivalent	Value
1957–61 (average)	1,765	1,471	$15,121	1,707	1,460	$16,202
1962	1,523	1,270	14,606	1,715	1,481	17,535
1963	1,771	1,478	16,701	1,725	1,483	17,543
1964	1,864	1,562	17,431	1,773	1,531	17,859
1965	1,911	1,593	17,974	2,100	1,803	20,786
1966	2,060	1,718	19,439	1,986	1,708	20,258

Bauxite producers in Arkansas accounted for 96 percent of total domestic output.

Mercury.—Mercury production was reported for the first time in 20 years. Arka-Tex Mining Corp. mined cinnabar north and west of Murfreesboro, Pike County, and processed the ore at its plant near Kirby. The corporation developed deposits adjacent to formerly worked mined and also processed ores remaining in mine dumps. The ore was crushed to 1½ inches, passed through a rotary kiln, and mercury was precipitated in a condenser system. Flue soots were treated in a retort and the contained mercury was separated from soot and dirt by hoeing the mixture with lime. Although several mercury mines were inundated by Lake Greeson, substantial areas and other mines in the Arkansas mercury district have commercial potential under influence of high prices.

Vanadium.—Union Carbide Corp. continued exploration and development drilling of vanadium deposits at Potash Sulphur Springs (Wilson Mineral Springs), Garland County. The company began strip-mining operations and stockpiled ore for processing. The company began constructing a 1,600-ton-per-day plant about 1 mile from the mine. The plant, scheduled to begin operating by mid-1967 will cost an estimated $14 million when completed. About $2 million of the cost will be absorbed in installation of dust precipitators and water purification devices to eliminate air and water pollution. The processing steps will involve drying and crushing the vanadium-bearing ore, salt roasting, digestion using hydrochloric acid, and recovery of vanadium oxide from solution by use of organic compounds. About 10 million pounds of vanadium oxide will be recovered annually. A 14-inch pipeline will convey water used in processing the ore from Lake Hamilton to a plant storage tank. The plant product will be shipped to Union Carbide's Marietta, Ohio, plant for conversion to a product used as a strengthening additive in the manufacture of steel and other alloys.

REVIEW BY COUNTIES

Mineral production was recorded in 72 of the State's 75 counties as compared with 73 in 1965; only Fulton, Sharp, and Woodruff Counties were lacking mineral output. Mineral production values increased in 38 counties and decreased in 33 counties. Twenty-one counties had mineral values in excess of $1 million; 15 additional counties had mineral values above $500,000. Mineral values of more than $5 million were recorded in 10 counties. The five leading counties—Columbia, Union, Saline, Lafayette, and Pulaski with 21 percent of the State's 1966 population [3]—accounted for 56 percent of the State's total mineral value.

Counties discussed in the following section were credited with more than $100,000 each in mineral value with exception of Garland which had the State's only output of abrasive stone and in which vanadium operations are of significance.

Boone.—Value of mineral output—stone and sand and gravel—increased nearly fourfold. A greatly expanded highway construction program of the Arkansas State Highway Department provided the principal market for the materials. Reynolds and Williams and McClinton, Inc., were the main producers of crushed limestone. Arkansas State Highway Department produced a small tonnage of crushed limestone.

Bradley.—Production of petroleum and sand and gravel diminished, and the resultant mineral value was 25 percent lower than that in 1965. Arkansas State Highway Department furnished the major market for the sand and gravel output. Seven of ten wells drilled for petroleum were successful producers. A well drilled by Fairway Oil and Gas Co. resulted in discovery of a new oil source in the Travis Peak Formation.

Calhoun.—Value and quantity of petroleum and sand and gravel decreased as compared with 1965. St. Francis Material Co. and Ouachita Aggregate Co. accounted for most of the sand and gravel production. Three exploratory wells drilled in the county were classified as dry holes. The county ranked last in production among the State's eight petroleum producing counties.

[3] Bureau of Business and Economic Research and Industrial Research and Extension Center. Arkansas Business Bulletin. Univ. of Arkansas, v. 34, No. 2, May 1967, 11 pp.

Table 17.—Value of mineral production in Arkansas, by counties [1]

County	1965 r	1966	Minerals produced in 1966 in order of value
Arkansas	$70,800	W	Sand and gravel, shell.
Ashley	412,996	$227,551	Sand and gravel, lime.
Baxter	68,328	24,935	Stone.
Benton	323,287	192,207	Stone, sand and gravel.
Boone	W	714,557	Do.
Bradley	989,202	741,981	Petroleum, sand and gravel.
Calhoun	1,159,190	996,748	Sand and gravel, petroleum.
Carroll	133,034	W	Sand and gravel.
Chicot	211,000	120,000	Do.
Clark	717,523	1,632,130	Sand and gravel, stone, clays.
Clay	325,000	114,000	Sand and gravel.
Cleburne	378,367	74,016	Stone.
Cleveland	28,000	43,000	Sand and gravel.
Columbia	33,819,530	30,288,754	Petroleum, natural gas liquids, natural gas, sand and gravel.
Conway	400,712	758,348	Stone, natural gas, sand and gravel.
Craighead	292,000	286,550	Sand and gravel, clays.
Crawford	2,644,538	2,708,557	Natural gas, stone, sand and gravel.
Crittenden	57,000	89,400	Sand and gravel, clays.
Cross	303,029	1,851,000	Sand and gravel.
Dallas	70,000	30,000	Do.
Desha	236,000	179,000	Do.
Drew	105,000	112,000	Do.
Faulkner	1,335,871	854,044	Stone, sand and gravel.
Franklin	5,415,923	5,564,808	Natural gas, coal, stone, sand and gravel.
Fulton	155,000	---	
Garland	259,292	395,651	Abrasive stone, sand and gravel, gem stones.
Grant	191,000	172,000	Sand and gravel.
Greene	321,000	322,000	Do.
Hempstead	240,156	173,360	Sand and gravel, clays.
Hot Spring	3,891,894	3,823,955	Barite, sand and gravel, clays, stone.
Howard	6,111,725	6,046,143	Cement, gypsum, stone, slate, clays, sand and gravel.
Independence	2,546,658	3,114,395	Stone, lime, shell, sand and gravel.
Izard	1,797,501	1,889,994	Stone, sand and gravel.
Jackson	204,000	214,725	Sand and gravel, shell.
Jefferson	615,210	781,323	Sand and gravel, lime.
Johnson	2,787,961	2,174,892	Natural gas, coal, stone, clays, sand and gravel.
Lafayette	15,625,377	16,848,222	Petroleum, natural gas, natural gas liquids, sand and gravel.
Lawrence	1,433,609	740,220	Stone, sand and gravel.
Lee	---	32,729	Shell.
Lincoln	207,000	335,000	Sand and gravel.
Little River	10,912,092	13,584,212	Cement, stone, clays, sand and gravel.
Logan	1,019,570	1,311,904	Stone, natural gas, sand and gravel.
Lonoke	1,358,811	387,099	Stone, clays.
Madison	143,725	505,305	Stone, sand and gravel.
Marion	103,550	83,299	Sand and gravel, stone.
Miller	6,116,776	6,468,373	Petroleum, sand and gravel, natural gas, natural gas liquids, clays.
Mississippi	63,000	48,000	Sand and gravel.
Monroe	40,100	687,852	Sand and gravel, shell.
Montgomery	684,833	765,451	Slate, sand and gravel, stone.
Nevada	2,857,434	2,298,853	Petroleum, sand and gravel, natural gas.
Newton	113,429	173,075	Stone, sand and gravel.
Ouachita	7,463,044	8,171,851	Petroleum, sand and gravel, natural gas, stone, clays.
Perry	335,291	158,337	Stone, sand and gravel.
Phillips	246,000	W	Sand and gravel.
Pike	1,177,982	788,401	Gypsum, sand and gravel, stone, tripoli, gem stones, mercury.
Poinsett	W	488,178	Sand and gravel, shell.
Polk	233,142	223,507	Sand and gravel, clays.
Pope	1,930,057	1,466,970	Stone, natural gas, sand and gravel.
Prairie	112,000	53,000	Sand and gravel.
Pulaski	11,763,596	14,991,948	Stone, clays, bauxite, sand and gravel.
Randolph	W	113,244	Stone, sand and gravel.
St. Francis	544,000	869,421	Sand and gravel, stone.
Saline	19,847,395	20,576,559	Buaxite, lime, sand and gravel, clays, soapstone, slate.
Scott	68,432	364,965	Sand and gravel, natural gas.
Searcy	17,086	1,000	Sand and gravel.
Sebastian	2,689,205	2,846,940	Natural gas, stone, sand and gravel, clays, coal.
Sevier	708,000	W	Sand and gravel.
Stone	70,207	17,111	Sand and gravel, stone.
Union	20,179,465	23,248,861	Petroleum, bromine, natural gas, natural gas liquids, clays, sand and gravel.
Van Buren	67,490	W	Phosphate rock.
Washington	1,016,733	985,076	Stone, sand and gravel, natural gas.
White	331,940	882,812	Stone, sand and gravel.
Woodruff	1,000	---	
Yell	231,515	282,391	Sand and gravel, stone.
Undistributed	779,387	2,614,810	
Total	179,110,000	190,127,000	

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Sharp County is not listed because no production was reported in 1965 or 1966.

Clark.—Combined value of clay, stone, and sand and gravel was more than twice that reported in 1965. About 95 percent of the 1966 mineral value was credited to sand and gravel output for which the county ranked third in the State. Arkadelphia Sand and Gravel Co., Malvern Gravel Co., McGeorge Contracting Co., and Arkansas Rock and Gravel Co. furnished the major part of the sand and gravel output. Most of the production was used in construction of new highways and dikes related to U.S. Army Corps of Engineers De Gray Dam project on Caddo River. Hope Brick Works mined a small tonnage of clay shale for use in brick.

Columbia.—The county had mineral production valued at $30.3 million and retained for the 10th straight year its rank as the leading producer in terms of value; accounting for 16 percent of the total value of Arkansas mineral output. Aside from a few thousand tons of sand and gravel, the entire value was attributable to production of petroleum, natural gas, and natural gas liquids. The county ranked first in petroleum and natural gas liquids output and third in natural gas production. Seven of 12 field development wells were successful producers of crude oil, but 4 wildcat wells were classified as dry holes. One new pool, Atlanta East, resulted from drilling activity.

Conway.—Substantial production gains in the county's three mineral products resulted in a net value increase of about $358,000, which was nearly equal to total value for 1965. Crushed sandstone production by Four Bros., Inc.; G. P. Freshour; Little Rock Quarry Co., Inc.; Pine Bluff Sand & Gravel Co.; and Mississippi Valley Engineering & Construction Co. was used by the Arkansas State Highway Department and the U.S. Army Corps of Engineers for construction purposes.

Crawford.—Production of natural gas accounted for more than half the total mineral value credited to the county. Crushed sandstone and sand and gravel output were substantially lower than in 1965. Seven of nine wells drilled were completed as gas producers. One new gas producing zone was discovered in the Arcei Sand Member of the Atoka Formation in the Hollis Lake gasfield. Arkhola Sand & Gravel Co. produced the entire output of sand and gravel. The same company accounted for most of the crushed sandstone production.

Cross.—Cross County mineral output, consisting entirely of sand and gravel, was sufficient to rank the county second in the State in terms of sand and gravel value. Several producers sold sand and gravel to Arkansas State Highway Department for highway construction.

Faulkner.—Mineral output comprised of stone and sand and gravel was nearly $500,000 lower than in 1965. Most of the mineral production was used on U.S. Army Corps of Engineers and Arkansas State Highway Department projects as in past years. G. P. Freshour, Pine Bluff Sand and Gravel Co., and Four Bros., Inc., were principal producers of crushed sandstone.

Franklin.—The county was the leading producer in the State of natural gas which had a value of more than $4 million. Production by Garland Coal & Mining Co. was sufficient to rank the county second in the State for coal output value. Value of stone production and sand and gravel showed major increases over comparable data for 1965. Fifteen of 23 wells drilled in the county were completed as gas producers. One new gasfield, Possumtrot, was discovered by a well that penetrated the Brentwood Formation. Two new pools were subsequently developed in the new field. Both were discovered in wells drilled into the Atoka Formation. Another well discovered another new pool in the Altus field. In this instance, the Lower Alma Sand of the Atoka Formation was gas productive.

Garland.—The county retained the distinction of being the only source of commercial-grade novaculite used in whetstone manufacture. Both Norton Pike Co., Division of Norton Co., and Arkansas Oilstone Co. reported larger outputs of stone than in 1965. The latter company processed a part of their crude novaculite to finished products. Establishment of vanadium mining and processing facilities by Union Carbide Corp. added to the importance of mineral developments in the county and the State. The company scheduled initial plant production of vanadium oxide by mid-1967. The vanadium ore body is the largest to become commercial in recent years and will be the largest in the United States mined exclusively for its vanadium content.

Hot Spring.—Value of the mineral output comprised of barite, sand and gravel, clays, and stone, in order of importance, was slightly less than that recorded in 1965. Barite production continued to be the county's most significant mineral product. The barite producing companies processed the crude ore to ground barite for use in oil well drilling muds. Malvern Brick and Tile Co. and Acme Brick Co. (Malvern and Perla plants) mined high-quality clays from the Wilcox Formation for firebrick manufacture. In addition, the companies produced several million building bricks for residential and business buildings. The county ranked second in quantity and value of clay mined and processed. Malvern Gravel Co. was the principal producer of sand and gravel for use on Arkansas State Highway Commission projects. Malvern Gravel Co. quarried and processed Arkansas novaculite for use in building and construction and in refractory silica bricks.

Howard.—Total value of mineral production was virtually the same as in 1965. Ideal Cement Co. manufactured cement at about the same level as in 1965. Gypsum output used for wallboard manufacture was about the same as that recorded in 1965. Dierks Forests, Inc., the State's only gypsum wallboard manufacturer, announced plans to increase plant capacity. Industrial Minerals, Inc., quarried and ground slate for filler compounds. The U.S. Army Corps of Engineers, Tulsa District, continued construction of the Gillham Dam project on the Cossatot River; principal work consisted of driving a diversion tunnel preparatory to actual dam construction.

Independence.—A 22-percent increase in value of the county's mineral products was due largely to increased output of mussel shell for use in propagating growth of cultured pearls. The county ranked third in the State in value of stone output. Batesville White Lime Co. continued to account for the major share of the mineral value credited to the county; the company produced lime and crushed limestone products for various uses for the 43d consecutive year. Other limestone producers included: Midwest Lime Co., Freshour Corp., and Limestone Products, Inc. Batesville Marble Co. quarried marble for building purposes. Galloway Sand & Gravel Co., Mobley Construction Co., Inc., and Southeast Construction Co., Inc., furnished sand and gravel for building applications and road construction.

Izard.—Combined value of stone and sand and gravel resulted in a small increase over that registered in 1965. Silica Products Co., Inc., accounted for the major part of the total value with production of silica sand used as molding sand, for glass manufacture, and for grinding and polishing applications. National Silica Co. mined and processed silica sand for use as molding sand. Aluminum Company of America and Reynolds Metals Co. were recipients of high-calcium limestone used in converting bauxite to alumina; the limestone was mined for both aluminum producing companies by Batesville White Lime Co. Cabot Quarries, Inc., quarried and crushed limestone for use in highway construction. Marble output was credited to Wolford Marble Co.

Jefferson.—Mineral output consisting of sand and gravel and lime attained a 27-percent increase in value over that of 1965. The entire increase was due to greater production of sand and gravel. Lime production, used in paper manufacture, decreased substantially. Arkla Chemical Corp. utilized salt for production of chlorine and caustic soda. Pine Bluff Sand and Gravel Co. dredged sand and gravel from the bed of Arkansas River for use on paving and construction projects.

Johnson.—Value of mineral output decreased by nearly $613,000 despite substantial gains in output of natural gas and clay. Mobley Construction Co., Inc., was credited with a major share of the sand and gravel output. The county retained its lead in coal production, with output obtained from both underground and strip mines valued at about $873,000. Eureka Brick & Tile Co. continued manufacture of brick and heavy clay products. Ben M. Hogan Co., Inc., and Southeast Construction Co., Inc., quarried and processed sandstone for use in highway construction and concrete aggregate. Of the 19 wells drilled in the county, 11 were gas producers. Two new gas pools were discovered by field development wells in the Altus and Ludwig gasfields.

Lafayette.—Combined value of mineral fuels and sand and gravel was sufficient for

the county to retain its rank of fourth in the State. The county was third in value of petroleum production and fourth in natural gas output. Natural gas liquids were recovered from natural gas at three plants operated by Austral Oil Co., Humble Oil and Refiining Co., and Sunray DX Oil Co. Olin Mathieson Chemical Corp. extracted byproduct sulfur from sour natural gas at its McKamie plant. Of 82 wells drilled in the county, only 23 were completed as producing oil wells. The poor success ratio suggested that favorable drilling targets were lacking although one new field, Lake June, was discovered and three new pools were found.

Gifford-Hill & Co., Inc., accounted for most of the sand and gravel output. The county ranked fourth in the State in value of sand and gravel production.

Lawrence.—An almost 50-percent decrease in value of mineral output was caused entirely by a major drop in crushed limestone production. Black Rock Limestone Products Co., Ben M. Hogan Co., Inc., and Valley Stone Co., Inc., quarried and crushed limestone for concrete aggregate, road construction, riprap, and agstone. The county dropped from first to seventh place in the State in terms of limestone output. Black Rock Sand & Gravel Co., Inc., and L. F. Parker supplied sand and gravel for paving and other road construction applications.

Little River.—The county retained sixth place in overall value of mineral output and first in value of limestone (chalk) production. Arkansas Cement Corp. completed installation of plant equipment to increase plant capacity to 5 million barrels of cement annually. As a result, cement output was substantially larger than in 1965. Agricultural lime was marketed by Ark-La Limestone Corp., and sand and gravel output was consumed by construction projects conducted by Arkansas State Highway Department.

Logan.—Combined value of outputs of natural gas, stone, and sand and gravel resulted in an increase of 29 percent. Value decreases in natural gas and sand and gravel production were offset by a more than twofold increase in value of dimension sandstone output. Five companies in the county quarried and processed sandstone from the Hartshorne Sandstone for use in residential and commercial building. The county was the only producer of dimension sandstone. Ben M. Hogan Co., Inc., D. F. Jones Construction Co., and Rock Products, Inc., accounted for substantial tonnages of crushed sandstone used for construction projects. Arkansas State Highway Department provided markets for the entire output of sand and gravel, except for 1,000 tons used by the U.S. Forest Service. Eight of nine field development wells drilled in the county were gas producers. A total of five wildcat wells resulted in discovery of three new gasfields. These were Fletcher Creek, Paris, and Sugar Grove. All new production was from the Atoka Formation. Two field development wells encountered new gas sources, also in the Atoka Formation.

Miller.—The major part of a 6-percent net value increase was a result of increased sand and gravel output and the addition of natural gas liquids as a mineral product. The county led in tonnage and value of sand and gravel output in Arkansas. Gifford-Hill and Co., Inc., accounted for more than 60 percent of value credited to county sand and gravel output. Arkansas State Highway Department was the recipient of most of the sand and gravel. W. S. Dickey Clay Manufacturing Co. produced and processed clay. Only two of 18 wells drilled in Miller County were completed as producers. One of the completed wells resulted in discovery of the new Chicken Creek field. A beginning production rate of 66 barrels of oil per day was established by the well penetrating the Tokio Sand.

Montgomery.—Increased output of slate, stone, and sand and gravel resulted in 12-percent value gain over comparable 1965 data. Bird and Son, Inc., was the leading slate producer in the State. The mineral commodity was used for roofing granules and as a filler in industrial compounds. The company planned to open a new slate quarry 2 miles east of its plant. The Arkansas State Highway Department and the U.S. Forest Service used the county output of sand and gravel for road construction. Four Bros., Inc., processed sandstone for road construction.

Nevada.—Production of petroleum accounted for more than 98 percent of the total mineral value. Output of natural gas and sand and gravel contributed the remaining value. The iron mine operated by Southwest Enterprises, Inc., was idle

throughout the year. Ten of 16 wells drilled in developed oilfields yielded new sources of supply. Only one of 12 exploratory wells discovered a new oil source, which was the Nichols field. Initial rate of production was 20 barrels per day of 18° American Petroleum Institute (API) gravity crude oil.

Ouachita.—Mineral fuels, primarily petroleum, accounted for 94 percent of the total value. Ouachita was the only county in the State that registered increased petroleum output value. Hope Brick Works mined and processed slightly more clay than in 1965 for building brick and tile. Pine Bluff Sand & Gravel Co. and Standard Gravel Co. accounted for most of the sand and gravel production. Forty-one of 75 wells drilled for oil and gas were completed as producers. The success ratio was the highest in south Arkansas, and the county ranked second in the State in discovery of new sources of oil supply. One field, classed as a rediscovery, produced only a small quantity of oil on a daily basis; however, four new pools contributed a combined total of 145 barrels of crude oil daily.

Pike.—The county reported mercury production for the first time since 1946. Value of the mercury recovered from furnacing cinnabar ore was higher than for the combined years of 1945 and 1946, primarily because of a substantial increase in price. Gypsum production by Dulin Bauxite Co., Gypsum Division, accounted for the largest segment of mineral value. Sand and gravel value increased markedly, but a substantial decrease in stone output resulted in a decrease in overall mineral value as compared with the 1965 output. Tripoli output was substantially lower than in former years. Diamonds were found by tourists at the only naturally occurring diamond-bearing deposit in the United States.

Pope.—Three mineral commodities—natural gas, sandstone, and sand and gravel—had a combined value about 24 percent under that recorded by the same mineral products in 1965. Ben M. Hogan Co., Inc., and Pine Bluff Sand and Gravel Co. supplied most of the crushed sandstone used by the U.S. Army Corps of Engineers and the Arkansas State Highway Department. Mobley Construction Co., Inc., dredged sand and gravel from the bed of the Arkansas River for paving and other road construction purposes.

Pulaski.—Total value of mineral output was sufficient for the county to retain its rank of fifth in the State. Aggregate value of bauxite, clay, stone, and sand and gravel was 27 percent more than in 1965. The county ranked first in the State in stone output. It was the most significant commodity and, at a value of $9.7 million, accounted for 65 percent of the mineral value credited to the county. Jeffrey Stone Co. was the major producer of crushed sandstone, whereas Big Rock Stone and Material Co. accounted for most of the syenite output. A host of other companies quarried and crushed syenite for use on U.S. Army Corps of Engineers construction projects. Syenite was also used for roofing granule manufacture, roadstone, ballast, fill, riprap, and concrete aggregate. Sand and gravel was dredged in substantial quantities from the bed of Arkansas River by Big Rock Stone and Material Co. and Jeffrey Sand Co. The commodity supplied markets for paving and construction programs.

A. P. Green Refractories Co. and Stauffer Chemical Co. mined kaolin at a greatly increased rate and accounted for the county's first place in the State in quantity and value of clay output. Clay was used for refractory clay products and chemical substances. Porocel Corp. and Stauffer Chemical Co. processed bauxite into products used principally by the oil industry. American Cyanamid Co. and Reynolds Mining Corp. recorded production of bauxite substantially above that of 1965. The 3-M Co. manufactured roofing granules from crushed syenite in decreased quantities.

Saline.—The county retained third place in total mineral value recorded in the State. Increased bauxite output by Aluminum Company of America (Alcoa), Reynolds Mining Corp., and American Cyanamid Co. accounted for most of the total value increase. Value of clay, slate, lime, and sand and gravel was substantially higher than in 1965. Soapstone output was lower. A. P. Green Refractories Co. registered a threefold increase in kaolin output. A marked rise in sand and gravel output was due to increased production by Belvedere Sand and Gravel Co. Alcoa and Reynolds Mining Co. processed larger quantities

of limestone for lime manufacture than in 1965. The lime was consumed in conversion of bauxite to alumina at company alumina plants. The Milwhite Co., Inc., accounted for the output of ground soapstone and slate. Norton Co. reported production of calcined bauxite for the first time in several years.

Sebastian.—Combined value of mineral output was 6 percent higher than that of 1965. An increase in output of natural gas was enough to offset value losses incurred by lower production of the other mineral commodities. The county was second in natural gas production in the State. Eight of 15 wells drilled for natural gas were successes. An exploratory well encountered gas in the McGuire Member of the Atoka Formation and resulted in the new Hackett field. Two new pools were discovered in the Ewing field; the wells indicated initial gas output rates at 5.8 million cubic feet per day from the Morris Sand of the Atoka Formation and 1.1 million cubic feet per day from the Penters Formation. Sand and Gravel was produced by Arkhola Sand and Gravel Co. and Shoffner Sand and Gravel Co. Acme Brick Co. mined and processed clay for building brick and heavy clay products. S & S Co. manufactured lightweight aggregate from shale of the Spadra Formation. The Arkansas State Highway Department and the U.S. Army Corps of Engineers provided major markets for crushed sandstone produced by several companies. Coal production from one strip mine and one underground mine, registering outputs of more than 1,000 tons each, was substantially less than that reported in 1965.

Union.—The county retained its rank as second in the State in total value of mineral production. A substantial gain was due to increased output of bromine which offset losses scored in production of sand and gravel, petroleum, natural gas, and natural gas liquids. El Dorado Brick Co. manufactured brick and tile. At yearend, the county ranked second in petroleum output. The county continued to be the most prolific in oil discoveries as 65 of 129 wells drilled were completed as producers. Five wells succeeded in finding new fields designated Bethlehem, Craig, Mt. Holley North, Olin Forest, and Smithville. Total daily production rate was 507 barrels with API gravities ranging from 23° to 46°. Field development drilling activities resulted in the discovery of seven new oil pools. Four refineries and two gas treatment plants operated throughout the year.

Washington.—Production of stone diminished and offset increases in output of natural gas and sand and gravel. The Arkansas State Highway Department consumed the entire production of sand and gravel. McClinton Brothers Co. and Reynolds and Williams quarried and crushed limestone for concrete aggregate and roadstone; McClinton Brothers Co. marketed a significant tonnage of agricultural limestone. Only the Westfork field was gas productive. Two wells accounted for the entire output of natural gas from the Sylamore Sandstone of Mississippian age.

White.—Sandstone and sand and gravel were the only mineral commodities produced and their value was double that of 1965. Acme Materials Co., Inc., Four Bros., Inc., and Freshour Corp. quarried and processed sandstone for roadstone, riprap, and concrete aggregate. The Arkansas State Highway Department used the entire output of sand and gravel.

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 Natural Resources, Division of Mines and Geology.

By L. E. Davis [1]

New production from recently discovered gasfields and recently developed oilfields was responsible for 77 percent of the total increase in the value of California's mineral output in 1966 over that in 1965. Petroleum and natural gas production rose in both quantity and value. Mineral fuels remained the dominant group with an overall value increase of nearly 8 percent.

Of 28 nonmetallic mineral commodities produced, value of output for 17 increased; the increase as a group was credited to boron compounds, cement, diatomite, salt, sand and gravel, and stone. Value increases over 1965 totals were reported for 9 of 14 metals, led by iron ore, which had a sharp advance in both quantity and value. Antimony was produced for the first time in 15 years.

Consumption, Trade, and Markets.—Despite the diversity of mineral production and abundance of mineral resources, California was not self-sufficient in minerals, particularly mineral fuels. Refinery receipts (all sources) rose 2 percent, and natural gas receipts (pipeline) from out-of-State, 3 percent from 1965. Plants within the State processed 2 billion cubic feet more wet gas than in 1965, however, output of natural gas liquids declined slightly below that of 1965. California was third highest in the nation in petroleum production but consumed more petroleum products than any other State, and sixth in output of natural gas yet received nearly 1,200 billion cubic feet from sources outside the State.

Trends and Developments.—California oil production rose to 942,000 barrels daily, continuing the steady increase begun in 1964. Credit for the increase went to offshore development in the Carpenteria and Wilmington (east area) oilfields, and to steam-injection operations at secondary recovery projects in Kern County. A large new type waterflood was started in the Huntington Beach oilfield. The California Lands Commission leased six offshore tracts in the Santa Barbara channel for oil development but refused bids on three parcels around San Miguel Island.

The principal areas of new onshore development were in Kern and Los Angeles Counties. Statewide, 6 new oilfields and 10 new productive horizons in old fields were discovered in 1966. Capacity of the State's 31 oil refineries was increased 5 percent to 1,427,050 barrels daily. Seven major oil companies increased or modified refinery facilities, primarily to boost gasoline production.

Overall natural gas production rose 9 percent to more than 715 billion cubic feet per year while the output of natural gas liquids was only slightly lower.

In 1966, U.S. Borax and Chemical Corp. developed and adopted an improved truck-shovel system for mining borates at Boron that is expected to reduce mining costs noticeably. The company also began constructing a plant to produce anhydrous boric acid by a new process with startup of production scheduled for April 1967.

[1] Physical scientist, Bureau of Mines, San Francisco, Calif.

Table 1.—Mineral production in California [1]

Mineral	1965 Short tons (unless otherwise stated)	1965 Value (thousands)	1966 Short tons (unless otherwise stated)	1966 Value (thousands)
Antimony ore and concentrates (content)	-----	-----	1	(2)
Asbestos	74,587	$6,177	81,671	$6,945
Barite (crude)	4,000	21	15,000	104
Boron minerals	807,000	64,180	866,000	68,209
Cement—376-pound barrels	45,352,000	144,852	45,387,000	146,302
Clays	3,207,236	7,226	2,984,000	6,708
Copper (recoverable content of ores, etc.)	1,165	825	1,078	780
Feldspar—long tons	95,975	W	100,915	W
Gem stones	NA	200	NA	200
Gold (recoverable content of ores, etc.) troy ounces	62,885	2,201	64,764	2,267
Gypsum	1,611,000	3,881	1,207,000	3,064
Lead (recoverable content of ores, etc.)	1,810	565	1,976	597
Lime	602,000	11,073	552,000	8,764
Magnesium compounds from sea-water bitterns (partly estimated)—M_gO equivalent	r 95,652	r 7,955	87,816	7,413
Mercury—76-pound flasks	13,404	7,650	16,070	7,100
Natural gas—million cubic feet	660,384	204,059	[3] 715,113	[3] 223,175
Natural-gas liquids:				
Natural gasoline and cycle products thousand gallons	655,780	49,850	634,638	48,867
LP gases—do	339,082	15,467	353,164	17,304
Peat	30,905	434	29,235	384
Petroleum (crude)—thousand 42-gallon barrels	316,428	753,099	[4] 345,295	812,834
Pumice, pumicite, and volcanic cinder	676,000	1,744	580,000	1,763
Salt (common)	1,638,000	W	1,693,000	W
Sand and gravel	118,310,000	136,227	120,692,000	139,157
Silver (recoverable content of ores, etc.) troy ounces	196,787	254	190,000	246
Stone [5]	42,575,000	59,668	43,051,000	61,336
Sulfur ore—long tons	360	2	557	5
Talc, pyrophyllite and soapstone	141,074	1,725	138,340	1,847
Tin concentrates (content)	W	W	13	21
Zinc (recoverable content of ores, etc.)	225	66	335	97
Value of items that cannot be disclosed: Bromine, calcium chloride, calcite (optical grade), carbon dioxide, coal (lignite), diatomite, iodine, iron ore, lithium minerals, mica (scrap), molybdenum, perlite, platinum-group metals, potassium salts, rare-earth metals, sodium carbonate, sodium sulfate, tungsten concentrates, uranium, wollastonite, and values indicated by symbol W	XX	r 117,897	XX	133,870
Total	XX	r 1,597,298	XX	1,699,359

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

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

[2] Less than ½ unit.

[3] Final figure; supersedes figure given in commodity section.

[4] Includes condensate.

[5] Includes slate.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Millions)

Year	Value [1]
1957	$1,655
1958	1,517
1959	1,460
1960	1,415
1961	1,421
1962	1,443
1963	1,505
1964	1,543
1965	1,579
1966	p 1,659

p Preliminary.

[1] Data for 1957, 1959–65 revised.

American Potash & Chemical Corp. began installing additional steam and electric power facilities at Trona that would expand power capacity by 50 percent and provide greater flexibility for present operations and a basis for increases in production. The company's new facility to produce granular potassium sulfate was scheduled for operation in April 1967. In the spring, American Potash constructed a novel type of solar evaporating pond to develop techniques for preconcentrating brine. At Lompoc, Johns-Manville Corp. began a modernization and expansion pro-

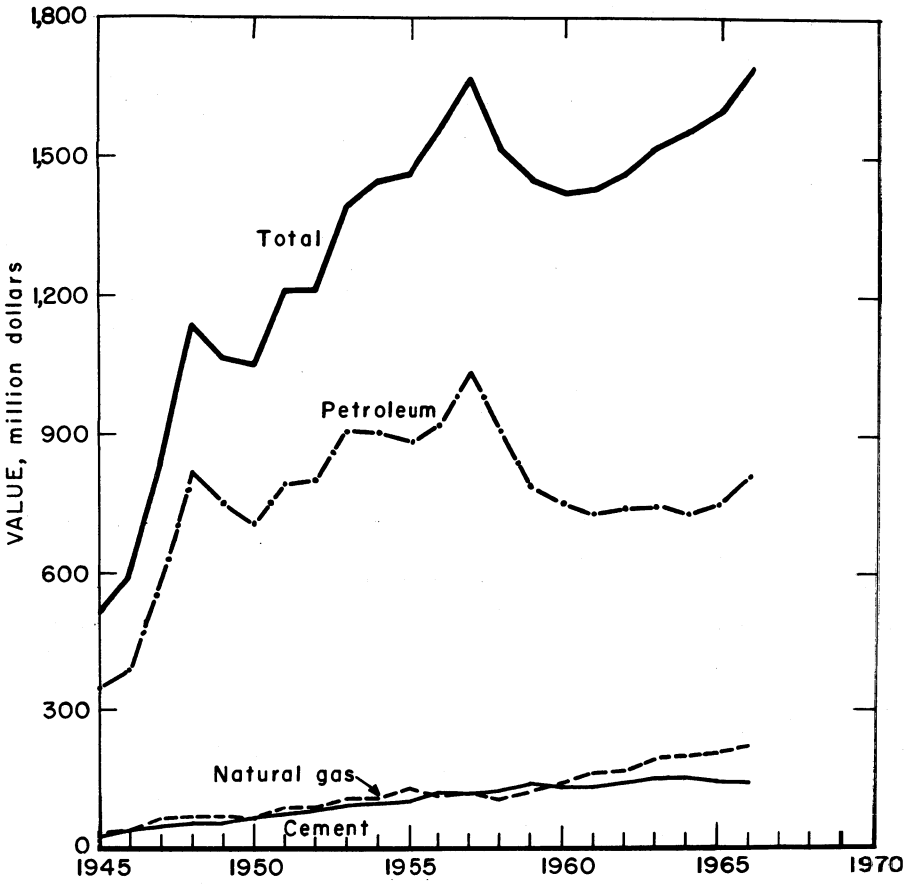

Figure 1.—Value of petroleum, natural gas, cement, and total value of mineral production in California.

gram to increase the output of diatomite filter aids 10 percent by mid-1968. The company purchased 1,535 acres of diatomite ore-bearing property adjacent to its present mine and mill, and executed a long-term lease for an additional 672 acres. Western Geothermal, Inc., in a joint venture with another company, began shipping liquid calcium chloride from a pilot plant located at one of its thermal wells in Imperial County. Expansion of the output was planned for 1967. Lassenite Industries, Inc., planned to begin producing pozzolan at its pit and plant near Hallelujah Junction, Lassen County, early in 1967. The plant product was to be used in the construction of Bullard's Bar Dam on the Yuba River.

Merck & Co., Inc., completed a multimillion-dollar modernization and revamping of its marine magnesium plant and processing equipment at South San Francisco. Sierra Lime Products Corp. completed and placed on stream a lime plant near Cool, El Dorado County. Port Costa Clay Products Co., a subsidiary of Homestake Mining Co., completed a $6 million expansion of its brick and lightweight aggregate facility in Contra Costa County. The new 3-million-barrel-per-year cement plant of Western Industries, Inc., Kern County, was

Table 3.—Employment 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
1965:								
Coal and peat	35	198	7	58	---	2	34.52	86
Metal	2,770	244	675	5,397	1	137	25.57	2,049
Nonmetal	4,914	274	1,347	10,904	1	164	15.13	1,159
Sand and gravel	5,184	233	1,205	9,784	9	179	19.22	5,996
Stone	4,727	295	1,396	11,196	6	119	11.16	3,856
Total	17,630	263	4,630	37,339	17	601	16.55	3,362
1966: p								
Coal and peat	35	179	6	51	---	---	---	---
Metal	3,080	246	759	6,077	5	164	27.81	6,832
Nonmetal	5,310	263	1,399	11,237	3	201	18.15	2,540
Sand and gravel	5,445	237	1,289	10,377	3	219	21.39	3,450
Stone	4,600	296	1,363	10,929	---	171	15.65	634
Total	18,470	261	4,816	38,671	11	755	19.81	2,917

p Preliminary.

Table 4.—Principal custom mills, commercial grinding plants, and primary smelters in 1966

Company	County	Nearest city or town	Minerals processed	Remarks
American Smelting and Refining Company.	Contra Costa	Selby	Lead, zinc, silver, gold.	Smelter, refinery, and fuming plant.
The Wilbur Ellis Co	Fresno	Fresno	Nonmetals	Commercial grinding.
Standard Industrial Minerals, Inc.	Inyo	Bishop	do	Do.
Macco Corp	Kern	Rosamond	do	Do.
Calada Materials Co	Los Angeles	Harbor City	do	Do.
American Minerals Co	do	Los Angeles	do	Do.
Western Talc Co	do	do	do	Do.
Industrial Minerals Co	Sacramento	Florin	do	Do.
Kaiser Steel Corp	San Bernardino	Fontana	Iron ore	Blast furnaces, steel plants, and fabricating plants.
Minerals, Pigments and Metals Division, Chas. Pfizer & Co., Inc.	do	Victorville	Nonmetals	Commercial grinding.
Yuba Minerals & Milling Co	Sutter	Sutter	do	Do.

nearing completion and was expected to be on stream early in 1967.

Utah Construction & Mining Co., under a long term lease with the State of California, acquired a substantial acreage at the mouth of the Russian River containing an estimated 60 million tons of sand and gravel. Utah plans to dredge the sand and gravel from the river bed and transport the material to San Francisco Bay for processing and sale. The first sale will be 800,000 tons for use as backfill on the trans-bay tube of the Bay Area Rapid Transit System. New Idria Mining & Chemical Co. announced the negotiation of a long-term lease for a phosphate deposit in San Benito County and expected to begin commercial production within a year. Chas. Pfizer & Co., Inc., acquired the assets and business of Southern California Minerals Co. The latter mined and/or processed nonmetallic minerals such as clays, limestone, sandstone, and talc. Molycorp, the world's largest producer of rare-earth compounds, expanded its Mountain Pass facilities, San Bernardino County, to an annual capacity of 50 million pounds of rare-earth (oxide) concentrates and 20,000 pounds of europium oxide.

The iodine extraction plant of The Dow Chemical Co. in Orange County was phased out in September. Morris P. Kirk & Son, Inc., announced that plans to build a new metals smelting and refining plant in Contra Costa County had been abandoned.

Exploration for minerals and metals in California was at a high level in 1966, with 129 active exploration projects reported. Companies were searching for 20 commodities, but gold was most actively sought with 55 projects, followed by talc with 10, mercury 9, lead 7, asbestos and clay 5 each, uranium 4, and copper, silver, and tungsten 3 each.

Legislative and Government Programs.—Public land orders restored over 18,000 acres of land to mineral location and leasing under U.S. mining laws, most of which was restored by the Bureau of Land Management, U.S. Department of the Interior. Other land orders withdrew about 27,000 acres for use by Federal agencies, principally the Department of Defense (U.S. Navy), and the Department of Agriculture (U.S. Forest Service). At yearend applications for withdrawal were pending for additional lands totaling nearly 5,600 acres. California received U.S. Treasury checks in the amount of $3,155,537.56 in bonuses, royalties, and rentals from mineral leases and permits on Federal lands within the State borders in 1966, over $380,000 more than in 1965.

On October 5, 1965, the Lead-Zinc Stabilization Program was extended to December 31, 1969, by enactment of Public Law 89–238. Revisions under the law required producers to be recertified after June 1, 1966, to be eligible for stabilization payments. Of the three applications received from California producers since enactment of the program in October 1962, two had been recertified and one had been withdrawn, suspended, or otherwise disqualified. No payments were made on 1966 production.

The San Francisco Petroleum Research Office, in cooperation with the Naval Petroleum Reserve, completed a study that provided the basis for calculating the position of injection wells, and the flow rates of water into the wells, that would prevent migration of oil from the Elk Hills-Asphalto 24 Z area of the petroleum reserve in California. Tests also were underway to find methods of treating water for injection into wells in the San Joaquin Valley oilfields to increase oil production by waterflooding. Water sources included (1) water produced with petroleum, (2) shallow saline aquifers, (3) transported sea water, and (4) waste irrigation water. Studies of the treatment needed for waste irrigation water were being conducted in cooperation with the California Department of Water Resources, Bureau of Reclamation, Federal Water Polution Control Administration, and other related agencies.

In cooperation with the City of Long Beach, the San Francisco Petroleum Research Office completed a pilot-plant study of methods for controlling deposition of barium sulfate scale in oil well pumps. The study indicated that scale deposition could be reduced significantly by coating the pump impellers and diffusers with a smooth plastic.

Several projects related to exploration and exploitation of minerals from the marine environment were initiated at the Bureau of Mines Marine Minerals Technology Center at Tiburon. One of these projects was a joint Bureau of Mines-Geological Survey attempt to find new deposits of heavy metals, and to develop new and improved techniques needed in undersea resource delineation. To assist in these studies, a 205-foot vessel obtained from the U.S. Naval Reserve Fleet was being converted to a marine mining research vessel, R/V Virginia City, a 37-foot boat was being converted to a research craft for geographical investigations, and a large test tank was under construction at the Center for testing of marine mineral sampling equipment in controlled environments.

The Bureau of Mines Berkeley Thermodynamics Laboratory conducted thermodynamic studies on silicates, refractory carbides, metal borates, and copper oxides. A study also was made on the mineral serpentine to determine thermodynamic conditions that exist during the natural formation of chrysolite asbestos.

The Region II Field Office, Office of Minerals Exloration (OME), U.S. Geological Survey, received six applications from persons interested in exploring for California minerals under the OME program. Of these, 5 applications were processed and five contracts were let. Seven contracts were active at yearend, 2 of which were continued from 1965.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS [4]

Carbon Black.—Overall production of carbon black advanced 16 percent over the 1965 total. Although increases were reported for all grades but one, the most marked rise was in thermal black. Continental Carbon Co., at Bakersfield, and United Carbon Co., Inc., at Mojave, Kern County, each produced five grades of carbon black from liquid hydrocarbons. Shell Chemical Co., at Pittsburg, Contra Costa County, produced thermal black from natural gas as a by-product of hydrogen production in an ammonia fertilizer plant. Output averaged about 5 pounds of carbon black per gallon from liquid hydrocarbons and 9.5 pounds per thousand cubic feet from natural gas. Plant outputs were used in the rubber, chemical, and metal industries.

Carbon Dioxide.—Tidewater Oil Co. and Standard Oil Co. of California extracted carbon dioxide from natural gas in natural gasoline plants near Taft, Kern County. Plant output by Tidewater rose 7 percent above that of 1965 and was sold to bottlers of carbonated beverages. Standard did not market any carbon dioxide, but removed the gas to insure that the natural gas would meet pipeline specifications.

Coal (Lignite).—American Lignite Products Co., Inc., the State's only lignite producer, mined lignite from an open pit mine near Ione, Amador County. The entire mine output was processed by the firm to recover several grades of wax, which were sold to the carbon paper, polish, and rubber industries. Production was virtually the same as in 1965.

Coke.—California's only coking facility was operated by Kaiser Steel Corp. at its Fontana steel plant, San Bernardino County. The coke was consumed in the company's blast furnaces and coke breeze was used in the nearby agglomerating plant. Consumption of coke and coke breeze declined 3 and 20 percent, respectively, from 1965 levels. The company obtained its coking coal from captive mines in New Mexico and Utah.

Natural Gas.—Marketed production of natural gas rose 8 percent above 1965 with 55 percent of the output coming from oil zones. Dry-gas production from 110 fields in 22 counties averaged about 875 million cubic feet daily, up 13 percent from 1965. Rio Vista, largest of the dry-gas fields and highest in btu content, yielded nearly 20 percent of the total output. Other fields with high yields in 1966 were the Grimes (33 billion cubic feet), Moleno offshore (30 billion), and Dutch Slough (23 billion). A total of 61 development wells were drilled in 32 fields during the year. The most active development drilling occurred in the Sherman Island and Malton fields in the Sacramento Valley, and the Ten Section field in San Joaquin Valley. Significant production increases were reported from the Coles Levee North and Dutch Slough fields in the San Joaquin Valley. Major declines occurred at the Bunker and Thorton West-Walnut Grove fields in the Sacramento Valley, and at the McMullin Ranch field in the San Joaquin Valley.

Exploratory drilling resulted in the discovery of two new gasfields, seven new producing formations in existing fields, and extension of the productive area of the Rice Creek field, in the Sacramento Valley. Four gasfields discovered in earlier years began producing in 1966. The most important of these was the Clarksburg field, discovered in 1963, in the Sacramento Valley.

The quantity of gas injected for re-pressuring and pressure-maintenance operation, was down 20 percent from 1965.

Natural Gas Liquids.—The volume of wet gas processed rose 2 billion cubic feet over that of 1965; production of natural gas liquids, however, continued to decrease although the decline from 1965 was less than 1 percent. The volume of liquefied petroleum (LP) gas produced was up 4 percent but the output of natural gasoline and cycle products was down over 3 percent. Of the eight contiguous counties where natural gas liquids were produced, only Santa Barbara County, with a 10-percent rise over that of 1965, had a significant increase. Kern County output was up 3 percent. Several plants were shut down during the year and changes were made in others, but at yearend 63 were operating, unchanged from 1965. The continued high demand for LP gas, principally butane, prompted some shifts in operating procedures. Total value of natural gas liquids

[4] Prepared by Calvin H. Riggs, Petroleum and Natural Gas Engineer, Bureau of Mines, San Francisco, Calif.

Table 5.—Natural gas (marketed production)[1] natural gas liquids, and petroleum produced in 1966, by counties

County	Petroleum[2]				Natural gas, marketed production				Natural gas liquids				
	Average number of producing wells		Production (thousand barrels)	Value (thousand dollars)	Oil zones		Dry gas zones		Natural gasoline and cycle products			LP gases	
	Oil	Dry gas			Million cubic feet	Thousand dollars	Million cubic feet	Thousand dollars	Number of plants	Thousand gallons	Thousand dollars	Thousand gallons	Thousand dollars
Butte	---	24	---	---	---	---	8,329	$2,076	---	---	---	---	---
Colusa	---	90	---	---	---	---	14,888	4,430	---	---	---	---	---
Contra Costa	38	60	577	$1,885	3,211	$1,060	28,391	9,057	---	---	---	---	---
Fresno	2,861	1	21,762	55,552	22,892	7,554	90	W	2	W	W	W	W
Glenn	---	99	---	---	---	---	15,406	4,529	---	---	---	---	---
Humboldt	---	21	---	---	---	---	2,977	893	---	---	---	---	---
Kern	20,439	97	120,645	269,754	146,245	48,261	8,812	2,573	18	166,258	$13,740	115,880	$5,976
Kings	210	8	1,143	3,348	24,382	8,046	1,555	468	3	W	W	W	W
Los Angeles	7,933	12	90,127	218,748	73,882	22,918	1,470	441	18	153,307	11,906	53,908	2,491
Madera	---	18	---	---	---	---	1,886	536	---	---	---	---	---
Monterey	870	---	17,498	24,208	3,230	1,066	---	---	---	---	---	---	---
Orange	3,962	2	39,878	92,947	29,337	9,100	999	300	5	97,881	7,460	16,511	737
Riverside	3	---	18	W	W	W	---	---	---	---	---	---	---
Sacramento	---	145	---	---	---	---	46,343	14,830	---	---	---	---	---
San Benito	29	4	129	394	59	20	262	W	---	---	---	---	---
San Bernardino	22	---	44	W	38	12	---	---	---	---	---	---	---
San Joaquin	---	106	---	---	---	---	36,809	9,865	---	---	---	---	---
San Luis Obispo	156	---	1,072	1,979	587	194	---	---	1	W	W	W	W
San Mateo	13	---	39	W	W	W	---	---	---	---	---	---	---
Santa Barbara	1,720	19	26,443	59,522	44,944	13,942	44,631	13,925	6	70,703	5,616	57,392	2,780
Solano	---	132	---	---	---	---	48,584	15,498	---	---	---	---	---
Sonoma	---	5	---	---	---	---	33	W	---	---	---	---	---
Sutter	---	129	---	---	---	---	48,635	14,201	---	---	---	---	---
Tehama	---	26	---	---	---	---	2,835	833	---	---	---	---	---
Tulare	28	39	54	W	---	---	4,986	1,511	---	---	---	---	---
Ventura	3,050	3	24,340	78,760	46,155	14,317	109	W	10	98,017	6,147	57,051	2,362
Yolo	---	18	---	---	---	---	2,119	570	---	---	---	---	---
Undistributed	---	---	---	377	2	1	---	148	---	48,472	3,998	52,422	2,958
Total	41,334	1,058	343,769	807,474	394,964	126,491	320,149	96,684	63	634,638	48,867	353,164	17,304

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

[1] Quantity figures courtesy of California Department of Conservation, Division of Oil and Gas.

[2] Excludes condensate. Quantity figures courtesy of Conservation Committee of California Oil Producers.

rose 1.3 percent—up nearly 12 percent for LP gas and down 2 percent for all other.

Peat.—Production and sales of peat continued a decline begun in 1964. Output of reed-sedge material came from only two producers, both in Contra Costa County. A Riverside County property was abandoned late in 1965. A Modoc County deposit yielded all the peat moss and an Orange County pit, all the humus material. The latter was sold directly from the pit. About two-thirds of the reed-sedge material was shredded and packaged, and all the peat moss was kiln dried and packaged for sale. All peat materials were sold for general soil improvement uses with only 21 percent sold in bulk.

Petroleum.—Production from an average of 41,334 active oil producing wells, 128 more than in 1965, rose 9 percent above that of the preceding year and averaged 942,000 barrels daily. The major increases were in the principal producing counties of Kern, Los Angeles, and Orange. Offshore production rose to nearly 16 percent of the State total.

Completion of 79 new wells in the East Wilmington offshore field added 10 million barrels in 1966, and steam injection and new drilling increased the yield from the Kern River field, Kern County, by 6 million barrels. Other fields showing substantial increases in production rates were the Coalinga, McKittrick, and Cymric in Kern County, the Huntington Beach in Orange County, and the San Ardo in San Luis Obispo County. New oil wells in all counties totaled 1,969, an increase of 5 percent. Average depth of new wells was only 2,906 feet, compared with 3,220 in 1965, reflecting the drilling activity in shallow fields for thermal (steam) stimulation.

Thermal recovery methods, particularly steam stimulation, accounted for production increases totaling 125,000 barrels daily from 5,079 wells. Of the 223 active steam injection projects, 139 were in Kern County, principally in the Coalinga, Kern River, and Midway-Sunset fields. The largest project, that of Tidewater Oil Co. in the Kern River field, included about 2,000 wells. Twenty in situ combustion projects were operated in 18 fields, up from 16 projects in 10 fields during 1965.

Waterflood projects totaled 168, including 15 begun during the year. About 1.7 million barrels of water was injected into 1,137 wells. The largest single project was in the Wilmington field, Los Angeles County, where water injection was used to prevent land subsidence. Over 248 million cubic feet of gas was injected daily into 102 wells to increase oil production at 45 projects. The greatest volumes of gas were injected at large unitized pressure-maintenance operations in Kern County.

Exploratory drilling totaled nearly 2 million feet for 331 wells seeking new production. Of these, 35 were discovery wells for a success ratio of 10.5 percent, down from 14.3 percent in 1965. One new field, the Carpenteria offshore in Santa Barbara County, yielded about 1 million barrels of oil from 28 wells drilled from offshore platforms. Several short gathering lines were completed between fields and refineries, and a right-of-way was purchased for a major pipeline to be laid between the Coalinga field, Kern County, and the San Francisco Bay area.

In Contra Costa County, capacity of the Shell Oil Co. Martinez refinery was more than doubled during the year, to 86,000 barrels of crude oil daily, and gasoline production was increased from 4,000 to 54,000 barrels daily. At the Richmond refinery of Standard Oil Co. of California, installation was completed on a 64,000-barrel-per-day hydrocracking unit and a 44,500-barrel-per-day solvent-deasphalting unit to process low value residuals into gasoline. In Solano County, Humble Oil and Refining Co. started construction of its new 72,000-barrel-per-day Benecia refinery. Four other refineries were nearing completion or under construction, one each by Atlantic Richfield Co., Douglas Oil Co. of California, Sequoia Refining Co., and Texaco Inc.

NONMETALS

Asbestos.—A high percentage of the 1966 increase in domestic asbestos production was credited to California producers, who accounted for 65 percent of the total output. Four companies produced chrysotile asbestos fiber—Atlas Minerals Corp. and Coalinga Asbestos Co., Fresno County; Pacific Asbestos Corp., Calaveras County; and Union Carbide Corp., San Benito County. The latter company processed the crude material in a plant at King City, Monterey County, whereas the other producers operated plants near the mine sites.

Most of the processed material was used to manufacture products for the construction industry. Three of the four producers prepared only group 7 fiber; the fourth prepared and shipped groups 4, 5, 6, and 7 fiber. Shipments were made to domestic and foreign customers. Asbestos Bonding Co., a Napa County producer in 1965, shut down its operations indefinitely.

Barite.—Production of crude barite rose sharply over that in 1965 with most of the increase coming from the Leviathan mine, San Bernardino County. Increased output also was reported from the Walton deposit, Inyo County, and the Embree property, Tulare County, began production. Shipments of crude ore to grinders were up more than threefold but shipments of ground barite increased only 11 percent. Six grinding plants operated in the State. Of those, two were operated by California barite producers (San Diego and Sutter Counties), two were custom grinders (Sacramento and Fresno Counties), and two depended on either purchased crude barite or crude ore received from company mines outside the State (Los Angeles and Kern). A barium chemicals plant in Stanislaus County used crude barite produced at a company mine in Nevada.

Boron Minerals and Compounds.—Bedded borate deposits in Kern and Inyo Counties, and brines of Searles Lake, San Bernardino County, yielded all the domestic production of boron minerals and compounds. In Inyo County, Kern County Land Co. mined colemanite and U. S. Borax and Chemical Corp. mined both colemanite and ulexite. The latter refined crude borates from the company's open-pit mine, Kern County, in plants in Kern and Los Angeles Counties. American Potash & Chemical Corp. and Stauffer Chemical Co. extracted boron compounds from brines in plants at Searles Lake. Stauffer also produced high-purity boron chemicals in its San Francisco plant using purchased Kern County borates. Total output of boron compounds was higher but the value was below that in 1965.

Bromine and Bromine Compounds.—FMC Corp. extracted elemental bromine from salt-works bitterns and converted it to ethylene dibromide in the company plant at Newark, Alameda County. Production rose 77 percent from 1965 levels and was sold principally for use as a soil fumigant. American Potash & Chemical Corp. recovered elemental bromine from Searles Lake brines in its Trona plant, San Bernardino County and sold it to the chemical and pharmaceutical industries. Output was nearly 6 percent below that of 1965.

Calcite (Optical Grade).—A small quantity of optical grade calcite was mined near Mount Baldwin, Mono County, for Bausch & Lomb, Inc., and shipped to the company in Rochester, N.Y. Output was almost 20 percent of that in 1965.

Calcium Chloride.—Liquid calcium chloride was recovered from Bristol Lake brine, San Bernardino County, by Leslie Salt Co. and National Chloride Co. of America, and from well brine by Chloride Products, Inc., near Calipatria, Imperial County. The latter was a new producer. Hill Bros. Chemical Co. purchased liquid calcium chloride and prepared a flake product in a plant near Bristol Lake. More liquid but less flake products were produced and sold than in 1965. The finished products were sold for use as a hygroscopic agents and a fireproofing materials to customers in Arizona, Nevada, and California.

Cement.—Production and shipments of portland cement were virtually unchanged from 1965 levels. However, shipments from southern California mills rose by 634,000 barrels whereas shipments from northern California mills were down nearly 600,000 barrels. About 3.8 million barrels was shipped to out-of-State customers. As in 1965, total apparent consumption in California was 42 million barrels, including receipts from other States.

Plant expansion and modernization by cement companies raised the combined annual production capacity for 13 plants to 58,750,000 barrels by yearend. The Pacific Western Industries, Inc., 3-million-barrel Los Robles plant, Kern County, was nearing completion and shipments were scheduled to begin in February 1967.

Clays.—About 2.7 million tons of clay was mined at captive operations, a drop of nearly 10 percent from that of 1965. Total output, sold and used, was down 7 percent. The declines were attributed to reduced construction activity, which resulted in lower demand for building brick, vitrified sewer pipe, and portland cement. Fire clays and miscellaneous clay used in making ce-

Table 6.—Finished portland cement
(Thousand 376-pound barrels and thousand dollars)

District [1]	Active plants	Capacity Dec. 31	Production	Shipments from mills: Quantity	Shipments from mills: Value: Total	Shipments from mills: Value: Average per barrel	Stocks at mills Dec. 31	Estimated consumption
1965:								
Northern California	6	21,150	19,402	19,619	$63,804	$3.25	1,511	18,394
Southern California	7	36,000	25,770	25,733	81,048	3.15	1,744	23,800
Total	13	57,150	45,172	45,352	144,852	3.19	3,255	42,194
1966:								
Northern California	6	21,150	18,930	19,020	63,088	3.32	1,372	17,912
Southern California	7	37,600	26,391	26,367	83,214	3.16	1,776	24,414
Total	13	58,750	45,321	45,387	146,302	3.22	3,148	42,326

[1] 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.

Table 7.—Source and destination of shipments of portland cement
(Thousand 376-pound barrels)

Destination	Source: Northern California mills		Source: Southern California mills		Total	
	1965	1966	1965	1966	1965	1966
Northern California	16,904	15,932	1,170	1,240	18,074	17,172
Southern California	482	359	23,294	24,039	23,776	24,398
Nevada	303	215	969	632	1,272	847
Oregon	W	W	W	W	(1)	(2)
Arizona	---	---	204	267	204	267
Other	[3] 1,930	[3] 2,514	[4] 96	[4] 189	2,026	2,703
Total	19,619	19,020	25,733	26,367	45,352	45,387
Building material dealers	1,404	1,171	3,307	2,893	4,711	4,064
Concrete product manufactures	1,526	1,840	2,766	3,090	4,292	4,930
Ready-mixed concrete	12,791	11,637	16,943	17,148	29,734	28,785
Contractors and Government agencies	3,713	4,251	2,446	2,962	6,159	7,213
Miscellaneous and own use	185	121	271	274	456	395
Total	19,619	19,020	25,733	26,367	45,352	45,387

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Included with "Other;" total 1,085,000 barrels shipped from northern and southern California to Oregon.
[2] Included with "Other;" total 1,171,000 barrels shipped from northern and southern California to Oregon.
[3] Includes Alaska, Colorado (1965), Idaho, New Mexico, Oregon, Washington, Foreign countries, and U.S. Possessions and Territories.
[4] Includes Colorado, Hawaii, Idaho (1966), Iowa, Kansas (1966), Michigan, Missouri, Nebraska (1966), New Mexico, Oklahoma (1966), Oregon, Texas, Utah, Washington, and foreign countries.

ment and heavy clay products represented over 59 percent of all clays sold or used.

Ball clay was mined at three properties, two in San Bernardino County and one in Stanislaus County. Bentonite was produced from five mines, two in Inyo County, and one each in Imperial, San Benito, and San Bernardino Counties. Fuller's earth production came from two deposits in Inyo County. Kaolin was mined from one deposit in Mono County and two properties in Orange County. Fire clays and stoneware clays were mined from 22 deposits in eight counties, and miscellaneous clays from 58 properties in 29 counties.

Diatomite.—Four open-pit operations near Lompoc, Santa Barbara County, accounted for most of the diatomite production. In Napa County, interplant shipments of diatomaceous silica were made from stockpile and the material ground for pozzolan. Diatomite was mined from a new deposit, the Castelan in Shasta County, and prepared for use as a filler in fertilizers. A low-grade diatomaceous material was mined in Tuolumne County and used for lightweight aggregate. Crude sales dropped 70 percent while prepared sales rose 10 percent, compared with 1965 levels. Prepared sales, in order of greatest demand,

Table 8.—Clays sold or used, by counties

County	1965			1966		
	Clays used in cement and heavy clay products (short tons)	Total clays		Clays used in cement and heavy clay products (short tons)	Total clays	
		Short tons	Value		Short tons	Value
Alameda	20,030	21,330	$35,954	9,392	11,392	$21,596
Amador	15,404	74,400	406,572	10,792	79,006	369,760
Calaveras	192,339	W	W	163,888	W	W
Contra Costa	53,900	53,900	81,120	52,500	81,500	118,700
Inyo	-----	9,124	39,553	-----	7,717	38,810
Kern	51,975	W	122,415	37,932	W	137,481
Lake	100	2,200	13,000	1,800	2,700	15,957
Los Angeles	385,215	385,988	501,038	173,106	173,806	240,596
Madera	7,650	7,650	9,563	7,650	7,650	9,563
Modoc	-----	W	W	-----	4,700	5,875
Orange	72,328	241,425	852,426	81,139	243,061	812,058
Placer	147,797	W	W	143,010	W	W
Plumas	-----	3,600	6,624	-----	-----	-----
Riverside	324,390	384,616	874,770	337,336	339,336	625,715
Sacramento	14,405	17,626	25,091	10,700	14,666	19,418
San Bernardino	203,407	269,011	914,105	132,904	172,759	320,849
San Joaquin	35,483	W	W	29,197	W	W
San Luis Obispo	9,150	9,150	11,438	9,149	9,149	11,436
San Mateo	177,945	W	W	184,615	W	W
Santa Clara	20,150	20,150	20,150	6,732	6,732	6,732
Santa Cruz	193,919	W	W	184,161	W	W
Shasta	90,583	W	W	90,800	W	W
Siskiyou	-----	4,200	7,728	-----	70,000	87,500
Stanislaus	2,801	4,157	21,921	1,612	3,112	23,269
Sutter	23,875	W	W	13,987	W	W
Trinity	-----	1,300	2,392	-----	-----	-----
Tulare	4,050	4,050	5,100	4,600	4,600	5,900
Yuba	20,055	W	W	11,151	W	W
Other counties	[1] r 97,767	[2] r 1,693,359	[2] r 3,274,885	[1] 79,754	[2] 1,752,201	[2] 3,836,461
Total	2,164,718	3,207,236	7,225,845	1,777,907	2,984,087	6,707,676

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Other counties."

[1] Includes Fresno, Marin, and San Diego counties.

[2] Includes Fresno, Imperial, Marin, Mono, Napa, San Benito, San Diego, Sonoma, Ventura, and counties indicated by symbol W.

were for filtration, filler, pozzolan, insulation, and lightweight aggregate.

Feldspar.—All feldspar was obtained from dune sands of the Monterey peninsula where Del Monte Properties Co. and Owens-Illinois Glass Co. mined and processed feldspathic sands near Pacific Grove. Both companies removed heavy minerals from the sand, Owens-Illinois by magnetic separation and Del Monte by froth flotation. The latter also produced feldspar and silica concentrates by flotation and blended and ground them to customer specifications, principally for manufacturing sanitary ware and glass fiber. Owens-Illinois shipped its plant product to company glass plants. Total marketable feldspar was 5 percent above that in 1965.

Gypsum.—Production of crude gypsum was 25 percent below the 1965 figure. Output for agricultural use declined because of increased byproduct production at phosphoric acid plants and that for manufacture of gypsum products because of a continued lag in residential construction. Crude gypsum from mines in California, Nevada, and Mexico was calcined in California plants. The new wallboard plant of U. S. Gypsum Co. at Santa Fe Springs, Los Angeles County, was placed on stream in 1966, using calcined gypsum from the company plant at Plaster City, Imperial County.

Iodine.—Crude iodine was recovered from oil well brines in the Los Angeles basin at the Seal Beach plant of The Dow Chemical Co. Dow closed the plant in September. The 1966 production was consumed in making titanium and potassium iodides.

Deepwater Chemical Co. operated a plant at Compton, Los Angels County, on purchased foreign crude iodine. Various iodates and iodides were produced and some crude iodine resublimed for resale.

Lime.—Production of lime and dead-burned dolomite declined 9 percent from

the record high of 1965. The 50,000-ton drop was attributed primarily to lesser demand by sugar refineries. Although declines also were reported for use in recovering magnesium compounds, making refractories, sewage treatment, and petroleum refining. Gains were reported for use in ore treatment and processing plants, agriculture and soil stabilization, metallurgical flux, paper manufacture, and magnesium (dead-burned dolomite).

Producers used about 369,000 tons of lime in their own plants and sold 183,000 tons to California and out-of-State customers. California consumers received 208,000 tons of lime from producers in Arizona, Missouri, Nevada, Ohio, Utah, and Washington, up slightly from the 1965 total. Overall consumption of primary lime in California was about 742,000 tons, 45,000 tons less than in 1965.

Two new lime plants went on stream in 1966—near Cool, El Dorado County, by Sierra Lime Products Corp. and at Richmond, Contra Costa County, by U.S. Lime Division, The Flintkote Co. In both instances plant products were used principally for soil stabilization.

Lithium Compounds.—Dilithium sodium phosphate was recovered from Searles Lake brines at Trona, San Bernardino County, by American Potash & Chemical Corp. The compound was converted to finished lithium carbonate. Production and sales were up nearly 8 percent from that of 1965 but the value of the output was lower owing to a unit price drop during the year.

Magnesium Compounds.—Production, sales, and producer consumption of all grades of magnesia except heavy USP and technical were lower than in 1965. The decline was particularly noticeable in the major consuming industries—refractories and pulp and paper. FMC Corp. extracted magnesia from salt-works bitterns at plants in Alameda and San Diego Counties. The latter plant also produced magnesium chloride. Kaiser Aluminum and Chemical Corp. and Merck & Co., Inc., recovered magnesia from sea water at plants in Monterey and San Mateo Counties, respectively. Kaiser consumed most of its output in the manufacture of refractories, chiefly for use in the Fontana plant of Kaiser Steel Corp. Merck also produced magnesium carbonate and magnesium trisilicate.

Mica.—Western Industrial Minerals mined and processed mica (sericite schist) near Ogilby, Imperial County, and sold the product for use in paint and welding-rod coating. Sericite was mined at the Banquet Canyon property of Rockton Mining & Manufacturing, Inc., near Saugus, Los Angeles. The material was purchased by Macco Corp. and ground in its plant at Rosamond, Kern County, for use in well drilling muds. Sunshine Mica Co. at Los Nietos, Los Angeles County ground stockpiled scrap mica for use as an ingredient in paint and roofing materials. The company ceased grinding operations in July for an indefinite period.

Near LeGrand, Mariposa County, Kelly-Moore Paint Co., Inc., mined and stockpiled mica schist. The material was to be processed in a flotation plant expected to be on stream in June 1967.

Perlite.—Except for a small tonnage mined in Napa County and used by the producer for lightweight aggregate, crude perlite production was limited to the Fish Spring quarry of American Perlite Co., Inyo County. American sold the crude material to expansion plants in Fresno and Los Angeles Counties.

A total of 11 expanding plants, 7 of which were in Los Angeles County, operated in 6 counties. Production and sales of expanded products declined 10 percent from that of 1965. About 47 percent of the expanded output was used as plaster aggregate, 28 percent for filter aid, 6 percent for loose fill insulation, 5 percent as concrete aggregate, 4 percent for soil conditioner, 3 percent as filler, and 7 percent for all other uses.

Potassium Salts.—American Potash & Chemical Corp. was California's only producer of potassium compounds. The company extracted potassium chloride from Searles Lake brines at Trona, San Bernardino County, and converted part of the output to potassium sulfate. Overall production was below that of 1965. Less sulfate was produced but sales were higher. Customers used both products for direct application to soils and in the manufacture of fertilizers.

Pumice.—Combined output of crude pumice, pumicite, and volcanic cinder declined nearly 15 percent and that of prepared material was down 13 percent from

1965 levels. Sales declines were most noticeable for crude pumice and pumicite, down 97 percent, and prepared volcanic cinder, 53 percent lower. Only 23 percent of the combined output of all materials was crushed, screened, ground, or otherwise processed before shipment.

Salt.—Seven companies and one metropolitan water district produced crude salt by solar evaporation. A high percentage of the output was recovered from sea water at salt ponds in three San Francisco Bay area counties—Alameda, Napa, and San Mateo. Solar salt also was recovered from sea water in Monterey, Orange, and San Diego Counties, and from inland dry lake areas in Kern and San Bernardino Counties. Leslie Salt Co., the State's largest producer, made all grades of salt, including crude, kiln-dried, and vacuum-refined, at an Alameda County plant. Morton Salt Co. refined purchased crude salt in an adjacent plant. All other plants in California produced only a crude product. Some rock salt was produced by Leslie at Bristol Lake, San Bernardino County. Although 60 percent of the total output went to consumers within the State, significant quantities were exported to Canada and Japan, and shipped to Arizona, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming, Alaska, and Hawaii.

Sand and Gravel.—Production of sand and gravel rose to a record of nearly 121 million tons, more than 2 million tons above the previous high of 1965. The increase was credited to continued high demand for materials used in highway construction, flood control programs, and water resource projects. In most areas of major sand and gravel production, the volume of material produced for these projects more than offset the losses sustained for residential construction. Alameda, Sacramento, and Santa Clara Counties were the exceptions.

Of the total output, 109 million tons of sand and gravel was processed in stationary or portable plants and 12 million tons was used as pit-run material. Commercial producers supplied about 103 million tons, the remainder was produced by government crews and on-site contractors. Of the 385 sand and gravel operations in the State classified as commercial, 25 produced over 1 million tons each, 39 between 500,000 and 1 million tons each, 121 between 100,000 and 500,000 tons each, and 200 less than 100,000 tons each.

Sand and gravel was produced in all 58 counties, and output ranged from 16,000 tons in Kings County to over 26 million tons in Los Angeles County. Six other counties yielded more than 5 million tons each—Alameda, Fresno, Orange, Riverside, San Bernardino, and San Diego.

Production of ground and unground specialty sands rose appreciably above the 1965 figures, particularly for glass manufacture, sandblasting, and railroad (engine) use.

Sodium Compounds.—Sales of sodium compounds were 1 percent above 1965 figures. Sodium carbonates were down in quantity but up in value while the reverse was true for the sulfates. Pittsburgh Plate Glass Co. recovered soda ash and sodium

Table 9.—Pumice [1] sold or used by producers in 1966, by counties

County	Crude		Prepared		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Inyo	-----	-----	W	W	W	W
Kern	-----	-----	1,610	$49,100	1,610	$49,100
Lake	21,000	$27,000	W	W	21,000	27,000
Lassen	142,302	140,302	W	W	142,302	140,302
Madera	-----	-----	W	W	W	W
Modoc	57,953	43,567	W	W	57,953	43,567
Mono	W	W	W	W	W	W
Napa	W	W	-----	-----	W	W
San Bernardino	-----	-----	16,340	33,874	16,340	33,874
Shasta	62,562	71,836	-----	-----	62,562	71,836
Siskiyou	148,572	182,190	W	W	148,572	182,190
Tehama	10,000	10,000	-----	-----	10,000	10,000
Undistributed	1,865	2,865	117,485	1,202,631	119,350	1,205,496
Total	444,254	477,760	135,435	1,285,605	579,689	1,763,365

W Withheld to avoid disclosing company confidential data; included with "Undistributed."
[1] Includes pumicite and volcanic cinder.

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

(Thousand short tons and thousand dollars)

Year	Sand		Gravel		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	35,321	$41,501	54,464	$63,077	89,785	$104,578
1962	47,463	54,293	60,197	70,629	107,660	124,922
1963	47,831	53,658	64,354	74,520	112,185	128,178
1964	45,297	53,309	67,698	76,024	112,995	129,333
1965	48,536	58,152	69,774	78,075	118,310	136,227
1966	48,930	57,144	71,762	82,013	120,692	139,157

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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Glass	869	$4,138	W	W
Molding	87	399	67	$320
Building	22,323	26,291	21,347	25,046
Paving	12,598	13,820	14,906	16,123
Blast	225	942	271	1,160
Engine	42	131	62	179
Filter	12	56	13	62
Other	4,786	3,993	6,062	8,746
Total	40,942	49,770	42,728	51,636
Gravel:				
Building	24,859	29,958	24,904	30,054
Paving	28,461	33,093	31,886	37,858
Railroad ballast	132	134	153	194
Other	2,876	2,849	3,513	3,632
Total	56,328	66,034	60,456	71,738
Total sand and gravel	97,270	115,804	103,184	123,374
Government-and-contractor operations: [1]				
Sand:				
Building	19	21	103	119
Paving	6,930	7,729	2,870	3,535
Fill	574	548	3,222	1,835
Other	71	84	7	19
Total	7,594	8,382	6,202	5,508
Gravel:				
Building	99	117	34	82
Paving	12,680	11,281	9,715	8,924
Fill	456	456	1,414	1,044
Other	211	187	143	225
Total	13,446	12,041	11,306	10,275
Total sand and gravel	21,040	20,423	17,508	15,783
All operations:				
Sand	48,536	58,152	48,930	57,144
Gravel	69,774	78,075	71,762	82,013
Total	118,310	136,227	120,692	139,157

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes figures for State, counties, municipalities, and other Government agencies.

Table 12.—Sand and gravel production in 1966, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Alameda	9,900	$10,308	Placer	344	$553
Butte	1,254	1,327	Plumas	296	285
Colusa	410	413	Riverside	5,212	6,119
Contra Costa	352	380	Sacramento	4,965	6,327
Del Norte	499	481	San Benito	561	622
El Dorado	250	381	San Bernardino	7,490	7,388
Fresno	5,356	6,635	San Diego	6,242	9,571
Humboldt	1,463	1,529	San Joaquin	3,555	4,464
Imperial	895	959	San Luis Obispo	219	280
Inyo	315	409	Santa Barbara	1,809	1,763
Kern	3,964	4,722	Santa Clara	2,714	2,589
Kings	16	16	Santa Cruz	1,307	1,358
Lake	668	787	Shasta	2,691	2,529
Lassen	436	461	Sierra	37	77
Los Angeles	26,317	29,522	Siskiyou	589	578
Madera	587	524	Sonoma	2,521	3,347
Mariposa	56	85	Stanislaus	1,250	1,459
Mendocino	601	862	Tehama	786	629
Merced	1,902	2,383	Trinity	69	92
Modoc	205	254	Tulare	932	1,102
Mono	307	321	Tuolumne	25	3
Monterey	925	1,873	Ventura	4,034	3,984
Napa	77	110	Other counties [1]	6,613	9,074
Nevada	251	332			
Orange	9,425	9,890	Total	120,692	139,157

[1] Includes Alpine, Amador, Calaveras, Glenn, Marin, San Francisco, San Mateo, Solano, Sutter, Yolo, and Yuba combined to avoid disclosing individual company confidential data.

sesquicarbonate from the brines of Owens Lake, Inyo County; U.S. Borax & Chemical Corp. produced byproduct salt cake in its Wilmington refinery, Los Angeles County, from borates mined by the company in Kern County; and American Potash & Chemical Corp. and Stauffer Chemical Co. each produced both soda ash and salt cake from Searles Lake brines, San Bernardino County. Stauffer also recovered byproduct anhydrous sodium sulfate from purchased Kern County borates in its San Francisco plant.

Stone.—Stone production rose to more than 43 million tons, up 1 percent from that of 1965. The slight increase was credited largely to requirements for riprap used in flood control in the northern counties, the San Luis water project in Merced County, and harbor construction in Los Angeles and San Diego Counties. The demand for stone for concrete aggregate and roadstone was relatively high in the producing areas. Sharp declines were reported in those areas where a lag in residential construction was most notable, particularly Alameda and Contra Costa Counties.

Outputs of limestone, granite, miscellaneous stone, and slate increased; those of basalt, sandstone, and marble declined. Over 16 million tons of limestone and oystershell was produced, of which 13 million tons was consumed in cement and lime plants. More limestone was used in making glass, paper, whiting, and mineral filler in animal feeds; less was used for sugar refining, metallurgical flux, and refractories.

Dimension stone production totaled less than 250,000 tons but was more than double the 1965 figure. The entire increase was rubble used in highway construction and water resource projects. Output for building construction declined appreciably.

Sulfur.—Operators at seven plants in three counties—two in Contra Costa, four in Los Angeles, and one in San Luis Obispo—recovered elemental sulfur from sour natural and refinery gases using a modified Klaus process. Production rose 8 percent, but shipments were virtually unchanged from 1965 levels as producers used more sulfur to produce other products.

Production and shipments of sulfur ore from the S Bar S deposit, Lake County, were virtually the same as in 1965. Sulfur ore was mined and shipped from the Gulch claims, Inyo County, after a lapse of several years.

Talc, Soapstone, and Pyrophyllite.—Combined output of talc, soapstone, and pyrophyllite and shipments to grinders declined 2 percent from 1965 levels. Consumer receipts were down 17 percent. Consumption

Table 13.—Stone sold or used by producers, by uses

Use	1965		1966	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction and rubble, short tons	98,130	$685,391	240,134	$759,823
Rough architectural, cubic feet	95,227	659,372	W	W
Approximate equivalent, short tons	7,912	-----	W	-----
Monuments and mausoleums, cubic feet	20,268	321,812	[1] 57,887	[1] 571,594
Approximate equivalent, short tons	1,726	-----	[1] 4,920	-----
Flagging, cubic feet	43,863	71,369	33,597	66,589
Approximate equivalent, short tons	3,742	-----	2,873	-----
Total dimension stone, approximate, do	111,510	1,737,944	247,927	1,398,006
Crushed and broken stone:				
Riprap, short tons	9,171,137	9,908,418	10,635,683	12,976,784
Metallurgical, do	W	W	W	W
Concrete and roadstone, do	16,273,902	21,377,686	15,450,210	20,509,414
Railroad ballast, do	W	W	W	W
Agricultural, do	20,329	118,099	W	W
Chemical, do	33,587	398,727	W	W
Miscellaneous [2], do	[3] 16,964,090	[3] 26,126,968	[4] 16,716,862	[4] 26,451,486
Total crushed and broken stone, do	42,463,045	57,929,898	42,802,755	59,937,684
Grand total, approximate, do	42,574,555	59,667,842	43,050,682	61,335,690

W Withheld to avoid disclosing individual company confidential data.
[1] Includes rough architectural.
[2] Includes whiting substitute, filler, mineral food, poultry grit, stucco, roofing granules, filter beds, terrazzo, miscellaneous, and crushed and broken stone uses indicated by symbol W.
[3] Includes 12,352,383 tons of limestone and oystershell used in cement valued at $11,897,936 and 640,320 tons of limestone used in lime valued at $1,972,412.
[4] Includes 12,022,091 tons of limestone and oystershell used in cement valued at $11,772,970 and 748,698 tons of limestone used in lime valued at $2,227,037.

Table 14.—Stone [1] production in 1966, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Alameda	2,518	$2,149	Riverside	1,736	$3,850
Alpine	W	W	Sacramento	2	3
Amador	44	92	San Benito	W	W
Butte	84	152	San Bernardino	5,915	9,351
Calaveras	W	W	San Diego	1,650	2,735
Contra Costa	3,185	5,052	San Luis Obispo	W	W
Del Norte	52	24	San Mateo	1,154	1,840
El Dorado	418	1,518	Santa Barbara	13	97
Fresno	218	715	Santa Clara	5,660	5,063
Humboldt	213	413	Santa Cruz	1,140	1,591
Imperial	83	86	Shasta	W	W
Inyo	165	863	Sierra	111	13
Kern	2,120	2,578	Siskiyou	191	225
Lake	13	30	Solano	W	W
Lassen	W	W	Sonoma	384	506
Los Angeles	2,261	3,804	Sutter	90	108
Madera	W	W	Tehama	10	17
Marin	W	W	Trinity	W	W
Mariposa	2	35	Tulare	200	93
Mendocino	59	146	Tuolumne	162	790
Merced	6,242	4,714	Ventura	194	563
Modoc	W	W	Yuba	215	274
Mono	[2]	[2]	Other counties	6,504	11,721
Monterey	W	W			
Napa	W	W	Total	43,051	61,336
Nevada	13	11			
Placer	24	110			
Plumas	6	4			

W Withheld to avoid disclosing individual company data. Included with "Other counties."
[1] Includes stone used in cement and lime.
[2] Less than ½ unit.

Table 15.—Stone sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Quantity	Value	Quantity	Value
	Granite		Basalt and related rocks (traprock)		Limestone [1]	
1962	4,484	$5,975	1,886	$2,200	15,694	$24,082
1963	3,814	6,098	2,024	2,801	16,447	22,806
1964	3,994	5,479	2,282	3,144	16,908	23,582
1965	4,286	6,193	2,480	3,035	15,840	22,959
1966	4,862	5,855	2,218	3,202	16,130	23,890
	Sandstone		Other stone [2]		Total	
1962	2,399	$4,038	10,313	$18,427	34,776	$54,722
1963	3,363	5,898	12,329	20,650	37,977	58,253
1964	3,065	6,118	19,556	25,243	45,805	63,566
1965	4,061	7,202	15,908	20,279	42,575	59,668
1966	3,569	7,080	16,272	21,309	43,051	61,336

[1] Includes limestone and oystershell used in cement and lime as follows (in thousand short tons and thousand dollars): 1962, 12,799 tons, $15,393; 1963, 13,242 tons, $13,580; 1964, 13,657 tons, $14,226; 1965, 12,993 tons, $13,870; 1966, 12,771 tons, $14,000.

[2] Includes light-colored volcanics, schist, serpentine, river boulders, and such other stone as cannot properly be classed in any main group; also marble and slate.

dropped in all categories except for use in paints. Exports (all talc) rose more than sevenfold. Higher average unit prices throughout the industry led to the use of substitute materials, particularly in ceramics and insecticides.

Water.—In 1966, five additional steam wells were drilled at The Big Geysers, Sonoma County, resulting in an increase of about 42,000 kilowatts (Kw) of energy capacity. The drilling was a part of the Magma-Thermal Power Project to develop the geothermal field for additional power units of Pacific Gas & Electric Co. (PG&E). A series of delays prevented PG&E from placing unit No. 3 (27,500 kw) on stream before yearend. The company scheduled Unit No. 4 (also 27,500 kw) for completion in December 1968. Late in 1966, Magma Power Co. and Thermal Power Co., joint venturers in The Geysers area, entered into a letter of intent with Earth Energy, Inc., a wholly owned subsidiary of Union Oil Company, which contemplated an exchange of interests in geothermal lease holdings and expenditures by the latter in development and operation of the joint properties.

In the Niland area, Imperial County, State pollution control regulations, which prevented discharge of waste brines into the Salton Sea, curtailed geothermal development. Pilot-plant operations of Earth Energy, Inc., were inactive, Western Geothermal, Inc., was recovering and shipping calcium chloride at yearend, and Imperial Thermal Products, a subsidiary of Morton International, planned to recover sodium and calcium chlorides by solar evaporation, using steam from the wells in the recovery operation. Morton had generating equipment on its property, used in pilot operations, but had no immediate plans to generate electric power.

In January 1966, the Office of Saline Water issued an invitation to bid for construction of a 1-million-gallon-per-day improved distillation plant at San Diego, Calif. The bids were not to be opened until January 16, 1967, about 1 year later. Meanwhile, groundbreaking ceremonies were held August 10, 1966, marking start of construction of this 1-million-gallon-per-day desalting plant and the associated San Diego Saline Water Test Facility. The plant was to be named the Senator Clair Engle Desalting Plant in honor of the late U.S. Senator from California.

In April, the Office of Saline Water awarded contracts for the construction of two reverse osmosis pilot plants larger than any currently in use. General Atomic Division, General Dynamics Corp., San Diego, Calif., was awarded a contract for a 10,000-gallon-per-day plant and Aeroject General Corp., Azusa, Calif., one for a 50,000-gallon-per-day plant.

Other Nonmetals.—Chas. Pfizer & Co., Inc., produced natural and manufactured iron oxide pigments in an Alameda County plant, the State's only such facility. Output was down 2 percent from that in 1965. De-

clines were reported in all categories except manufactured yellows and mixtures of natural and manufactured reds.

Phosphate rock from mines in Idaho, Wyoming, and Utah, and pebble phosphate from Florida, were shipped to California chemical and fertilizer plants. Pebble phosphate shipments into the State were virtually the same as in 1965 but receipts of phosphate rock by consumers in the State declined 32 percent.

Blast-furnace slag from Kaiser Steel Corp. at Fontana was used for railroad ballast, prepared for roofing granules, used as paving material, made into mineral wool insulation, subsittuted for sand as fill material, and used as a sewage filter medium and a filler in fertilizers.

Vermiculite exfoliation plants were operated in Alameda, Los Angeles, and Sacramento Counties by California Zonolite Co., using crude mineral received from the company mine in Montana. In February, the Sacramento County plant was closed. La Habra Products Co. exfoliated crude vermiculite imported from South Africa in an Orange County plant. Plant products were used chiefly as aggregate in plaster and concrete, as a soil conditioner at nurseries, and as thermal and accoustical insulation. All sales except those for aggregate were higher than in 1965.

Float wollastonite collected near Midland and wollastonite quarried near Blythe, Riverside County, was sold for building and ornamental stone. A comparatively small tonnage of the quarried material was used in ceramics. In Inyo County, wollastonite mined at a new operation near Spanish Springs was stockpiled except for a comparatively small quantity shipped for testing in ceramics. Some stockpiled wollastonite at the nearby J. O. claims was sold to a plastics manufacturer.

METALS

Antimony.—A small quantity of antimony ore was mined at the San Buena property near Essex, San Bernardino County, and shipped to a smelter at Laredo, Tex. This is the first report of antimony ore production in California since 1952 when an equally small tonnage was mined and concentrated in Kern County but not marketed.

Copper.—There was virtually no activity at copper mines in 1966, with only 321 tons of copper ore mined and shipped. Most of the copper output was as a byproduct of tungsten ore milling at Pine Creek, Inyo County. Lead and lead-zinc ores mined in San Bernardino County contained much of the remaining recoverable copper credited to the State.

Gold.—Gold production rose 3 percent above that 1965 figure, reversing a 3-year downtrend. The increase came from expanded placer operations. Gold from placers represented 97 percent of the total. One bucketline dredging operation (3 dredges), 3 dragline excavating and sluicing operations, 2 suction dredges, and 19 nonfloating washing plants recovered nearly 99 percent of the placer gold. All but one of the nonfloat plants were sand and gravel preparation plants where placer gold was recovered as a byproduct. Placer gold recovery also was reported from two drift mines and 16 small handpanning and sluicing operations. At yearend one of the three bucketline dredges was shut down.

Lode gold output was 62 percent lower and there was one more operating mine than in 1965. Only six lode mines yielded more than 100 ounces of gold each—the Zaca silver mine, Alpine County; the Columbia lead-zinc mine and Pine Creek tungsten mine, Inyo County; the Original 16 to 1 gold mine (ore mined before shutdown in December 1965), Sierra County; the Kelly gold mine, Trinity County; and the Gold Star gold property, Tuolumne County. These six mines yielded 69 percent of the lode gold.

Iron Ore.—Production of usable iron ore increased 26 percent above that in 1965. Shipments to domestic consumers were down 7 percent while exports rose 72 percent. One-third of all shipments were pellets, reflecting the first full year of operation for the mine-site pellet plant of Kaiser Steel Corp. The company's Eagle Mountain mine, Riverside County, continued to yield most of the State iron ore output. In San Bernardino County, production and shipments of concentrate from the Iron Age mine were higher; mine production of direct-shipping-grade ore at the Silver Lake dropped 77 percent whereas shipments were only slightly lower. In both instances the customers were domestic steel plants.

Table 16.—Mine production of gold, silver, copper, lead, and zinc in 1966, by counties, in terms of recoverable metals

County	Mines producing[1]		Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Troy ounces	Value	Troy ounces	Value
Alpine	1	---	302	$10,570	10,131	$13,100
Butte	1	1	27	945	4	6
El Dorado	1	1	30	1,050	4	6
Fresno	---	(2)	579	20,265	79	102
Inyo	7	---	323	11,305	167,742	216,890
Lake	---	---	1	35	W	W
Madera	1	(2)	3	105	W	W
Mariposa	3	(2)	90	3,150	12	16
Merced	---	(2)	23	805	W	W
Nevada	2	6	347	12,145	71	91
Placer	2	3	168	5,880	W	W
Plumas	---	3	13	455	---	---
Riverside	3	---	4	140	78	101
San Bernardino	10	1	30	1,050	W	W
Shasta	2	---	147	5,145	12	16
Sierra	6	3	550	19,250	72	93
Stanislaus	---	---	361	12,635	W	W
Tulare	---	---	22	770	2	3
Yuba	---	2	58,912	2,061,920	2,987	3,862
Undistributed[3]	13	5	2,832	99,120	8,795	11,370
Total	52	25	64,764	2,266,740	189,989	245,656

	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Alpine	500	$181	2,500	$378	3,000	$435	$24,664
Butte	---	---	---	---	---	---	951
El Dorado	---	---	---	---	---	---	1,056
Fresno	---	---	---	---	---	---	20,367
Inyo	W	W	3,764,000	568,929	654,500	94,902	892,026
Lake	---	---	---	---	---	---	35
Madera	W	W	---	---	---	---	105
Mariposa	---	---	---	---	---	---	3,166
Merced	---	---	---	---	---	---	805
Nevada	---	---	---	---	---	---	12,236
Placer	---	---	---	---	---	---	5,880
Plumas	---	---	---	---	---	---	455
Riverside	W	W	W	W	W	W	241
San Bernardino	18,100	6,547	12,900	1,950	8,700	1,262	10,809
Shasta	---	---	---	---	---	---	5,161
Sierra	---	---	---	---	---	---	19,343
Stanislaus	W	W	W	W	W	W	12,635
Tulare	---	---	---	---	---	---	773
Yuba	---	---	---	---	---	---	2,065,782
Undistributed[3]	2,137,400	773,097	172,600	26,088	3,800	551	910,226
Total	2,156,000	779,825	3,952,000	597,345	670,000	97,150	3,986,716

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Excludes itinerant prospectors, "snipers," "high-graders," and others who gave no evidence of legal right to property.
[2] From property not classed as a mine.
[3] Includes Imperial, Kern, Los Angeles, Monterey, Sacramento, San Diego, San Joaquin, Siskiyou, Trinity, and Tuolumne Counties and counties indicated by symbol W.

In Shasta County, a few hundred tons of stockpiled ore was shipped from the Iron Mountain mine to a domestic consumer.

Lead.—As in 1965, lead production came principally from four mines in Inyo County. The Columbia lead-zinc mine and the Jubilee, Queen of Sheba, and Santa Rosa lead mines yielded 95 percent of the total lead recovered. About 166 tons more lead was recovered from all ores than in 1965, including cleanup material and shipments from unnamed properties at undisclosed locations in the State.

Mercury.—Mercury production and shipments rose significantly despite a drop of $129 per flask in the average unit price from the alltime high of $570.75 in 1965. Fewer properties were in production but the average grade of ore treated was 21 percent higher. Although 72 operators reported production, only 12 operations produced more than 100 flasks each. These 12 operations yielded 94 percent of the State total. The three major producers—New Idria Mining and Chemical Co., San Benito County; Buena Vista Mines, Inc., San

Table 17.—Gold produced at placer mines, by classes of mines and methods of recovery [1]

Class and method	Mines producing [2]	Number of washing plants (dredges)	Material treated (thousand cubic yards)	Gold recovered		
				Troy ounces	Value	Average value per cubic yard
Surface placers:						
Gravel mechanically handled:						
Bucketline dredges:						
1957–61 (average)	2	7	25,551	105,655	3,697,911	$0.145
1962	3	6	17,547	93,707	3,279,745	.187
1963	2	6	12,817	77,448	2,710,680	.212
1964	1	3	11,611	62,422	2,184,770	.188
1965	1	3	12,412	53,937	1,887,795	.152
1966	1	3	12,102	58,863	2,060,205	.170
Dragline dredges: [3]						
1957–61 (average)	6	7	213	804	28,147	.132
1962	6	6	472	761	26,635	.056
1963	3	3	256	1,109	38,815	.152
1964	1	1	132	545	19,075	.145
1965	2	2	540	1,096	38,360	.071
1966	3	3	191	1,314	45,990	.241
Suction dredges:						
1957–61 (average)	2	2	15	22	763	.509
1962	5	5	(4)	20	700	5.833
1963	10	10	12	178	6,230	.498
1964	3	3	1	112	3,920	3.439
1965	1	1	(4)	8	280	.560
1966	2	2	10	52	1,820	.182
Nonfloating washing plants: [3 5]						
1957–61 (average)	4	12	73	909	31,808	.436
1962	4	10	187	679	23,765	.127
1963	2	19	(4)	1,349	47,215	89.085
1964	2	18	5	1,203	42,105	.381
1965	1	16	(4)	1,047	36,645	3.500
1966	1	19	(4)	2,028	70,980	.514
Gravel hydraulically handled:						
1957–61 (average)	4	---	5	63	2,205	.441
1962	4	---	21	85	2,975	.141
1963	4	---	13	100	3,500	.279
1964	1	---	2	73	2,555	1.278
1965	---	---	---	---	---	---
1966	---	---	---	---	---	---
Small-scale hand method: [6]						
1957–61 (average) [7]	29	---	59	1,164	40,754	.691
1962	14	---	266	661	23,135	.087
1963	51	---	54	2,612	91,420	1.701
1964	30	---	54	1,420	49,700	.918
1965	21	---	24	2,476	86,660	3.617
1966	16	---	27	851	29,785	1.110
Underground placers: Drift:						
1957–61 (average)	4	---	1	49	1,708	1.708
1962	1	---	1	5	175	.170
1963	7	---	4	202	7,070	1.656
1964	1	---	16	163	5,705	.352
1965	1	---	(4)	7	245	4.900
1966	2	---	(4)	13	455	7.583
Grand total placers:						
1957–61 (average)	51	---	25,917	108,666	3,803,296	.141
1962	37	---	18,494	95,918	3,357,130	.182
1963	79	---	r 13,156	82,998	2,904,930	.221
1964	39	---	11,821	65,938	2,307,830	.195
1965	27	---	12,976	58,571	2,049,985	.158
1966	25	---	12,330	63,121	2,209,235	.179
1848–1966	---	---	NA	68,414,183	1,530,234,051	NA

r Revised. NA Not available.

[1] For historical data by years, see Minerals Yearbook, Review of 1940, p. 219.

[2] Excludes itinerant prospectors, "snipers," "high-graders," and others who gave no evidence of legal right to property.

[3] Includes commercial rock plants and tungsten mines that produced byproduct gold from gravels: byproduct gold is included with gold recovered, but material treated and average value per cubic yard refer only to straight gold dredging.

[4] Less than 1,000 cubic yards.

[5] Includes all placer operations using power excavator and washing plants both on dry land; when the washing plant is a movable outfit, it is termed "dryland dredge."

[6] Includes all operation in which hand labor is principal factor in delivering gravel to sluices, long tons.

[7] Includes gold recovered by electrostatic separation; combined to avoid disclosing individual company confidential data.

Table 18.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing [2]		Material sold or treated [3] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousand dollars)	Troy ounces	Value (thousand dollars)
1957–61 (average)	92	52	138	144,579	$5,060	231,298	$210
1962	65	37	43	106,272	3,720	132,505	144
1963	50	79	21	86,867	3,040	156,528	200
1964	43	39	16	71,028	2,486	171,621	222
1965	51	27	20	62,885	2,201	196,787	254
1966	52	25	25	64,764	2,267	189,989	246
1848–1966	---	---	NA	106,194,107	2,418,897	119,865,161	97,999

Year	Copper		Lead		Zinc		Total value (thousand dollars)
	Short tons	Value (thousand dollars)	Short tons	Value (thousand dollars)	Short tons	Value (thousand dollars)	
1957–61 (average)	965	$579	874	$240	773	$181	$6,270
1962	1,162	716	455	84	322	74	4,738
1963	916	564	823	178	101	23	4,005
1964	1,035	675	1,546	405	143	39	3,827
1965	1,165	825	1,810	565	225	66	3,911
1966	1,078	780	1,976	597	335	97	3,987
1848–1966	644,126	211,948	270,031	54,191	151,379	35,771	2,818,806

NA Not available.
[1] Includes recoverable metal content of gravel washed (placer operations); ore milled; old tailings or slimes retreated; tungsten ore; and ore, old tailings, slag, flue dust, and pyritic ore residue shipped to smelters during calendar year indicated.
[2] Excludes itinerant prospectors, "snipers," "high-graders," and others who gave no evidence of legal right to property.
[3] Does not include gravel washed.

Table 19.—Mine production of gold, silver, copper, lead, and zinc in 1966, by types of material processed and methods of recovery, in terms of recoverable metals [1]

Type of material processed, and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Amalgamation:					
Ore	565	179	-----	-----	-----
Old tailings	70	12	-----	-----	-----
Total	635	191	-----	-----	-----
Concentration and smelting of concentrates: Ore [2]	766	69,296	2,114,400	56,700	4,800
Direct smelting: Ore and copper precipitates [3]	242	116,947	41,600	3,895,300	665,200
Placer	63,121	3,555	-----	-----	-----
Grand total	64,764	189,989	2,156,000	3,952,000	670,000

[1] Includes gold recovered as "natural gold."
[2] Includes tungsten-ore concentrate.
[3] Combined to avoid disclosing individual company confidential data.

Luis Obispo County; and Sonoma International, Inc., Sonoma County—accounted for 68 percent of the total production and 66 percent of the shipments. New Idria continued as the Nation's individual mercury producer.

Notable increases in production were reported by Sonoma International and Buena Vista; significant new production was achieved by New Idria, and by Atlas Minerals Corp. at the Little King mine, Kings County.

Molybdenum.—Molybdenite and powellite were recovered by Union Carbide Corp. as byproducts in the treatment of tungsten ores from the Pine Creek mine, Inyo County. A marked drop in production and shipments of molybdenite was report-

Table 20.—Mine production of gold, silver, copper, lead, and zinc in 1966, by classes of ore or other source materials in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Gold	31	3,660	939	330	---	---	100
Gold-silver	1	2,650	302	10,131	500	2,500	3,000
Silver	6	419	16	4,787	2,000	2,500	2,600
Silver-lead	1	14	---	280	---	5,500	---
Copper and tungsten ore	5	[2] 321	106	57,538	2,134,300	---	---
Lead	6	8,947	84	104,725	13,900	3,588,900	571,800
Lead-zinc	2	9,087	126	8,631	5,300	352,600	92,500
Total	52	25,098	1,573	186,422	2,156,000	3,952,000	670,000
Other lode material: Old tailings	[3]	155	70	12	---	---	---
Total lode material	52	25,253	1,643	186,434	2,156,000	3,952,000	670,000
Placer	25	[4]	63,121	3,555	---	---	---
Total all sources	77	25,253	64,764	189,989	2,156,000	3,952,000	670,000

[1] Detail will not necessarily add to total, because some mines produce more than one class of material.
[2] Tungsten-ore tonnage not included.
[3] From property not classed as a mine.
[4] 12,305,049 cubic yards. Does not include material washed at commercial gravel plants to produce 2,023 ounces of byproduct gold and 300 ounces of byproduct silver included in placer totals.

ed but those for powellite rose slightly. All shipments were consigned to domestic consumers.

The company did not report in 1966 on its plant for recovering high-purity byproduct molybdenum metal.

Pig Iron, Sinter, and Ferrous Scrap.—All of the State's pig iron was produced at the Fontana blast furnace of Kaiser Steel Corp. San Bernardino County. The furnace consumed 3 percent less ore (concentrate) and 4 percent less agglomerate (sinter and pellets) in producing 1 percent less pig iron. The output was 94 percent basic pig iron and 6 percent direct castings. Kaiser steel furnaces consumed 43 percent less ore (concentrate), only slightly less pig iron (hot metal), and nearly 15 percent more scrap (home and purchased) than in 1965. Only one other steel producer, U.S. Steel Corp. at Torrance, Los Angeles County, used pig iron in addition to scrap. All others operated on scrap alone. Overall consumption of ferrous scrap was up 6 percent while the use at steel furnaces rose nearly 8 percent.

The Bureau of Mines automobile body and chassis scrap accumulation and utilization study in southern California was about 75 percent complete at yearend.

Platinum.—Byproduct platinum-group metals were recovered from stream and ancient riverbed gravels at a bucket-line dredging operation on the Yuba River in the Hammonton area, Yuba County. This was the only reported recovery of platinum in California. The quantity recovered was more than 50 percent above that in 1965.

Rare-Earth Minerals.—As stated in the 1966 Annual Report of Molybdenum Corporation of America, (Molycorp.) sales of rare-earth products were $9.9 million, up from $3.8 million in 1965. Most of the increase resulted from sales of europium oxide. Approximately 7.5 million pounds of rare-earth oxides were sold in concentrate form, and 20 million pounds utilized to produce europium oxide, rare-earth chloride, and metallurgical compounds. The total rare-earth oxide requirement was 27.5 million pounds, compared with 15 million pounds in 1965.

In May, Molycorp completed a concentrating plant at Mountain Pass, San Bernardino County, with an annual capacity of 30 million pounds of rare-earth oxides. By December this plant was expanded to 50 million pounds annually. The company processed 179,000 tons of ore, utilizing both the old and new concentrating plants, and produced 25 million pounds of rare-earth oxides as against 6 million pounds in 1965. Operation of the old concentrator was discontinued by yearend but was kept on a standby basis.

Silver.—Ores from five lode mines—one

Table 21.—Mercury production, by methods of recovery

Year	Operating mines	Recovery method: Furnaced[1] Ore treated (short tons)	Furnaced[1] 76-pound flasks	Retorted Ore treated (short tons)	Retorted 76-pound flasks	Unclassified 76-pound flasks[2]	Total 76-pound flasks	Total Value[3]
1957–61 (average)	44	118,349	17,070	8,015	1,352	263	18,685	4,147,672
1962	37	79,948	15,407	3,728	496	48	15,951	3,049,991
1963	31	61,595	13,273	4,068	303	16	13,592	2,575,004
1964	39	89,630	8,949	12,595	1,334	8	10,291	3,259,504
1965	84	137,079	11,219	21,060	2,168	17	13,404	7,650,333
1966	72	136,693	13,714	16,292	2,344	12	16,070	7,100,047

[1] Includes ore and mercury from dumps not separable.
[2] Includes mercury recovered from miscellaneous dump material, placer, and cleanup operations.
[3] Value calculated at average New York price.

silver (Zaca) Alpine County, and one tungsten (Pine Creek), one lead-zinc (Columbia), and two lead (Jubilee and Santa Rosa), Inyo County—yielded 94 percent of the recoverable lode silver and 92 percent of all the silver recovered in 1966. Lode silver production declined 4 percent while placer silver (recovered as a coproduct in placer gold mining) rose 8 percent.

Despite the national interest in silver, exploration for silver ore was in progress at only four properties in California, two each in Alpine and San Bernardino Counties.

Tin.—Production and shipments of tin concentrate rose nearly threefold over that in 1965. The producer's name was changed from Gold Canyon Mines, Inc., to American Tin Corp. in July. All production was from the Meeke-Hogan mine, Kern County, but American Tin acquired the nearby Butler mine. American Tin completed construction of a 150-ton-per-day gravity concentrator to separate the tin oxide (cassiterite) from the iron oxide (magnetite) with which it is associated.

Tungsten.—The Pine Creek mine, Inyo County, of Union Carbide Corp. yielded a high percentage of the State's tungsten production. The company purchased concentrates from smaller producers in Kern and Madera Counties, and from producers and former producers in Colorado, Idaho, and Nevada. Purchases also were made from stocks held by firms in California and Texas, and from the Government stockpile. Some of the produced and purchased concentrates were converted to paratungstate in the Pine Creek plant. Union Carbide shipped concentrates and paratungstate to customers throughout the United States.

New Idria Mining & Chemical Co. reactivated its Strawberry tungsten mine and mill as soon as the weather permitted and

Table 22.—Ferrous scrap and pig iron consumption

(Thousand short tons)

Year	Ferrous scrap	Pig iron
1957–61 (average)	2,273	1,588
1962	2,248	1,818
1963	2,415	1,891
1964	2,575	2,250
1965	2,829	2,319
1966	2,991	2,267

Table 23.—Ferrous scrap and pig iron consumption by types of furnaces and miscellaneous uses

(Thousand short tons)

Ferrous scrap and pig iron charged to—	1965	1966
Steel furnaces:[1]		
Scrap	2,409	2,592
Pig iron	2,111	2,059
Total	4,520	4,651
Iron furnaces:[2]		
Scrap	391	379
Pig iron	208	208
Total	599	587
Miscellaneous uses:[3] Scrap	29	20
Total scrap	2,829	2,991
Total pig iron	2,319	2,267
Grand total	5,148	5,258

[1] Includes open hearth electric furnace, and basic oxygen process.
[2] Includes cupola and direct castings.
[3] Includes rerolling, copper precipitation, nonferrous, and chemical uses.

shipped concentrates to Union Carbide and to various east coast customers. The Atolia mine, San Bernardino County, was reactivated by Mines Exploration, Inc., and produced and sold concentrate to a Nevada tungsten carbide plant.

The average unit price for tungsten concentrate was over $4 per unit higher than in 1965.

Uranium.—In 1966, ore was shipped from seven uranium mines to a processing plant in Moab, Utah. In 1965 only one mine was operating. Despite the apparent increase in activity, total shipments were only a fraction of those of the preceding year and the average grade was lower. The major producers were the South East No. 2 claim (David Halmot), Riverside County, and the Juniper mine (Paradox Mining Co.), Tuolumne County.

Zinc.—Inyo County mines yielded nearly 98 percent of the zinc recovered in 1966. Ore from the Santa Rosa mine alone contained 81 percent of the total recoverable zinc produced in the State. Overall production was 49 percent above that in 1965.

REVIEW BY COUNTIES

Each of California's 58 counties reported production of one or more mineral commodities. However, output in eight counties—Fresno, Kern, Los Angeles, Orange, Riverside, San Bernardino, Santa Barbara, and Ventura—represented 78 percent of the total State mineral value in 1966. These eight counties yielded all the State's iodine and sodium sulfate; over 90 percent of its diatomite, iron ore, mica, natural gas liquids, and petroleum; and most of its boron compounds, calcium chloride, cement, gypsum, and sodium carbonate.

For certain commodities, all of the State's production came exclusively from a single county. All lignite came from Amador County, all molybdenum from Inyo County, all carbon dioxide and tin from Kern County, all optical grade calcite from Mono County, all feldspar from Monterey County, all wollastonite from Riverside County, all antimony, lithium and potassium salts, and rare-earth minerals from San Bernardino County, and all platinum from Yuba County. Information on these commodities, all reference to sand and gravel, stone, and volcanic cinder used in the construction industry, and clays used in making cement and heavy clay products, will be found in the "Review by Mineral Commodities" section and the commodity tables, and will not be repeated in the following review. Only those counties with significant additional production or activity will be discussed.

Alameda.—Salt was harvested from several thousand acres of evaporating ponds in the south San Francisco Bay area. The

Table 24.—Value of mineral production in California, by counties

County	1965	1966	Minerals produced in 1966 in order of value
Alameda	$22,775,728	$22,873,682	Sand and gravel, salt, stone, magnesium compounds, lime, bromine, clays.
Alpine	81,251	57,564	Sand and gravel, silver, gold, stone, zinc, lead, copper.
Amador	3,059,571	3,066,348	Sand and gravel, clays, coal, stone, soapstone.
Butte	3,620,599	3,555,712	Natural gas, sand and gravel, stone, gold, silver.
Calaveras	18,127,702	19,407,836	Cement, asbestos, stone, clays, sand and gravel.
Colusa	4,016,858	4,847,288	Natural gas, sand and gravel, mercury.
Contra Costa	11,639,527	17,766,749	Natural gas, stone, petroleum, sand and gravel, peat, clays, mercury.
Del Norte	470,525	504,941	Sand and gravel and stone.
El Dorado	2,617,346	2,638,668	Stone, lime, sand and gravel, soapstone, gold, silver.
Fresno	74,742,040	74,315,131	Petroleum, natural gas, sand and gravel, asbestos, natural gas liquids, stone, mercury, gold, clays, silver.
Glenn	5,419,879	6,078,993	Natural gas, sand and gravel, lime.
Humboldt	2,155,768	2,835,261	Sand and gravel, natural gas, stone.
Imperial	2,856,839	2,815,964	Gypsum, sand and gravel, lime, stone, clays, calcium chloride, mica, barite, gold, copper, silver.
Inyo	18,083,716	20,614,146	Tungsten, sodium carbonate, talc, stone, molybdenum, copper, lead, sand and gravel, silver, pumice and volcanic cinder, zinc, perlite, barite, boron, clays, gold, sulfur.

See footnotes at end of table.

Table 24.—Value of mineral production in California, by counties—Continued

County	1965	1966	Minerals produced in 1966 in order of value
Kern	$381,528,961	$426,956,114	Petroleum, boron, natural gas, cement, natural gas liquids, sand and gravel, stone, gypsum, sodium sulfate, clays, salt, mercury, carbon dioxide, pumicite, tin, tungsten, lead, silver, gold.
Kings	17,190,739	17,039,802	Natural gas, natural gas liquids, petroleum, mercury, sand and gravel.
Lake	817,742	1,046,879	Sand and gravel, pumicite and volcanic cinder, stone, clays, mercury, sulfur, gold, silver.
Lassen	W	622,691	Sand and gravel, volcanic cinder, stone, uranium.
Los Angeles	266,816,956	290,227,105	Petroleum, sand and gravel, natural gas, natural gas liquids, stone, clays, iodine, mica, gold, soapstone, silver.
Madera	1,558,545	2,158,321	Tungsten, natural gas, sand and gravel, stone, volcanic cinder, clays, copper, silver, gold.
Marin	3,169,924	2,973,252	Stone, sand and gravel, clays, mercury.
Mariposa	140,618	123,381	Sand and gravel, stone, gold, silver.
Mendocino	755,375	1,011,705	Sand and gravel, stone, mercury.
Merced	7,407,520	7,103,427	Stone, sand and gravel, gypsum, gold, silver.
Modoc	470,200	539,940	Sand and gravel, peat, volcanic cinder, clays, stone.
Mono	833,287	1,167,169	Pumice and volcanic cinder, sand and gravel, clays, pyrophyllite, calcite (optical grade), stone.
Monterey	r31,355,507	35,835,560	Petroleum, magnesium compounds, lime, sand and gravel, stone, natural gas, feldspar, salt, gold, silver.
Napa	2,068,284	3,841,656	Stone, clays, salt, mercury, diatomite, sand and gravel, volcanic cinder, perlite.
Nevada	798,640	354,726	Sand and gravel, gold, stone, silver.
Orange	113,560,571	121,413,023	Petroleum, sand and gravel, natural gas, natural gas liquids, clays, lime, salt, iodine, peat.
Placer	1,190,463	1,165,044	Sand and gravel, clays, stone, gold, silver.
Plumas	286,992	288,953	Sand and gravel, stone, gold.
Riverside	r56,434,608	67,046,753	Iron ore, cement, sand and gravel, stone, clays, gypsum, wollastonite, petroleum, copper, lead, uranium, zinc, gold, silver, natural gas.
Sacramento	21,751,206	21,199,899	Natural gas, sand and gravel, gold, clays, stone, silver.
San Benito	10,691,141	10,471,981	Cement, stone, mercury, asbestos, sand and gravel, petroleum, natural gas, clays.
San Bernardino	r112,596,522	112,604,458	Cement, boron, stone, sodium carbonate, potassium salts, sand and gravel, sodium sulfate, rare-earth minerals, salt, iron ore, lime, lithium minerals, calcium chloride, talc and pyrophyllite, clays, bromine, tungsten, petroleum, pumice and volcanic cinder, natural gas, gypsum, copper, silver, barite, lead, zinc, gold, antimony.
San Diego	11,799,776	12,811,989	Sand and gravel, stone, salt, magnesium compounds, clays, pyrophyllite, gold, silver.
San Francisco	W	W	Sand and gravel.
San Joaquin	17,169,039	14,932,952	Natural gas, sand and gravel, lime, clays, gold, silver.
San Luis Obispo	6,477,715	5,141,754	Petroleum, mercury, natural gas liquids, stone, sand and gravel, natural gas, gypsum, clays.
San Mateo	14,509,513	14,638,201	Cement, magnesium compounds, salt, stone, sand and gravel, clays, petroleum, natural gas.
Santa Barbara	126,012,581	126,309,266	Petroleum, diatomite, natural gas, natural gas liquids, sand and gravel, lime, mercury, stone.
Santa Clara	33,634,912	32,816,421	Cement, stone, sand and gravel, mercury, clays.
Santa Cruz	12,271,234	11,529,324	Cement, stone, sand and gravel, calys.
Shasta	7,733,039	8,921,723	Cement, sand and gravel, clays, volcanic cinder, barite, gold, diatomite, iron ore, silver.
Sierra	101,058	109,194	Sand and gravel, gold, stone, silver.
Siskiyou	799,497	1,164,864	Sand and gravel, pumice and volcanic cinder, stone, clays, gold, silver.
Solano	14,026,648	16,239,472	Natural gas, stone, sand and gravel.
Sonoma	5,551,505	5,257,405	Sand and gravel, mercury, stone, clays, natural gas.
Stanislaus	1,345,607	1,508,876	Sand and gravel, clays, lead, gold, silver, copper.
Sutter	13,275,844	14,429,138	Natural gas, stone, sand and gravel, clays.
Tehama	2,904,388	1,489,975	Natural gas, sand and gravel, stone, volcanic cinder.
Trinity	295,340	190,450	Sand and gravel, mercury, stone, gold, silver.
Tulare	3,303,002	2,842,214	Natural gas, sand and gravel, petroleum, stone, barite, clays, gold, silver.
Tuolumne	1,678,461	1,479,824	Stone, lime, gold, sand and gravel, diatomite, uranium, silver, zinc.
Ventura	104,321,786	107,501,291	Petroleum, natural gas, natural gas liquids, sand and gravel, clays, stone, gypsum.
Yolo	3,920,781	4,142,062	Sand and gravel, lime, natural gas.
Yuba	3,391,949	3,235,578	Gold, sand and gravel, stone, clays, platinum, silver.
Undistributed [1]	r11,683,175	[2] 6,091,905	
Total	1,597,298,000	1,699,359,000	

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

[1] Includes gem stones, mercury, lead, silver, zinc, tungsten, copper, gold, and uranium that cannot be assigned to specific counties and value indicated by symbol W.

[2] Includes petroleum condensate.

crude salt was processed in plants at Mt. Eden and Newark, and refined in two plants at Newark. Leslie Salt Co. supplied crude salt to the adjacent Morton Salt Co. refinery and sold salt-works bitterns to FMC Corp., which recovered magnesia and bromine from the liquor in a nearby plant. FMC quarried dolomite from a quarry outside the county, calcined it, and used it in the process. Byproduct gypsum was another plant product. Newark and Fremont gypsum products plants used crude gypsum from Nevada mines. An Emeryville plant made insulation, using purchased California-produced magnesia as a raw material. A chemical plant in Berkeley used magnesite obtained from a Nevada producer to make epsom salts. Pits in the Niles area supplied clay used in making floor and wall tile. An Alvarado sugar refinery calcined purchased limestone for use in the refining process. Basalt from the Leona quarry in Oakland and miscellaneous stone from quarries near Fremont, Hayward, Newark, and San Leandro was used chiefly for base material.

Open-hearth furnaces at Emeryville and Fremont were operated entirely on ferrous scrap.

Alpine.—Ore from the Zaca mine in the Monitor area was milled by the operator and the concentrate shipped to the Selby smelter for recovery of gold, silver, copper, lead and zinc.

Amador.—Pits in the Ione area were worked for sand used in manufacturing glass products and in foundries, and for clays, some of which were consumed in making mortar and refractories. Quarries near Volcano and Ione provided stone for riprap and roadstone. Soapstone was mined at the Lavina deposit near Sutter Creek and shipped to a grinding plant near Sacramento. A small tonnage of pumicite was mined near Buena Vista and used by the producer for lightweight aggregate.

Butte.—Natural gas production from the county's six dry-gas fields declined for the second consecutive year, dropping 12 percent from the 1965 figure.

Stream gravels were panned in the Cherokee, Butte Creek, and Oroville areas to recover placer gold and silver. Ore from the 3 Ravines lode claims in the Big Bar Mountain area was treated to recover small quantities of gold and silver.

Calaveras.—Calaveras Cement Co. produced portland cement in a wet process plant at San Andreas and shipped the output to customers in northern California and outside the State. Raw materials were obtained from pits and quarries near Burson and San Andreas. Limestone for cement, riprap, and roadstone came from two quarries in the San Andreas area. A quarry near Avery supplied dimension building stone, and one near Alta was a source for roofing granules. Pacific Asbestos Corp. produced groups 4, 5, 6, and 7 asbestos fibers at its mine and mill near Copperopolis. The plant products were used in cement pipe and sheet, and asphalt tile.

Colusa.—Natural gas production increased 9-percent and reversed the decline reported in 1965. A new gas discovery was made in the Moon Bend-Meridian field where two wells encountered gas in the Forbes formation. Withdrawals from these wells had not begun at yearend.

A few flasks of mercury were recovered by retorting ore mined from the Rathburn claims near Wilbur Springs.

Contra Costa.—Dry natural gas production increased more than fourfold above that of 1965. Most of the increase came from the Dutch Slough field where production from 28 wells began late in 1965. Oil output from the Brentwood field, the only oilfield in the county, dropped 26 percent and the associated wet gas was down 20 percent. Petroleum refineries operated at Martinez, Richmond, Avon, and Oleum. During the year, capacity of the Martinez refinery was more than doubled, and at the Richmond refinery hydrocracking and solvent-deasphalting units were added. The new refinery of Sequoia Refining Co. at Hercules was nearing completion and was expected to be on stream early in 1967. Sulfur recovery plants were operated at all except the Martinez refinery.

Stack gases of the Selby lead smelter were treated to recover sulfuric acid and liquid sulfur dioxide. A Pittsburg chemical plant produced thermal carbon black as a byproduct of hydrogen production. A Martinez Chemical plant reclaimed copper from solution residues and shipped the metal to an out-of-State smelter for recovery of copper, gold, lead, and silver.

Crude gypsum from Mexico was calcined at plants in Antioch and Richmond for use in making gypsum products. Byproduct gypsum, for agricultural use, was produced

in a phosphoric acid plant at Nichols. Sand from a pit near Cowell was prepared for foundry use. Sandstone was quarried near El Sobrante, Pacheco, and Richmond, and basalt near Orinda for riprap and aggregate.

Reed-sedge peat was dredged in the San Joaquin River delta and dried, shredded, and packaged for sale to garden supply firms.

El Dorado.—Limestone was quarried near Diamond Springs and Cool, principally for making lime, although some was sold to sugar refineries. The new lime plant at Cool sold its entire output for soil stabilization in highway construction. Output from the Diamond Springs lime plant was sold chiefly for construction, metallurgical, and chemical uses. A rhyolite quarry near Placerville supplied dimension building stone. Slate quarries near Chili Bar was used for roofing and flagstone, crushed for roofing granules, and ground for flour. Soapstone from the Shrub deposit near Shingle Springs was ground in the producer's San Francisco plant. Soapstone from a nearby property was ground by the producer for use in ceramics.

Small quantities of placer gold and silver were panned from stream gravels along the American River and its tributaries.

Fresno.—Crude oil production from the county's 29 oilfields was virtually unchanged from 1965. Increased outputs from fields in the Coalinga area were offset by corresponding decreases at fields in the Fresno area. Sixteen exploratory wells failed to find new production. Two processing plants extracted natural gas liquids from oil zone gas. Dry natural gas production from the Gill Ranch field declined slightly and withdrawals had not begun from the San Joaquin Northwest gasfield, discovered in 1965.

Atlas Minerals Corp. and Coalinga Asbestos Co. mined asbestos from deposits northwest of Coalinga and produced asbestos fiber (group 7 shorts) in milling plants near the mine sites. A Fresno perlite expansion plant was idle all year. Byproduct agricultural gypsum was produced in a phosphoric acid plant at Helm. Granite was quarried near Clovis and Sanger for architectural use and riprap.

Four sand and gravel washing plants on the San Joaquin River recovered byproduct placer gold and silver from stream and ancient riverbed gravels. Over 50 flasks of mercury were retorted from ore of the Ero Cucheo mine near the San Benito County line.

Glenn.—Dry natural gas production was nearly 8 percent below the 1965 figure. The Black Butte field, discovered in 1965, began producing in 1966. A new productive zone in Kione sandstone was discovered in the Rancho Capay field during the year.

A beet sugar refinery at Hamilton City purchased limestone and produced lime and carbon dioxide used in the refining process.

Humboldt.—Dry natural gas production from the Tompkins Hill (Eureka) field rose about 880 million cubic feet, up 42 percent from the 1965 level. A comparatively small quantity of dry gas also was withdrawn from the Table Bluff gasfield, discovered in 1960. The Grizzley Bluff gasfield, discovered in 1964, was still shut-in at yearend.

Imperial.—U.S. Gypsum Co. mined crude gypsum from the Fish Creek Mountain deposit and calcined it in the company's Plaster City gypsum products plant. The Carlton beet-sugar refinery purchased limestone to produce lime and carbon dioxide used in the refining process. Cal-Min Co. mined bentonite near Brawley and prepared it for use as a filler in animal feeds. Organic Mineral Sales, Inc., mined barite from the White Swan deposit near Blythe and shipped it to the company grinding plant in San Diego County. Chloride Products, Inc., recovered calcium chloride from hot well brines near Calipatria, and sold the material in liquid form. Decomposed granite was quarried near Ocotillo and used for road base.

Ore from the Calcite and Big Chief claims near Mesquite was treated to recover a few ounces of gold. Copper ore from an unidentified property in the Cargo Muchacho Mountains was shipped to an out-of-State smelter for recovery of copper, gold, and silver.

Inyo.—The Pine Creek tungsten mine of Union Carbide Corp. was the source of all the molybdenum produced in the State, a high percentage of the copper and tungsten, and a notable quantity of the recoverable silver. Lead ores from the Santa Rosa mine near Keeler and the Jubilee and Queen of Sheba mines, together with lead-

zinc ore from the Columbia mine in the Shoshone area, yielded most of the recoverable lead, zinc, and silver. Small quantities of gold and silver were recovered in treating ores from three gold properties and one silver property.

Pittsburgh Plate Glass Co. recovered soda ash and sodium sesquicarbonate from brines of Owens Lake in a plant at Bartlett. Kern County Land Co. mined colemanite and U.S. Borax & Chemical Corp mined both colemanite and ulexite from deposits north of Shoshone and shipped to refineries outside the county. Talc production was reported from 11 mines in 1966. Output from the Warm Springs deposit of Grantham Mines was more than from all others combined. Talc from this mine was shipped to grinders in southern California, Nebraska, and Mexico. Talc also was ground in plants at Keeler and Laws.

Limestone was quarried near Searles Lake by Stauffer Chemical Co. and trucked to the company processing plant in San Bernardino County. Marble from the Premier quarry near Lone Pine was prepared for roofing granules, terrazzo, decorative rock, ceramic filler, and other building trades uses. Some quartzite was quarried in the same area and sold for use in making silica brick. Pumice from a deposit near Coso Junction and volcanic cinder from one near Little Lake were used for concrete aggregate. Perlite was obtained from the Fish Springs quarry near Zurich and expanded in a plant outside the county. The Calearth and Jones deposits near Olancha yielded fuller's earth that was prepared for use as a carrier in insecticides and a clarifier for mineral and vegetable oils. Bentonite mined at deposits near Tecopa and Death Valley was prepared for various filler uses and was used untreated in reservoir linings. The Gunter Canyon barite mine near Laws was the source for crude barite shipped to a grinding plant in Kern County.

Kern.—Kern County led all others in production of petroleum and natural gas. Oil production rose 9 percent, to 330,000 barrels daily. Most of the increase resulted from steam stimulation projects in heavy-gravity oilfields, particularly the Kern River and Midway-Sunset fields where production increased, respectively, 16,000 and 9,000 barrels daily. Output of light-gravity oil from the Cymric field was up 41 percent; that from the McKittrick field was up 38 percent. A total of 168 exploratory wells was drilled, resulting in the discovery of one oilfield (Seventh Standard), and five new pools in older fields. Eight oil refineries, all in the Bakersfield area, operated at near capacity throughout the year and no additions or changes were reported. Oil-zone gas production rose 34 percent, and production from the county's 22 dry gasfields was up 48 percent. Slightly more wet gas was processed in the 18 processing plants in the county, and more liquified petroleum gas was recovered, but less natural gasoline and cycle products were produced than in 1965.

U.S. Borax & Chemical Corp. mined crude borates from its open-pit Boron mine and refined or partially refined them in the adjacent company plant. Some partially refined products were shipped to the company refinery in Los Angeles County for final processing. The Boron plant also processed crude borates from the producer's Inyo County mines, and produced sodium sulfate as a byproduct of boron refining. Plant products were shipped to domestic and foreign customers. California Portland Cement Co., at Mojave, and Monolith Portland Cement Co., at Monolith, produced cement in dry- and wet-process plants, respectively. Limestone and quartz used in the processes were obtained from quarries near the plant sites. Clays were purchased for use in the Mojave plant and mined from company-owned pits for the Monolith plant. Some cement was bagged but most shipments were made in bulk, principally to ready-mixed concrete plants in California and Nevada. Crude gypsum was mined near Lost Hills, McKittrick, and Taft, chiefly for agricultural use, although some was used in making cement.

Pits in the McKittrick area yielded clays used in oilwell drilling muds and as absorbants; clays from the Cantil area were used in making stone ware. Solar-evaporated salt was harvested from Koehn dry lake by Western Salt Co. and processed in the Saltdale plant. Pumicite from the Calsilco property north of Saltdale was used as fill and prepared for absorbant use, concrete admixture, and scouring agent. Limestone was quarried by Chas. Pfizer & Co. and prepared for metallurgical flux, poultry grit, and roofing granules. Near Rosamond,

varicolored quartz was quarried for decorative aggregate, and rhyolite from the same area was used for roofing granules.

Both furnace and retort were used to recover mercury from ore of the Techachepi mine. Tungsten ores from the Gwyne and Locarno mines near Claraville, and the Last Hope near Mojave, were milled and the concentrates sold to an Inyo County buyer. The Whitmore lode property near Mojave yielded silver ore that also contained recoverable lead. A few ounces of lode gold was recovered in treating ores from prospects in the Mojave and Clear Creek areas.

Kings.—Petroleum production declined slightly from 1965 but natural gas output, wet and dry, rose 15 and 8 percent, respectively. Eleven exploratory wells were drilled during the year, but no discoveries were made. The Hanford oil refinery of Caminol Oil Co., Kings County's only refinery, operated below capacity throughout the year. Less oil-zone gas was processed in the county's three natural gas liquids plants, yielding less natural gasoline but more liquified petroleum gas.

Atlas Minerals Corp. installed a furnace at the Little King property near Parkfield and recovered a substantial quantity of mercury from the ore. Mercury also was recovered by retorting ore from the Dawson mine in the same area.

Lake.—Volcanic cinder was mined from deposits near Clearlake Highlands and Clearlake Oaks. About half the material was used as concrete aggregate; the remainder was sold for landscaping. Shale was mined from a quarry near Kelseyville and sold for use as lightweight aggregate and in other building products.

Ores from four mercury mines were retorted to recover the metal, but only the Konocti near Kelseyville produced more than 10 flasks. Cleanup operations at the Wall Street mine near Middletown yielded small quantities of lode gold and silver.

Los Angeles.—Petroleum production increased 13 percent over that of 1965, principally because of development in the Wilmington field (east area) where 73 new slant wells were drilled from piers and offshore islands. By yearend Wilmington field had surpassed East Texas to become the largest oilfield in the United States, yielding about 144,000 barrels daily. Natural gas from oil zones rose nearly 3 percent while production from dry-gas fields dropped 22 percent. Natural gas liquids plants processed less wet gas and plant products were down 5 percent from the 1965 level. The drilling of 14 exploratory wells resulted in the discovery of one new oilfield (Venice Beach), and an extension of the El Segundo oilfield.

Silica sand was obtained from a pit near El Segundo and prepared for foundry, blast, and engine use. Dimension building stone was quarried near Palos Verdes and Saugus. A quarry near Oxnard yielded sandstone for riprap. Also, large tonnages of stone for riprap were obtained from two quarries on Santa Catalina Island and barged to the mainland for use in harbor and shoreline protection. Decomposed granite for base material was obtained at a half-dozen locations in the county. Crude gypsum was calcined at three plants. A plant at South Gate received crude ore from a Nevada mine, and two plants in the Long Beach area used crude gypsum from Mexico. A fourth plant, at Santa Fe Springs, produced wallboard only, and received calcined gypsum from a company plant in Imperial County. The Katz quarry in the San Fernando area was the source for shale processed for use as a carrier in dry insecticides. Soapstone was mined from a deposit in Sierra Paloma Valley and shipped to a Los Angeles grinding plant. Five plants in the county ground talc and soapstone received from California and Nevada producers. Seven plants in the Los Angeles area expanded perlite obtained from California and out-of-State producers. A Harbor City grinding plant processed crude barite from a Nevada mine for use in oil-well drilling muds.

Two sand and gravel washing plant on the San Gabriel River channel recovered byproduct placer gold and silver in preparing ancient riverbed gravels for construction uses.

Madera.—Dry natural gas production was chiefly from the Gill Ranch field and the yield from five wells in the Moffat Ranch field was nearly double that in 1965. However, overall output dropped 22 percent.

The Strawberry tungsten mine (idle in 1965) of New Idria Mining & Chemical Co.

near Bass Lake yielded nearly 700,000 pounds of concentrate that was sold to various customers. Two other tungsten properties were active and concentrates were shipped to the Inyo County plant of Union Carbide Corp. Silver ore from a mine at an unidentified location was shipped to an Arizona smelter for recovery of silver and copper. A sand and gravel operation in the Grub Gulch area recovered a few ounces of byproduct placer gold and silver.

Dimension granite was quarried near Raymond for building and monument use. Volcanic ash was obtained from the Taylor deposit near Belleview and prepared for use as a diluent in insecticides. A pit near Madera yielded a clay used in making adobe brick.

Marin.—Ores from the Corda prospect and the Gambonini mine near Marshall were retorted to recover a total of more than 100 flasks of mercury.

In the San Rafael area, shale was quarried for use as lightweight aggregate and sandstone for riprap and concrete aggregate. Basalt from a quarry near Novato also was prepared for aggregate use.

Mariposa.—Slate was produced at several quarries near Mariposa for flagging, and in blocks and slabs for milling. Dimension building stone was quarried near Coulterville.

Three gold properties in the Mother Lode area yielded ores that were treated to recover gold and silver. A sand and gravel plant in the same area washed old tailing and recovered some byproduct placer gold.

Mendocino.—Ore from the Chew-Janusz mercury property near Hopland was retorted and a few flasks of the metal recovered.

Merced.—Gypsite was mined near Los Banos for agricultural use.

Byproduct placer gold and silver were recovered in two sand and gravel washing plants on the Merced River.

Modoc.—Peat moss from a Jess Valley bog was prepared for sale as a soil conditioner.

Crews and contractors for State and County road agencies mined volcanic cinder for maintenance and repair use. The U.S. Forest Service sold several thousand tons of the material for use as concrete aggregate. Pumice from the Free deposit near Glass Mountain was prepared for lightweight aggregate. The Forest Service also mined over 4,000 tons of clay and used the material in flood control projects.

Mono.—Pumice was mined from four deposits. Material from one deposit near Lee Vining was sold for landscaping use; that from a second deposit was prepared for abrasive uses. Pumice from the Cowan property near Benton was used for concrete aggregate and that from the Boyd deposit near Chalfant for an abrasive, an aggregate in plaster, and an ingredient in sweeping compounds. The U.S. Forest Service sold and used volcanic cinder for concrete aggregate.

Kaolin was mined from the Hat Creek deposit in the Casa Diablo area and prepared for use in plaster. Pyrophyllite from the Pacific mine near White Mountain was ground in the producer's plant at Laws, Inyo County.

Monterey.—Crude oil production rose 37 percent from that of 1965, principally as the result of thermal recovery operations, both steam injection and in situ combustion, in the San Ardo field. Natural gas output, from oil zones, increased slightly. Ten exploratory wells were drilled during the year, but no discoveries were made.

Dolomite was quarried and upgraded at Natividad to produce dead-burned dolomite for use in steel furnaces, and calcined dolomite for a magnesia plant at Moss Landing. Some crushed dolomite was sold to glass and fertilizer manufacturers, and for roofing granules. A sugar refinery at Spreckles purchased limestone and produced lime and carbon dioxide used in the refining process. Industrial sands were produced from beach and dune deposits near Castroville, Marina, and Pacific Grove for glass, foundry, ceramic, blast, and filtration uses. Crude salt was harvested from solar evaporating ponds and sold to local customers. A King City asbestos fiber mill operated on ore received from the producer's San Benito County mine. Decomposed granite was quarried near Carmel Valley, Pebble Beach, and Salinas for use as base material.

Gold ore mined from the Mariposa prospect near Los Burros was treated to recover small quantities of gold and silver. Mercury properties in the Parkfield area were idle throughout the year.

Napa.—Leslie Salt Co. harvested crude salt from solar evaporating ponds along San Pablo Bay. Shale was quarried near Oakville and expanded in a Napa plant. The plant also prepared a pozzolan for cement, using diatomaceous silica from a deposit near Napa. The Phoenix asbestos mine and plant, in the Napa area, were shut down indefinitely. Volcanic ash from the Pearl deposit in the McGeorge area was used for concrete aggregate and sold for use as a soil conditioner. Dimension building stone was quarried near St. Helena and a basalt quarry near Napa was a source for riprap and aggregate. A small tonnage of crude perlite from the Alvo mine was expanded in the adjacent plant near St. Helena and used by the producer for plaster aggregate.

Mercury was recovered from ores and dump material at seven mines in the county, and by three operators who worked the James Creek gravels to recover metal washed down from the old Oat Hill operation. Only four mines—Aetna, Corona, Knoxville, and Oat Hill—yielded more than 15 flasks each of mercury. The Knoxville was the major producer with more than 275 flasks.

Nevada.—Lode gold production was virtually limited to that recovered in cleanup operations and the treatment of old tailings at the Ancho Erie, Empire, and New Brunswick groups of claims. Several placer properties were active in 1966, a dragline dredging operation in the French Corral area, a drift mine in the Washington area, and a number of sluicing operations. However, most of the placer gold and silver was recovered by individuals who panned stream gravels.

Orange.—Petroleum production rose 10 percent from that of 1965 with much of the increase resulting from new drilling and from waterflood operations in the Huntington Beach field. Production was up 150 percent in the Belmont offshore field where 23 new wells were completed. One zone in the Belmont yielded dry natural gas and represented the first dry-gas production in the county. Production of oil-zone gas also increased significantly. The volume of wet gas processed in the county's five natural gas liquids plants was essentially the same as in 1965. Four exploratory wells were drilled but no new oil or gas reserves were discovered.

Two producers mined sand-clay mixtures, one in Trabucco Canyon and the other in the El Toro area, primarily for foundry ganister. Both producers also sold washed kaolin and sand products. Some silica sand was sold for use in cement. Shale was mined and expanded for lightweight aggregate near San Clemente. Near Dyer, a sugar refinery purchased limestone and produced lime and carbon dioxide used in processing. Western Salt Co. harvested crude salt from solar evaporating ponds at Corona Del Mar and sold it locally, chiefly to water-softener service companies. Peat humus from a Huntington Beach pit was sold for soil conditioning.

Placer.—Industrial sand was prepared at a Bear River deposit near Auburn and sold for blast, foundry, engine, and filter uses. Dimension granite was quarried near Rocklin for building stone and monuments. A lesser tonnage was crushed for roofing granules.

Gold ores from the Bowman (Butcher Ranch) and one unidentified property were treated to recover gold and silver. Ancient riverbed and stream gravels were worked at four placer properties in the Colfax and Iowa Hill areas to recover a few ounces of gold and silver. All other placer gold and silver was recovered by individuals who panned stream gravels along the American River and its tributaries.

Riverside.—Iron-ore production at the Eagle Mountain mine of Kaiser Steel Corp. was 30 percent above that in 1965. The pelletizing plant completed its first full year of operation. Shipments to the producer's steel furnaces in San Bernardino County were lower, but exports rose 72 percent. Ore from the Bryan gold mine was smelted to recover gold, silver, lead, and zinc. Old tailings were treated at the Hoag gold mine and small quantities of gold and silver recovered. Treatment of ore from the Jubilo silver prospect yielded a few ounces of silver and copper precipitates were recovered from a few tons of material at the Silver Bell property.

American Cement Corp. produced gray and white portland cements at Crestmore using limestone from a nearby underground quarry and sand and clay from pits near Corona and Riverside as raw materials. Some Corona sand also was sold for use in making glass. Quartzite was quarried near Whitewater for building stone

and landscape rock, and granite near Corona, Homeland, and Riverside for riprap and base material. Miscellaneous stone from a Temescal Canyon quarry was prepared for roofing granules and concrete aggregate. Crude gypsum was mined and calcined at Midland for use in plaster and wallboard products.

Petroleum production from the Prado Dam field continued its decline but production from the new Prado Corona field raised the total yield 7,000 barrels above that in 1965. Oil-zone gas from these fields was marketed in 1966 but not in 1965.

Sacramento.—Dry natural gas production was 10 percent above that in 1965 and Sacramento returned to third place among the dry-gas producing counties. Four exploratory wells were drilled and one new productive zone was discovered in Hamilton Sandstone. The discovery was in the Sherman Island field but no withdrawals from the zone were reported by yearend.

Metal production was limited to byproduct placer gold and silver recovered at sand and gravel washing plants on the American River, and to recoveries made by individuals who panned stream gravels n the same areas.

Clays were mined in the Ione area and used in mortar, filler in fertilizers, and as a carrier in insecticides.

San Benito.—Ideal Cement Co. produced portland cement in a plant at San Juan Bautista using limestone from a nearby quarry and shale from a deposit in Santa Cruz County as raw materials. The plant also ground clinker from a company facility in San Mateo County to meet customer demands. Dolomite was quarried near Hollister by FMC Corp. for use in the company magnesia plant in Alameda County. The State's largest granite quarry, at Logan, was a source for riprap, concrete aggregate, roadstone, and railroad ballast.

Asbestos ore was mined south of Idria and processed in the producer's plant in Monterey County. In the same area, bentonite was mined from the Lewis pit and prepared for foundry use, and as a carrier in insecticides, a component in well-drilling muds, and a water seal in reservoirs. Some was pelletized for absorbent use.

Of the nine active mercury mines and prospects, only New Idria and North Star had yields exceeding 20 flasks of the metal. Four of the nine, including New Idria and North Star, used furnaces to recover the mercury. The other five used retorts. The New Idria mine continued to be the Nation's largest mercury producer.

The county's three oilfields yielded slightly less crude oil than in 1965, and dry natural gas production declined virtually to insignificance.

San Bernardino.—Four portland cement plants—at Colton, Cushenbury, Oro Grande, and Victorville—were in operation, representing a combined annual capacity of nearly 24 million barrels by yearend. All producers worked company-owned quarries for limestone and all except the Victorville plant obtained silica and clay or shale for cement needs from company deposits. The Victorville plant purchased its clay and silica requirements. A lime plant in Lucerne Valley produced a variety of lime products for construction, chemical, and other industrial uses. Limestone also was quarried near Colton for glass and poultry grit, in Lucerne Valley for glass, flux, and filler uses, and near San Bernardino for landscape rock, roofing granules, and concrete aggregate. Quarries near Colton, Ponoma, Big Bear Lake, and Wrightwood were sources for decomposed granite used as base material. Quartzite from an Oro Grande quarry was used in making rock wool and for aggregate. Quartz quarries near Big Bear Lake, Hinkley, and Bryman supplied stone for building and decorative uses, exposed aggregate, and industrial fillers. Some dimension building stone was quarried near Baker and stone from a Barstow quarry was used for roofing granules.

Searles Lake brines were processed by American Potash & Chemical Corp., at Trona, and by Stauffer Chemical Co., at Westend, to extract boron and sodium compounds, lithium and potassium salts, and bromine. Stauffer also operated a lime kiln at Westend using limestone from Inyo County. Solar evaporated salt was harvested at Searles Lake and at Danby and Bristol (dry) lakes. Solar salt harvested near Rice was used for water softening purposes by Metropolitan Water District of Southern California. Rock salt also was mined in the Bristol Lake area near Amboy.

Iron-ore production at the Iron Age mine near Twenty-nine Palms increased 8 percent over that in 1965. Shipments of lump ore to steel plants were lower but

those of fines to cement plants rose appreciably. Production of lump iron ore by Kaiser Steel Corp. from the Silver Lake mine near Baker dropped noticeably, but shipments, including those from stockpile, were only slightly lower. Relatively small tonnages of gold, silver, copper, and lead ores were mined and shipped from mines and prospects in the Whipple Mountain, Randsburg, Monumental Peak, Clark Mountain, and Kelso areas. The value of all precious and base metal production was less than $20,000. A few ounces of placer gold and silver were panned from stream gravels in the Belleville area.

Clays from deposits in the Ivanpah area were used in making whiteware and floor and wall tile, and to a lesser extent, as a fine polishing agent. Bentonite was produced at the Honey Brown property near Vidal for use as a filler in animal feeds. Shale was obtained from the Pavolite pit near Chino and expanded for lightweight aggregate. Four companies worked nine talc deposits in the county and produced nearly one-fourth the State's talc output. In all instances, the talc was shipped to the producers' grinding plants in Los Angeles County. The Victorite pyrophyllite deposit was idle but shipments were made from stockpile to a Victorville grinding plant. Gypsum was mined in the Victorville area and sold locally for agricultural use. Crude barite was mined and shipped from the Leviathan mine near Calico to a Kern County grinding plant. Volcanic cinder from the Aiken Cinder Cone near Cima was used as lightweight aggregate, and pumice from the Williams Bros. deposit in the Opal Mountain area was prepared for sale as a soil conditioner.

Relatively small quantities of petroleum and oil-zone natural gas were produced from two fields near the Orange County line. Output from these fields had been declining for several years.

San Diego.—Silica sand from a deposit near Oceanside was prepared for use in glass and stucco, as molding and blast sand in foundries, and for various other industrial uses. Granite was quarried near Escondido and Vista for architectural stone, monuments, and surface plates. Granite from quarries near Carlsbad, Lakeside, and San Marcos was used for riprap and base material. Quartz was quarried near Campo for decorative building stone, and miscellaneous stone near San Diego for riprap and aggregate.

Solar-evaporated salt was harvested from ponds at South Bay and processed in a Chula Vista plant for sale locally. Saltworks bitterns were sold to a nearby plant for extraction of magnesium chloride. Pyrophyllite was mined from three deposits in the San Dieguito area; output from the Four Gee mine was shipped to a Los Angeles Chemical plant, that from the Harborlite (Harris) property was ground by the producer for use in insecticides, and that from the Kaolinite (Pioneer) deposit was stockpiled. The owner of the Harborlite property also expanded perlite received from out-of-State producers.

Stream gravels were panned in the Campo area to recover small quantities of placer gold and silver.

San Joaquin.—Natural gas production declined 19 percent from that of 1965, dropping the county from first to fifth among the dry-gas producing counties. Drilling of 16 exploratory wells in 1966 resulted in the discovery of 2 new pools in older fields.

Sugar refineries at Manteca and Tracy purchased limestone to produce lime and carbon dioxide used in the refining process. Byproduct gypsum recovered in the manufacture of phosphoric acid at a Lathrop fertilizer plant was sold for agricultural use.

Byproduct placer gold and silver were recovered at a sand and gravel washing plant working stream gravel on the Mokelumne River near Clements.

San Luis Obispo.—Crude oil production declined 5 percent from 1965 levels and natural gas from oil zones dropped 18 percent. Although 3 percent more gas was processed in the county's only processing plant at the Russell Ranch field, the output of natural gas liquids was 4 percent less. A sulfur recovery plant was operated in conjunction with the county's lone oil refinery. Exploratory drilling consisted of six wells, all dry holes. The Meridian Anticline field, discovered late in 1965 as a gas producer, became an oil producer in August 1966.

Six mercury properties were active in 1966 but only the Buena Vista and The Klau yielded more than 30 flasks of metal. Ore from the underground Buena Vista

mine was furnaced; all other operators used retorts to recover the metal.

Industrial sand mined near Oceano was processed principally for foundry use. Limestone was quarried near Adelaide and sold to sugar refineries or for agricultural use. Dimension building stone and stone for decorative uses were quarried near Paso Robles and Cambria. Gypsite was mined near Simmler and sold for agricultural use.

San Mateo.—Ideal Cement Co., at Redwood City the only cement plant in California located on a navigable waterway, used oystershell and clay dredged from the bay as raw materials. At yearend the company had completed new storage silos as a part of its 6-million-barrel-per-year expansion program. Two other companies dredged oystershell from the bay and sold the washed shell for use as poultry grit, filler in animal feeds, and soil additive. Limestone was quarried at Rockaway Beach, sandstone near Brisbane, and basalt near Woodside for concrete aggregate, roadstone, and base material.

Magnesia was extracted from seawater by Merck & Co., Inc., in a South San Francisco Plant, using a purchased dolomite-limestone mixture as a precipitant. Solar-evaporated salt was harvested from ponds that extended into Alameda and Santa Clara Counties. The crude salt was prepared for shipment, principally export, in a bayside Redwood City plant. Gypsum was imported from Mexico and stockpiled at Redwood City for use by the cement and agricultural industries.

Less than 40,000 barrels of crude oil was produced, down 11 percent from that of 1965. The volume of oil-zone gas obtained with the oil was virtually insignificant.

Santa Barbara.—Petroleum production remained essentially the same as in 1965 but outputs of oil-zone and dry natural gas rose significantly. The new Carpinteria offshore oilfield yielded nearly 1 million barrels of crude oil and 500 million cubic feet of gas. Dry-gas production from offshore fields, principally the Molino, contributed appreciably to the 10-percent total gas increase. The county's six natural gas liquids plants processed 15 percent more wet gas than in 1965 resulting in a 10-percent increase in plant products recovered. Drilling of 19 exploratory wells resulted in the discovery of two new oilfields and two new productive zones in older fields.

Most of the California diatomite production, and a high percentage of the U.S. output, came from three operations in Santa Barbara County, two near Lompoc and one near Santa Maria. A fourth producer, in the Lompoc area, mined and processed diatomite for specialty products. A Betteravia sugar refinery calcined purchased limestone for lime and carbon dioxide used in the refining process. Limestone also was quarried near Lompoc for riprap. Sandstone quarried near Goleta and Carpinteria was used for building stone and riprap. Decorative building stone was obtained from quarries near Santa Maria, Lompoc, and Guadalupe.

Only two mercury mines were active in 1966. Ore from the Gibralter mine in the Los Prietos area was furnaced to recover over 500 flasks of mercury while ore from the Red Lion property, Cachuma area, was retorted and a much smaller quantity of the metal recovered.

Santa Clara.—Kaiser Cement & Gypsum Corp. operated the State's largest producing cement plant at Permanente. The producer obtained limestone from a nearby quarry, and sold some of the stone to local contractors for a variety of uses. Sandstone was quarried near Los Gatos and used for base material. Aggregate and base material came from quarries near San Jose, Los Altos, Palo Alto, and Gilroy.

Lessees worked various sections of the New Alamaden mine to produce more than half the mercury output in the county. San Jose Mining Co. was by far the major producer, and was the only lessee using a furnace to recover the metal. The Guadalupe and Last Chance were the only other producing properties. The former used both a furnace and retorts while the latter used only retorts in recovering the mercury.

Santa Cruz.—Lone Star Cement Corp. (Pacific Cement & Aggregates Division) produced portland cement at Davenport, using limestone and shale from nearby quarries. Shale also was produced at the Chittenden quarry for use by a San Benito County cement producer. Limestone also was quarried near Santa Cruz for agricultural use, building stone, poultry grit, and filler in animal feeds. Granite was obtained from quarries near Felton and Soquel for aggregate and base material.

Shasta.—Calaveras Cement Co. produced

portland cement in a plant near Redding, using shale and limestone from nearby quarries as raw materials. The limestone was delivered to the plant by a 1.5-mile-long covered belt conveyor. Some of the limestone was sold to sugar refineries. Over 30,000 tons of volcanic cinder was mined for use by State and Federal agencies in road surfacing, maintenance, and ice control. Cinder from the H&H Ranch near Glenburn and the Sanford property near Fall River Mills was used for the same purpose. A lesser tonnage of the Sanford material was sold for landscaping rock. Volcanic cinder (scoria) from the Black Butte deposit near Manton was prepared for sale as lightweight aggregate. Crude barite was mined near Castella and shipped to the producer's Sutter County grinding plant. Diatomite was obtained from a deposit on the Pit River and used as a filler in fertilizer.

Iron ore was shipped from stockpile at the Iron Mountain mine to a domestic steel plant. Gold ore from two prospects in the French Gulch area was treated to recover a few ounces of lode gold. A sand and gravel washing plant near Redding recovered byproduct placer gold and silver in working ancient riverbed gravels. Additional recoveries were made by individuals who panned stream gravels on Coltonwood Creek, and in the French Gulch, Redding, and Shasta areas.

Sierra.—Six lode gold mines reported yields of gold and silver but only the Original 16 to 1 mine at Alleghany (from ore mined in a previous year) produced a significant quantity. Cleanup operations and treatment of old tailings at idle properties also accounted for a few ounces of lode gold and silver. Except for one drift mine, using sluices, and a suction dredge in the Alleghany area, all placer gold and silver was recovered by individuals who panned stream gravels in the Alleghany and Downieville areas.

Siskiyou.—Over 90,000 tons of volcanic cinder was mined and used by county, State, and Federal agencies and their contractors, for concrete aggregate. Additionally, more than 50,000 tons was used in road maintenance and repair, and nearly 24,000 tons by railroads for ballast. Only a small tonnage was used for other purposes, chiefly landscaping rock. The U.S. Forest Service reported that 70,000 tons of clay was mined in the Klamath National Forest for a variety of uses, including flood control projects and for fill.

Stream and bench gravels on Humbug Creek and the Klamath and Salmon Rivers were worked to recover placer gold and silver but only one operation, a dragline on Humbug Creek, recovered a significant quantity of the metals.

Solano.—Natural gas production rose 13 percent above that of 1965, placing Solano second among the dry-gas producing counties. Exploratory drilling totaled 19 wells and resulted in the discovery of two new gas producing zones—the Starkey Sandstone in the Denverton Creek field and the Martinez Formation in the Rio Vista field. At yearend no withdrawals had been made from either discovery.

Limestone was quarried near Fairfield for rubble and terrazzo chips. Basalt and miscellaneous stone was obtained from quarries near Benecia and Cordelia for riprap and aggregate.

Sonoma.—Production was reported from 10 mercury mines and prospects in 1966 but only the Mt. Jackson and Socrates mines yielded more than 30 flasks each. Ore from the Mt. Jackson mine was furnaced; all other ores were retorted. The Culver Bear property was worked by two operators, in different sections of the mine.

Dimension stone and flagging were produced from a sandstone quarry near Glen Ellen, and basalt for aggregate from quarries near Petaluma and Forestville. Base material was quarried near Cotati and Occidental.

A small volume of natural gas was withdrawn from the Petaluma dry-gas field. The output dropped 18 percent from that in 1965.

Stanislaus.—Ball clay was mined on the Rodden property near Knights Ferry and sold for use in making whiteware. Clay from a pit near Cooperstown was used in compounding well-drilling muds.

Cleanup operations at an unidentified lead mine yielded material shipped to a Montana smelter for recovery of lead, silver, and copper. Byproduct placer gold and silver were recovered from stream and ancient riverbed gravels in a sand and gravel washing plant on the Stanislaus River.

Sutter.—An 11-percent increase in natural gas production over the 1965 figure

moved Sutter into first place among the dry-gas producing counties. Two fields, Grimes and Sutter Butte, yielded 95 percent of the county output.

A custom grinding plant for nonmetallic minerals operated at Sutter.

Tehama.—Natural gas production was 75 percent above that in 1965, and was credited principally to the Rice Creek field. Of the eight exploratory wells drilled in 1966, one encountered a new productive zone in the Rice Creek field, the Kione zone of Cretaceous age.

Crews of the California Division of Highways mined and used 10,000 tons of volcanic cinder in road construction, maintenance, and repair.

Trinity.—Ore from the Altoona mine in the Castle Creek area was furnaced to yield over 100 flasks of mercury. Ores from a gold-silver property in the Trinity River area and from two gold mines in the Hayfork area were treated to recover gold and silver. Only the Kelley mine in the latter area yielded more than a few ounces of bullion. Stream gravels in the Lewiston and Trinity areas were panned by individuals who recovered small quantities of placer gold and silver.

Stone was quarried at Island Mountain for riprap and railroad ballast.

Tulare.—Natural gas production was 18 percent above that of 1965 but petroleum output was slightly lower. The Trico gasfield and the Deer Creek oilfield yielded all the county's natural gas and crude oil.

Crude barite was mined from the Baro claims and Embree property in the Bald Mountain area, and from the Barite King mine in Nine Mile Canyon. The latter material was stockpiled; that from the Baro and Embree was shipped to a Kern County grinding plant. Limestone was quarried near Porterville for use as mineral filler in animal feeds and for poultry grit, and near Orosi for dimension building stone.

Byproduct placer gold and silver was recovered from stream gravels in a sand and gravel washing plant on the Tule River.

Tuolumne.—The Flintkote Co. quarried limestone from open and underground quarries in the Columbia-Sonora area. Most of the stone was converted to lime in the company's Sonora plant but some was sold to sugar refiners, processors of animal feeds, water treatment and magnesia plants, petroleum refineries, and other industries. Marble was quarried in the Sonora area for terrazzo and exposed aggregate, and miscellaneous stone near Twain Harte was mined for drain rock and concrete aggregate. Diatomite was mined from a deposit near Keystone and sold for lightweight aggregate.

Ores from three gold properties were treated to recover gold and silver but only the ore from the Golden Star in the East Belt area, which was smelted, yielded more than a few ounces of the metals. A few ounces of placer gold was recovered by individuals who panned stream gravels.

Ventura.—Crude oil production declined 6 percent from 1965 despite two new discoveries—the Big Mountain field and a new pool in the Tar Creek-Topa Topa field. The new discoveries were not in production until December. Oil-zone natural gas output also was lower, by 12 percent. Dry natural gas production declined almost to insignificance. The volume of wet gas treated in the county's 10 natural gas liquids plants was 9 percent less and the quantities of plant products produced dropped 6 percent.

Shale was quarried near Frazier Park and Ventura. In both instances the material was expanded by the producer for lightweight aggregate. Limestone was quarried near Santa Susana for animal feed, fertilizer filler, and poultry grit. Sandstone from quarries near Camarillo and Oxnard was used for riprap. Industrial sands obtained from pits in the Santa Paula and Oxnard areas were prepared for sandblasting and filtration uses. Gypsum was mined near Maricopa for use in the producer's Kern County cement plant as a retarder.

Yolo.—Dry natural gas production rose 37 percent from that in 1966. Six exploratory wells were drilled during the year, resulting in two new gas discoveries—a new formation in the Clarksburg field and a new field, the Merritt Island in the Winters formation. No withdrawals had been reported from either discovery by yearend.

Limestone was purchased by sugar refineries at Clarksburg and Woodland and calcined to produce lime and carbon dioxide used in the refining process.

Yuba.—Yuba Consolidated Gold Fields operated three bucket-line dredges on the

Yuba River near Marysville and recovered a high percentage of the State's placer gold and silver, and all of the platinum group metals. Other producers of placer gold and silver were the Good Luck "7" Mining Co. operation (nonfloat washing plant) near Challenge, and individuals who panned stream gravels in the Dobbins (Indian Ranch) area.

Old dredge tailings were the source for large tonnages of sand and gravel used in Yuba and Sutter Counties. Some industrial sands were obtained from pits near Marysville and sold locally.

The Mineral Industry of Colorado

By Carl L. Bieniewski [1] and William C. Henkes [2]

Mineral production in Colorado in 1966 was valued at $352 million, a record for the State; the previous high was $346.2 million in 1961. The total value increased $20.8 million above that of 1965, primarily because of substantial increases in molybdenum and stone production. Colorado continued to be the leading State in the Nation for the production of molybdenum, tin, and vanadium. Record outputs were reported for iron ore, molybdenum, sand and gravel, stone, and tin. Coal production, on the rise since 1962, surpassed the 5-million-ton mark for the first time since 1948.

Of the 33 mineral commodities produced in the State, 22 had increases in value, 9 had decreases, and 2 had no changes. Of the commodities produced, 20 had values exceeding $1 million. Petroleum and molybdenum output value amounted to $186.3 million, 53 percent of the total State mineral production value. Metals collectively accounted for 43 percent of the total value, fuels 42 percent, and nonmetals 15 percent. This was the first year since 1945 that metals accounted for more of the total value than did the fuels.

Mineral activity was highlighted by events concerning molybdenum, oil shale, and uranium. Climax Molybdenum Co. Division, American Metal Climax, Inc., mined a record tonnage, started operation of a new $20 million hydrometallurgical plant at its Climax mine, and announced plans to sink a shaft to a newly discovered molybdenum ore body near its Urad mine. The knowledge that Colorado oil shales contain dawsonite, a relatively uncommon mineral containing aluminum and sodium, and nahcolite, a sodium mineral, resulted in the staking of numerous claims and applications for sodium leases on these lands. The status of these claims and leases however, was placed in jeopardy when the U.S. Department of Interior announced that mining oil-shale for the recovery of aluminum and/or sodium would not entitle the agent to recover the oil. A uranium exploration boom got underway after it became known that future demands for atomic power would require substantially more uranium than previously estimated and that present known ore reserves would not be adequate to meet the anticipated increase.

Employment and Injuries.—Final statistics for 1965 of employment and injuries in the mineral industries, excluding the petroleum industry, and preliminary data for 1966, compiled by the Bureau of Mines, are given in table 3.

Legislation and Government Programs.—The Office of Minerals Exploration (OME) awarded two contracts for silver exploration in the State. One contract, estimated to cost $31,080, was with M K Exploration Co., Englewood, for diamond core drilling at the Bird Creek mine in Mineral County. The other contract was with Congdon & Carey, Ltd., Denver, for similar work, estimated to cost $54,660, at its property in the Round Mountain area in Custer County. The Government participation in each project was to be 75 percent of the cost.

Various Government agencies published reports on beryllium and manganese occur-

[1] Mining engineer, Bureau of Mines, Denver, Colo.

[2] Petroleum engineer, Bureau of Mines, Denver, Colo.

[3] Meeves, Henry C. Nonpegmatitic Beryllium Occurrences in Arizona, Colorado, New Mexico, Utah, and Four Adjacent States. BuMines Rept. of Inv. 6828, 1966, 68 pp.

Meeves, Henry C., Clarence M. Harrer, Melford H. Salsbury, Albert S. Konselman, and Spencer S. Shannon, Jr. Reconnaissance of Beryllium-Bearing Pegmatite Deposits in Six Western States: Arizona, Colorado, New Mexico, South Dakota, Utah, and Wyoming. BuMines Inf. Circ. 8298, 1966, 34 pp.

Young, William E. Manganese Occurrences in the Eureka-Animas Forks Area of the San Juan Mountains, San Juan County, Colo. BuMines Inf. Circ. 8303, 1966, 52 pp.

Table 1.—Mineral production in Colorado [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Carbon dioxide (natural)—thousand cubic feet	155,668	$26	147,292	$25
Clays—thousand short tons	631	1,446	569	1,054
Coal (bituminous)—do	4,790	24,431	5,222	26,075
Copper (recoverable content of ores, etc.)—short tons	3,828	2,710	4,237	3,065
Feldspar—long tons	521	3	891	6
Gem stones	NA	80	NA	80
Gold (recoverable content of ores, etc.)—troy ounces	37,228	1,303	31,915	1,117
Gypsum—thousand short tons	r 100	r 379	75	269
Iron ore (usable)—thousand long tons, gross weight	114	787	164	1,133
Lead (recoverable content of ores, etc.)—short tons	22,495	7,018	23,082	6,978
Lime—thousand short tons	118	2,074	126	2,327
Molybdenum (content of concentrate)—thousand pounds	[2] 50,715	[2] 78,609	57,289	88,851
Natural gas (marketed)—million cubic feet	126,881	16,303	136,667	17,767
Natural gas liquids:				
LP gases—thousand gallons	91,399	3,930	73,390	3,596
Natural gasoline and cycle products—do	54,180	3,034	59,420	3,565
Peat—short tons	31,179	236	37,111	278
Petroleum (crude)—thousand 42-gallon barrels	33,511	96,512	33,492	97,462
Pumice—thousand short tons	56	134	46	104
Pyrites—thousand long tons	30	90	W	W
Sand and gravel—thousand short tons	20,810	22,041	22,245	23,485
Silver (recoverable content of ores, etc.)—thousand troy ounces	2,051	2,652	2,085	2,697
Stone—thousand short tons	4,789	8,638	7,031	11,331
Tin (content of concentrate)—long tons	32	76	44	99
Tungsten concentrate (60-percent WO_3 basis)—short tons	1,176	1,985	1,494	3,626
Uranium ore—do	574,795	10,651	633,113	10,530
Vanadium—do	4,017	14,056	3,697	15,888
Zinc (recoverable content of ores, etc.)—short tons	53,870	15,730	54,822	15,898
Value of items that cannot be disclosed: Beryllium concentrate, cement, fluorspar, perlite, rare-earth metal concentrate (1966), salt, and values indicated by footnote 2 and symbol W	XX	16,234	XX	14,699
Total	XX	r 331,168	XX	352,005

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.

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

[2] Excludes shipments and value of Nye Metals, Inc.; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in constant 1957–59 dollars

(Millions)

Year	Value [1]
1957	$335
1958	307
1959	316
1960	343
1961	345
1962	305
1963	310
1964	305
1965	316
1966	332

[1] Data for 1957–65 revised.

rences,[3] construction of the underground facilities of the North American Air Defense Command (NORAD),[5] an analysis of mining the Boulder-Weld coalfield,[6] mineral resources of the Flat Tops Primitive Area,[6] and strip-mining activities and problems in the State.[7]

A U.S. District Court decision rendered in Denver in December upheld private ownership of about 150,000 oil shale mining claims staked before Congress withdrew oil shale lands from mineral location in 1920. The U.S. Department of Interior had sought to have the claims declared null and void because the claim owners had not completed annual assessment work.

The 1966 Colorado State Legislature passed two bills that would have some effect on mineral-processing operations: The Water Pollution Control Act and the Air Pollution Control Act.

[4] Howes, Merwin H. Methods and Costs of Constructing the Underground Facility of North American Air Defense Command at Cheyenne Mountain, El Paso County, Colo. BuMines Inf. Circ. 8294, 1966, 69 pp.

[5] Lowrie, Raymond L. Analysis of the Coal Industry in Boulder-Weld Coalfield, Colorado. BuMines Rept. of Inv. 6726, 1966, 79 pp.

[6] Mallory, W. W., E. V. Post, P. J. Ruane, W. L. Lehmbeck, and R. B. Stotelmeyer. Mineral Resources of the Flat Tops Primitive Area, Colorado. Geol. Survey Bull. 1230–C, 1966, 30 pp.

[7] Colorado Legislative Council. Strip Mining. Res. Pub. 121, December 1966, 24 pp.

Table 3.—Employment 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
1965:								
Coal	1,536	217	334	2,631	11	109	45.61	26,381
Metal	4,528	264	1,198	9,588	3	401	42.14	3,301
Nonmetal	528	177	93	752	1	21	29.26	8,784
Sand and gravel	1,278	201	257	2,093	3	45	22.94	8,995
Stone	749	244	183	1,506	1	28	19.26	4,341
Peat	35	84	3	23	---	2	87.39	2,840
Total	8,654	239	2,068	16,593	19	606	37.67	8,020
1966: p								
Coal	1,535	209	322	2,501	5	104	43.58	13,284
Metal	4,995	262	1,309	10,488	8	393	38.23	6,485
Nonmetal	450	157	71	567	---	12	21.16	610
Sand and gravel	1,265	196	247	1,994	3	41	22.07	9,703
Stone	685	218	150	1,207	2	43	37.28	10,896
Peat	21	164	3	23	---	-----	-----	-----
Total	8,951	235	2,102	16,780	18	593	36.41	7,991

p Preliminary.

On October 20, the U.S. Atomic Energy Commission (AEC) received from Public Service Company of Colorado an application for permission to construct a high-temperature, gas-cooled reactor similar to the Peach Bottom, Pa., reactor. The application was the first for a commercial power reactor in the Rocky Mountain area. Plans call for building the 330-megawatt capacity plant on a 2,163-acre site in Weld County, 3½ miles northwest of Platteville near the junction of the South Platte and St. Vrain

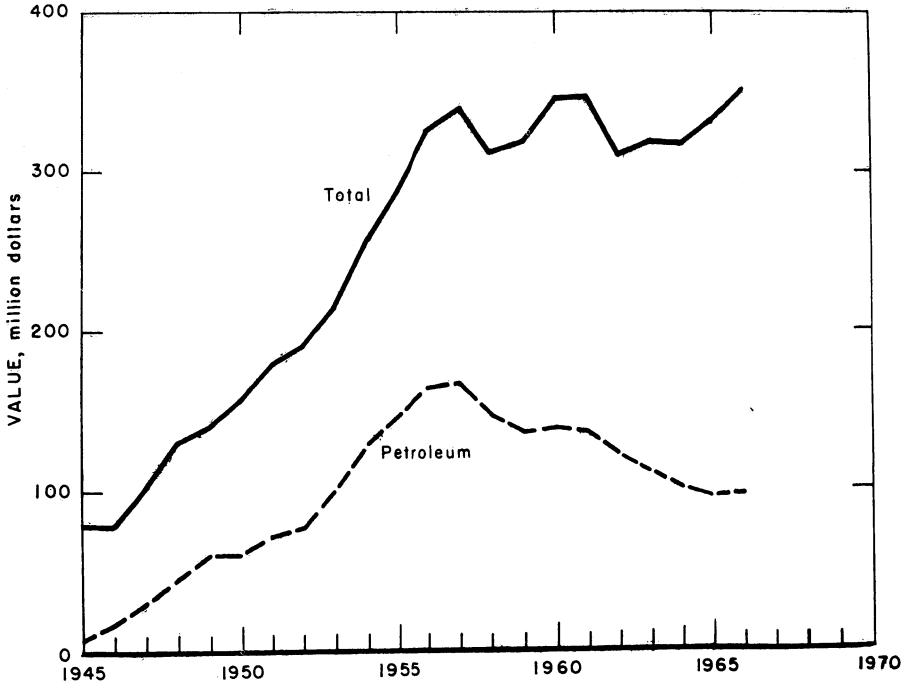

Figure 1.—Value of petroleum, and total value of mineral production in Colorado.

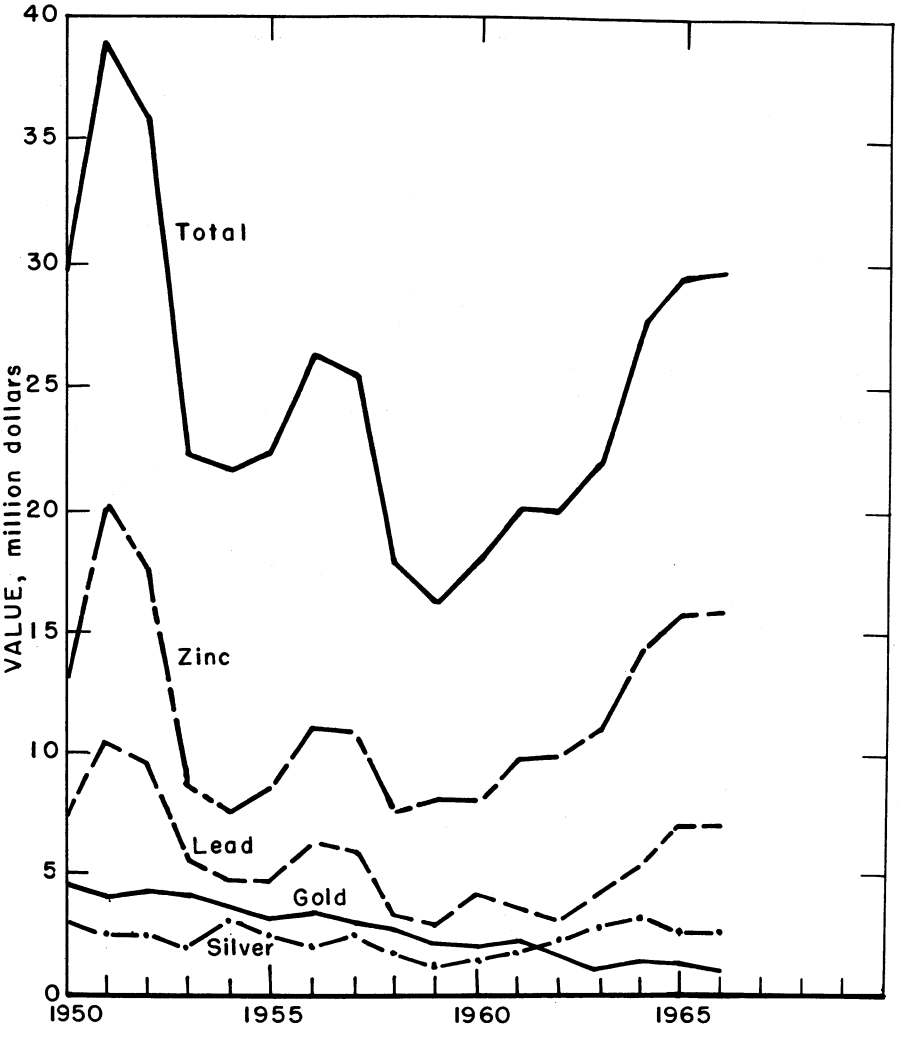

Figure 2.—Value of mine production of gold, silver, lead, and zinc and total value of these minerals (including copper) in Colorado.

Rivers. General Dynamics Corp. was engaged to design and construct the reactor and to fabricate and supply the fuel.

Road- and dam-construction projects, financed by Federal, State, county, and municipal Governments, absorbed much of the cement, sand and gravel, and stone production. State highway construction contracts awarded during the year totaled $53.6 million, a $4.4 million increase over that of 1965. Slightly more than one-half of the funds was for road building in the National System of Interstate and Defense Highways.[8] Of the 945.9 miles in this system designated for the State, 546.8 miles had been opened to traffic at yearend; 259.8 miles had work in progress; and 139.3 miles had no work started.[9] Major dam construction was under way on the Morrow Point, Rifle Gap, Ruedi, and Silver Jack Dams.

REVIEW BY MINERAL COMMODITIES

METALS

Beryllium.—Colorado and South Dakota were the only States in the Nation that produced beryllium concentrate. Although output in Colorado was greater than that of the previous year, the quantity was still only a few tons of hand-cobbed beryl. The only known producing operations were the Blackhawk operated by Ralph J. Pierce in Fremont County and the Lone Pine Hill Top operated by Smith Brothers in El Paso County. Beryl Ores Co. processed beryl for making beryllium compounds at its plant near Arvada; the beryl came from small operations in the State and South Dakota.

Cadmium, Indium, and Thallium.—At its Globe plant in Denver, American Smelting and Refining Co. (Asarco) produced cadmium, indium, and thallium metal and thallous sulfate from flue dust, dross, and other byproduct material from smelters and processing plants outside the State. A facility for producing high-purity indium was completed at midyear. The value of the products was not included as part of the mineral production of Colorado because the origin of the processed material was out of State.

Copper.—Copper production increased 11 percent in quantity and 13 percent in value; the greater percentage in value reflected the increase in the average price, which rose from 35.40 cents per pound to 36.17 cents. Output came from 47 operations in 16 counties, compared with 48 operations in 17 counties in 1965. The Idarado mine of Idarado Mining Co. located in Ouray and San Miguel Counties yielded two-thirds of the State output; ore production was 20 percent greater than in 1965. Other mines that had substantial production (over 100 tons of copper), in order of output, were the Eagle mine of The New Jersey Zinc Co. in Eagle County, Keystone mine of McFarland & Hullinger in Gunnison County, Emperius mine of Emperius Mining Co. in Mineral County, and Sunnyside a mine of Standard Metals Corp. in San Juan County.

Gold.—Gold production was down 5,313 troy ounces, 14 percent below that of 1965. The decrease was about equal to the decline in gold recovery at the Idarado mine of Idarado Mining Co., even though more ore was mined than during last year. This mine still accounted for about three-fourths of the State gold output.

A total of 43 lode and 14 placer mines had production, compared with 47 and 13, respectively, in 1965. A very small quantity of gold, less than 25 troy ounces, was obtained from cleanup operations at mills, an assay office, and railroad cars that had carried lead and zinc concentrates. Gold from placer operations totaled 1,374 troy ounces, only 4 percent of the total output. Eight of the placer mines were actually sand and gravel operations from which gold was recovered. The only lode mines, other than the Idarado, that had gold production exceeding 1,000 troy ounces were the Eagle mine of The New Jersey Zinc Co. and the Sunnyside mine of Standard Metals Corp. Five lode mines had production between 100 and 1,000 troy ounces; the other 35 lode operations had production varying from 1 troy ounce up to 100 troy ounces.

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[8] Engineering News-Record. State Highway Department's Construction Contracting Plans for 1967 . . . and Budgets for Maintenance: Highway Construction Spending Will Reach for a Record This Year. V. 178, No. 12, Mar. 23, 1967, pp. 24–25.

[9] Bureau of Public Roads. Quarterly Report on The Federal-Aid Highway Program, Dec. 31, 1966. Press Release BPR 67–5, Feb. 1, 1967.

Table 4.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1957–61 (average)	80	17	899	71,470	$2,501	1,962	$1,783
1962	25	16	872	48,882	1,711	2,088	2,265
1963	47	19	975	33,605	1,176	2,307	2,951
1964	58	19	1,052	42,122	1,474	2,626	3,396
1965	58	13	1,021	37,228	1,303	2,051	2,652
1966	62	14	1,225	31,915	1,117	2,085	2,697
1858–1966	NA	NA	NA	40,807,838	922,151	779,624	615,997

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1957–61 (average)	3,927	$2,332	16,771	$4,033	38,689	$8,899	$19,549
1962	4,534	2,793	17,411	3,204	43,351	9,971	19,944
1963	4,169	2,568	19,918	4,302	48,109	11,065	22,062
1964	4,653	3,034	20,563	5,388	53,682	14,602	27,894
1965	3,828	2,710	22,495	7,018	53,870	15,730	29,413
1966	4,237	3,065	23,082	6,978	54,822	15,898	29,755
1858–1966	324,593	110,744	2,882,547	357,837	2,221,337	435,199	2,441,928

NA Not available.
[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings or slimes re-treated, and ore, old slag, or tailings shipped to smelters during the calendar year indicated.
[2] Does not include gravel washed.

Iron Ore.—With an output of 164,000 long tons, iron ore production reached a record high, 50 percent greater than in 1965, the previous high. The increase was due to greater production from the Pitkin Iron Corp. property in Pitkin County; output from the mine was shipped to the Pueblo steel plant of CF&I Steel Corp. (CF&I). State output came from four operations located in Dolores, Fremont, Pitkin, and San Miguel Counties. Dolores County production was brown ore (limonite) that Rico Argentine Mining Co. had produced and stockpiled previously but shipped in 1966. Chas. Pfizer & Co., Inc., mined brown ore (limonite) from its property in San Miguel County. The brown ore from Dolores and San Miguel Counties was used for making paint pigments. A small quantity of magnitite was mined in Fremont County for use as a heavy aggregate.

Agglomerates (containing about 65 percent iron) were obtained by General Chemical Division, Allied Chemical Corp., from processing pyrites at its sulfuric acid plant in Denver. The output, sold for use in making steel and cement, was classified as a secondary product and, therefore, not considered as mineral production.

Lead.—The quantity of recoverable lead was up 587 short tons, 3 percent more than that of the previous year; however, because of a drop of about half a cent a pound in the average price, production value was 1 percent below that of 1965. With 44 percent of the State output, the Idarado mine of Idarado Mining Co. was the largest single source of lead; production from this mine was up 17 percent.

Of the 51 mines, the same number as in 1965, 6 had outputs exceeding 1,000 tons, and accounted for 89 percent of the total lead production. The other mines beside the Idarado with such production, in order of output, were Sunnyside of Standard Metals Corp., Eagle mine of The New Jersey Zinc Co., Keystone of McFarland & Hullinger, Emperius of Emperius Mining Co., and Rico Argentine of Rico Argentine Mining Co. The Brenneman mine of Standard Metals Corp. in San Juan County had an output of about 950 tons, slightly more than twice that of 1965.

Molybdenum.—Record molybdenum production of 57.3 million pounds, represented 62 percent of the national total, and exceeded the previous high of 51.6 million pounds in 1960. The value of production

Table 5.—Mine production of gold, silver, copper, lead, and zinc in 1966, by counties in terms of recoverable metals

County	Mines producing [1]		Material sold or treated [2] (short tons)	Gold (lode and placer)		Silver (lode and Placer)	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
Adams	-----	4	[3] 174,524	[3] 1,804	[3] $63,140	[3] 87,262	[3] $112,828
Boulder	4	-----	72	2	70	154	199
Clear Creek	10	-----	1,891	113	3,955	15,579	20,144
Conejos	1	-----	(3)	(3)	(3)	(3)	(3)
Custer	1	-----	10	-----	-----	153	198
Dolores	2	-----	(3)	(3)	(3)	(3)	(3)
Eagle	1	-----	239,023	1,195	41,825	357,203	461,863
Gilpin	3	3	61	20	700	139	180
Gunnison	6	-----	85,083	116	4,060	340,733	440,568
Hinsdale	3	-----	723	5	175	1,615	2,088
Jefferson	1	4	(3)	(3)	(3)	(3)	(3)
Lake	-----	1	-----	8	280	2	3
La Plata	1	-----	2,042	99	3,465	163	211
Mineral	2	-----	44,895	618	21,630	143,034	184,943
Moffat	-----	1	(3)	(3)	(3)	(3)	(3)
Montrose	-----	-----	-----	5	175	-----	-----
Ouray	6	-----	102,563	4,292	150,220	211,248	273,144
Park	2	1	1,543	69	2,415	17,881	23,120
Pitkin	1	-----	(3)	(3)	(3)	(3)	(3)
Pueblo	-----	-----	133	3	105	749	968
Saguache	1	-----	733	7	245	4,471	5,781
San Juan	13	-----	197,989	3,364	117,740	252,979	327,102
San Miguel	3	-----	373,585	20,193	706,755	652,135	843,211
Summit	1	-----	100	2	70	34	44
Total:							
1966	62	14	1,224,970	31,915	1,117,025	2,085,534	2,696,595
1965	58	13	1,020,640	37,288	1,302,980	2,051,105	2,652,079

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Adams	[3] 34	[3] $24,343	[3] 1,165	[3] $351,906	[3] 1,159	[3] $336,241	[3] $888,458
Boulder	-----	-----	1	378	1	203	850
Clear Creek	2	1,664	43	13,135	30	8,772	47,670
Conejos	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Custer	[4]	326	2	741	-----	-----	1,265
Dolores	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Eagle	492	355,660	2,559	773,571	22,991	6,667,404	8,300,323
Gilpin	-----	-----	[4]	30	-----	-----	910
Gunnison	247	178,463	2,204	666,375	4,040	1,171,600	2,461,066
Hinsdale	-----	-----	82	24,894	6	1,595	28,752
Jefferson	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Lake	-----	-----	-----	-----	-----	-----	283
La Plata	[4]	36	-----	-----	-----	-----	3,712
Mineral	232	167,829	1,539	465,089	1,988	576,390	1,415,881
Moffat	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Montrose	-----	-----	-----	-----	-----	-----	175
Ouray	500	361,844	2,059	622,557	2,954	856,791	2,264,556
Park	5	3,798	122	36,850	18	5,234	71,417
Pitkin	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Pueblo	1	868	7	2,056	48	13,978	17,975
Saguache	5	3,508	40	11,941	23	6,757	28,232
San Juan	355	256,879	4,746	1,434,822	8,339	2,418,252	4,554,795
San Miguel	2,364	1,709,756	8,508	2,571,908	13,225	3,835,163	9,666,793
Summit	[4]	72	5	1,436	-----	-----	1,622
Total:							
1966	4,237	3,065,046	23,082	6,977,689	54,822	15,898,380	29,754,735
1965	3,828	2,710,224	22,495	7,018,440	53,870	15,730,040	29,413,763

[1] Operations at slag dumps and old mill or miscellaneous cleanups not counted as producing mines.
[2] Does not include gravel washed.
[3] Production of Adams, Conejos, Dolores, Jefferson, Moffat, and Pitkin Counties combined to avoid disclosing individual company confidential data.
[4] Less than ½ unit.

Table 6.—Mine production of gold, silver, copper, lead, and zinc in 1966, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Dry gold	4	2,132	167	196	100	-----	-----
Dry gold-silver	2	2,049	394	10,572	1,400	400	200
Dry silver	13	139,696	82	51,589	9,800	119,500	30,200
Total	19	143,877	643	62,357	11,300	119,900	30,400
Copper	3	8,787	730	160,001	730,900	59,900	-----
Copper-lead	2	16	21	369	1,200	7,700	-----
Copper-lead-zinc	5	452,164	24,290	792,089	5,739,300	20,592,400	31,919,300
Lead	15	4,083	162	36,339	23,700	555,400	56,100
Lead-zinc and zinc [2]	[3] 24	615,900	4,671	1,033,326	1,964,900	24,812,900	77,541,500
Total	45	1,080,950	29,874	2,022,124	8,460,000	46,028,300	109,516,900
Other "lode" material:							
Gold cleanup	[4]	[5]	11	4	-----	-----	-----
Gold mill cleanup	[4]	2	5	1	-----	-----	-----
Copper-lead cleanup	[4]	6	4	75	300	900	300
Lead cleanup	[4]	2	1	33	-----	1,300	-----
Lead-zinc cleanup	[4]	27	2	237	600	5,000	17,800
Zinc cleanup	[4]	106	1	512	1,800	8,600	78,600
Total	---	143	24	862	2,700	15,800	96,700
Total "lode" material	62	1,224,970	30,541	2,085,343	8,474,000	46,164,000	109,644,000
Placer	14	-----	1,374	191	-----	-----	-----
Total all sources	76	1,224,970	31,915	2,085,534	8,474,000	46,164,000	109,644,000

[1] Detail will not necessarily add to totals because some mines produce more than one class of material.
[2] Lead-zinc and zinc combined to avoid disclosing individual company confidential data.
[3] Twenty-three lead-zinc mines and one zinc mine.
[4] From properties not classed as mines.
[5] Less than ½ unit.

Table 7.—Mine production of gold, silver, copper, lead, and zinc in 1966, 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 (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Amalgamation:					
Ore	7,811	2,777	-------	-------	-------
Cleanup	16	5	-------	-------	-------
Total	7,827	2,782	-------	-------	-------
Concentration, and smelting of concentrates: Ore	21,785	1,869,534	7,745,200	45,708,200	109,458,000
Direct-smelting:					
Ore	921	212,170	726,100	440,000	89,300
Cleanup	8	857	2,700	15,800	96,700
Total	929	213,027	728,800	455,800	186,000
Placer	1,374	191	-------	-------	-------
Grand total	31,915	2,085,534	8,474,000	46,164,000	109,644,000

was $88.9 million, 25 percent of the State's total mineral production value; only petroleum production had a greater value. All output was from the Climax Molybdenum Co. Climax mine, considered the largest underground mining operation in the world. According to the 1966 annual report of American Metal Climax, Inc., the parent company of Climax Molybdenum Co., a record 15.2 million tons of ore was produced with the mine operating around the clock, 7 days per week; the daily output averaged approximately 42,300 tons. The new $20 million ore-treatment plant for recovering oxidized molybdenum from the ore was placed in operation in September. The plant was designed to recover 3 million pounds of molybdenum annually.

Mine development work and surface plant construction continued on schedule at the Urad mine of Climax Molybdenum Co. in Clear Creek County. Initial production was scheduled for mid-1967. Company evaluation of the Henderson deposit, a newly discovered ore body near the Urad mine, placed the proven and probable ore reserves in excess of 236 million tons at a grade of 0.45 percent MoS_2. Continued diamond drilling was expected to increase this reserve estimate.

Rare-Earth Metals.—Climax Molybdenum Co. resumed recovery of monazite (a combination of rare earth phosphates) from mill tailings at the Climax molybdenum operation. The product shipped from Climax was a low-grade concentrate containing the monazite and some wolframite, a tungsten mineral.

Yttrium oxide production began in the fall at the new million-dollar plant of Yttrium Corporation of America at Louviers; annual production capacity was expected to be 180,000 pounds of pure yttrium oxide. Molybdenum Corporation of America, part owner of Yttrium Corp., began construction of additional facilities at Louviers to produce high-purity, rare-earth oxides.

Silver.—Silver production, up 35,000 troy ounces or 2 percent over 1965, came from 61 lode mines, 11 placers, and some cleanup operations. The 280,000 troy ounce increase in production from the Idarado mine of Idarado Mining Co. offset many of the declines from other mines. Lode operations accounted for all except 1,053 ounces of the State output. Mines with production exceeding 100,000 troy ounces, in order of output, were Idarado of Idarado Mining Co., Eagle of The New Jersey Zinc Co., Keystone of McFarland & Hullinger, Sunnyside of Standard Metals Corp., and Emperius of Emperius Mining Co. These five mines accounted for 84 percent of the State total.

Of the 22 counties with silver production, San Miguel had the highest: 652,135 troy ounces, about one-third of the State output. Other counties with production over 100,000 troy ounces were Eagle, Gunnison, Mineral, Ouray, and San Juan.

Homestake Mining Co. continued exploring the Bulldog silver prospect near Creede. According to the company annual report, significant silver values were located and the property could develop into a small but profitable operation.

Tin.—Colorado, accounting for 45 percent of the total output of the Nation, was one of five States with tin production. Production in 1966 was 44 long tons, 12 more than that of the previous high set in 1965. The tin came from tailings at the Climax molybdenum operation of Climax Molybdenum Co. The record outputs were achieved because more ore had been milled each year at the Climax operation. The tin concentrate was sold to Fred H. Lenway & Co., Inc., which upgraded the concentrate at its mill near Boulder before shipping to a tin smelter.

Tungsten.—Surpassed in output only by California, the State production of tungsten concentrate was 27 percent greater than in 1965. Most of the output was obtained as a byproduct of milling molybdenum ore at the Climax mine of Climax Molybdenum Co. Some tungsten concentrate came from tungsten ore mined at the Canyon Mining Corp. Eureka mine in Boulder County.

Uranium Ore.—Although uranium ore production was up 58,318 tons, 10 percent over that of 1965, value was down $121,000 or 1 percent. The value decline was attributable to the facts that lower grade ores were mined and that price was dependent on ore grade. The total output contained 2,680,399 pounds of U_3O_8 making the average grade of ore 0.21 percent U_3O_8; in 1965 the average grade was 0.23 percent.

The output of uranium ore came from 351 operations in 15 counties, whereas in 1965 there were 244 operations in 7 counties. Having 195 operations Montrose was

the leading county with 47 percent of the State output. Counties that had no shipments in 1965 but had some in 1966 were Boulder, Custer, Jefferson, La Plata, Larimer, Park, Saguache, and San Juan; some of these counties had not recorded production for 10 years.

Of the 69 producers, 20 had outputs exceeding 1,000 tons. The principal producers, in order of output, were Mining and Metals Division, Union Carbide Corp.; Climax Uranium Co., Climax Molybdenum Co. Division, American Metal Climax, Inc.; Vanadium Corporation of America; and Beaver Mesa Uranium, Inc. Output of these four companies amounted to 578,305 tons, or 91 percent of the State total. Beaver Mesa Uranium, Inc., was purchased in the summer by Union Carbide Corp.

Three uranium mills, Rifle and Uravan of Union Carbide Corp. and Grand Junction of Climax Uranium Co., were operated throughout the year. Some of the uranium ore mined in Colorado was processed at the Moab (Utah) mill of Atlas Minerals Division, Atlas Corp. and at the Shiprock (N. Mex.) mill of Vanadium Corporation of America. Although its contract for delivery of uranium concentrates to AEC expired on December 31, Climax Uranium Co. was expected to continue operating its Grand Junction mill because the company had obtained a contract for delivery of concentrate to General Electric Co.

The Canon City uranium mill of Cotter Corp., shut down since February 1965, was reopened in the latter part of the year to produce uranium concentrate for domestic and foreign sale. The Schwartzwalder, a high-grade uranium mine near Golden closed since early 1965, was purchased by Cotter from Denver-Golden Corp. and reopened in the fall to provide part of the feed.

Uranium exploration in the State was accelerated when it became known that present ore reserves were only sufficient to meet short-term future needs and that significant discoveries would be needed to supply long-term demands. Exploration drilling for uranium was 1.1 million feet, triple that reported in 1965.

Vanadium.—Of the vanadium produced in the United States, 72 percent came from Colorado. Although the State output was 8 percent below that of 1965, the value was 13 percent greater because of a higher market price than in 1965. The vanadium, in the form of fused vanadium oxide (V_2O_5), was recovered from uranium-vanadium ores processed at the uranium mills of Climax Uranium Co. at Grand Junction, Union Carbide Corp. at Rifle and Uravan, and Vanadium Corporation of America at Shiprock, N. Mex.

Of the five counties with vanadium production, Montrose had the greatest, followed by San Miguel, Mesa, Garfield, and Rio Blanco. The Rifle mine of Union Carbide Corp. in Garfield County was the largest single source; most of the ore was mined from pillars left for support from previous operations.

Zinc.—Zinc output of 54,822 tons was the highest since the 1951 production of 55,114 tons. Compared with that of 1965, zinc production was 2 percent more in quantity and 1 percent more in value. Of the three base metals (copper, lead, and zinc) produced in the State, zinc was the only one with a value exceeding $10 million; the value, $15.9 million, was the sixth highest of all mineral commodities produced in Colorado.

Production came from 39 operations, five less than in 1965. Output of The New Jersey Zinc Co. Eagle mine, the largest single source, was below that of 1965 because of an 11-percent drop in zinc ore production. Other important mines, those with production exceeding 1,000 tons, in order of output, were Idarado of Idarado Mining Co., Sunnyside of Standard Metals Corp., Keystone of McFarland & Hullinger, Brenneman of Standard Metals Corp., Emperius of Emperius Mining Co., and Rico Argentine of Rico Argentine Mining Co.; only the Idarado and Brenneman mines had greater zinc production than in 1965. The seven mines, including the Eagle mine, accounted for 98 percent of the State total.

MINERAL FUELS

Asphalt and Related Bitumens (Gilsonite).—American Gilsonite Co. operated its gilsonite refinery near Fruita throughout the year. Gilsonite for the plant came through a 72-mile pipeline from the company mines at Bonanza, Utah. A major change was made in the type of products recovered at the plant. Gasoline and diesel production was cut because of decreasing profits, and emphasis was placed on producing high-quality metallurgical coke and

asphalt. Additional changes were designed to produce some chemical products. The company announced development of an economically feasible extraction and hydrogenation process for producing a broad range of nitrogen heterocyclics rich in quinolines and indoles from gilsonite. The nitrogen heterocyclics can be used as organic solvents, ore flotation reagents, asphalt emulsifiers, and corrosion inhibitors.

Carbon Dioxide.—The only carbon dioxide sold was to Colorado Carbonics, Inc., Cortez, and came from the McElmo field, Montezuma County. It was produced from the Mississippian Formation in the field; the Shinarump formation (Triassic) yielded small quanties of low heat-content natural gas used for field fuel.

Unmarketable because of entrained hydrocarbons, 9.6 billion cubic feet of carbon dioxide produced with oil in Jackson County, was released to the atmosphere, after the oil was extracted.

Coal (Bituminous).—Coal production, on the rise since 1962, surpassed the 5-million-ton mark for the first time since 1948. Although there were eight fewer mines in production than in 1965, the output was 9 percent or 432,000 tons, greater. The increase was due to larger output from four strip mines that produced coal for electric-power generation. The value of the total production, $26.1 million, was the third largest of all the mineral commodities produced in the State.

Seventy-two operations had production exceeding 1,000 tons; 65 were underground, 6 were strip, and 1 was auger. Production from the underground operations was 3.6 million tons, 68 percent of the total output; stripping operations 1.6 million tons, 31 percent; and the auger operation 5,000 tons, 1 percent. Of the 5.2 million tons produced only 1.3 million tons was shipped out of State.

Thirty-five mines had production between 1,000 and 10,000 tons, 25 between 10,000 and 100,000 tons, 7 between 100,000 and 500,000 tons, and 4 between 500,000 and 1,000,000 tons. The four operations with the largest production were, in order of output, the Allen mine of CF&I Steel Corp. in Las Animas County, Edna mine of The Pittsburg & Midway Coal Mining Co. in Routt County, Dutch Creek mine of Mid-Continent Coal and Coke Co. in Pitkin County, and Somerset of United States Steel Corp. (USS) in Delta and Gunnison Counties. Of these four, only the Edna mine was a stripping operation; the others were underground mines.

Table 8.—Coal (bituminous) production, by counties

(Short tons)
(Excludes mines producing less than 1,000 short tons)

County	1965	1966
Delta	186,233	303,508
Fremont	282,331	300,680
Garfield	6,975	6,029
Gunninson	304,761	364,329
Huerfano	48,279	36,677
La Plata	26,024	21,681
Las Animas	871,061	844,076
Mesa	113,390	109,775
Moffat	194,671	194,142
Montrose	67,175	74,826
Pitkin	767,876	718,205
Rio Blanco	6,110	5,309
Routt	1,211,147	1,557,736
Weld	704,425	685,399
Total	4,790,458	5,222,372

Using about 45 percent of the total output, the electric-power generating companies were the major consumers of coal. Strip mines in Montrose and Routt Counties and underground mines in Las Animas, Mesa, and Weld Counties were the principal sources of coal for power generation. The other major consumers were steel companies, which converted the coal into coke for use in making steel. Coal for this purpose came mostly from the Allen mine in Las Animas County; Somerset mine in Delta and Gunnison Counties; and Dutch Creek and Thompson Creek mines in Pitkin County.

Public Service Company of Colorado awarded a contract in August for installing a $40 million electric-generating unit at its Cherokee steam-electric plant in Denver. This new 350,000-kilowatt generating unit would increase plant capacity to more than 750,000 kilowatts, thereby making it the largest generating plant in the Rocky Mountain region. Annual coal consumption at this plant in recent years had been about 800,000 tons.

The status of the Colorado-Ute Electric Association, Inc., new coal-fired steam-electric generating plant at Hayden and associated transmission lines, together valued at $30 million, was placed in jeopardy when the Colorado State Supreme Court in February ruled that the plant was illegally constructed and operated. The Court had acted on protests by Western Colorado Power Co. and Public Service Company of Colorado alleging they would be adversely

affected. Colorado-Ute appealed the decision to the U.S. Supreme Court; however, in October, the Federal high court refused to rule on the right of Colorado-Ute to build the plant and transmission lines. The Rural Electrification Administration (REA) distribution members of Colorado-Ute later petitioned the Federal Power Commission (FPC) to assume jurisdiction and prohibit the closing of the plant. At yearend the FPC still had the matter under consideration.

Of the 14 counties having coal production, only five—Delta, Fremont, Gunnison, Montrose, and Routt—had increases above their 1965 output. Routt County with 30 percent of the State output had the largest production.

The average price of the coal produced was $4.99 per ton, a decrease of 11 cents. Coal from underground operations averaged $5.73 per ton and that from strip mines $3.37.

Natural Gas.—Marketed natural gas increased 8 percent in quantity and 9 percent in value. The State Oil and Gas Conservation Commission[10] reported natural gas production of 132.9 billion cubic feet, virtually unchanged from that of 1965.

Although La Plata, Moffat, and Rio Blanco Counties were ranked, in order of sales, as in 1965, Mesa County was moved up to fourth rank because of new pipeline outlets from Divide Creek field. This field was connected to pipeline in November 1965; in the first full calendar year of production, output was 7.4 billion cubic feet of gas.

The most productive dry-gas fields were Ignacio-Blanco (37.9 billion cubic feet), Divide Creek (7.4 billion), West Hiawatha (5.9 billion), Piceance Creek (4.6 billion), and Powder Wash (3.1 billion cubic feet). The Rangely Weber horizon yielded 22.6 billion cubic feet of wet gas; Adena had production of 4.1 billion cubic feet.

At yearend, 826 gas wells were productive; 192 were shut in. Of the 53 new gas wells completed during the year, 10 were exploratory discoveries.

The American Gas Association (AGA) and American Petroleum Institute (API) reported[11] natural gas reserves in Colorado at yearend of 1.7 trillion cubic feet, a decrease of 66.2 billion cubic feet. Additions because of discoveries, extensions, and revisions were insufficient to offset the depletion of reserves by production.

At a cost of $3 million, Colorado Interstate Gas Co. (CIG) built 60 miles of 20-inch gas pipeline between Colorado Springs and Denver. The line was tied into the Denver system at Watkins Junction, east of Aurora, and replaced an older line built in 1928. In other developments, CIG received approval from the FPC to absorb its wholly owned subsidiary, Natural Gas Producers, Inc., and to incorporate its gas-storage facilities at the Fort Morgan field into CIG Denver supply system; among other improvements, a 57-mile, 16-inch pipeline was to be built from Fort Morgan to Denver.

Late in the year, two companies applied to the AEC for approval of proposals to fracture by nuclear explosions low-permeability gas sands in western Colorado. The proposals were similar to "Project Gasbuggy," which was approved for northwestern New Mexico. Continental Oil Co. proposed that in the Dragon Trail area, 17 miles south of Rangely in Rio Blanco County, a 40-kiloton device be fired in the interbedded sandstones and shales of the Mancos Formation (Cretaceous). The sandstone contained an estimated 10 billion cubic feet of gas. Austral Oil Co., Inc., recommended that two 50-kiloton devices spaced 1,000 feet apart in the same well bore be fired in the Rulison field in Garfield County. The formation to be tested was the Mesaverde (Cretaceous) which contained an estimated 96 to 125 billion cubic feet of gas.

Natural Gas Liquids.—Output of natural gas liquids was down 9 percent; however, because of increased unit value of the products, output value was 3 percent higher than in 1965. The number of liquids-extraction plants increased by one in August when the Buck Peak plant of Western Slope Gas Co. went on stream. The plant, a mechanical-refrigeration type, had a design capacity of 700,000 cubic feet of gas per day at 400 pounds per square inch operating pressure; the processed gas came from four wells in the Buck Peak field.

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[10] The Oil and Gas Conservation Commission of the State of Colorado. Colorado Oil and Gas Statistics. 1966, Part II. All field petroleum and natural gas production figures cited in the chapter also are from this work.

[11] The Oil and Gas Journal. V. 65, No. 14, Apr. 3, 1967, p. 130.

The 15 plants in the State processed a total of 104.8 billion cubic feet of gas, yielding 3.2 million barrels of liquids.[12]

The API and AGA estimated reserves of natural gas liquids at 25.6 million barrels, a 2-million-barrel increase over that of 1965.

Oil Shale.—Interest in oil shale continued. One development was the staking of mining claims and filing of applications for sodium leases on oil shale lands after it became known that the oil shale contained two minerals, dawsonite (a basic carbonate of aluminum and sodium) and nahcolite (sodium bicarbonate). According to the U.S. Department of Interior, these claims and leases did not include the right to the oil contained in the oil shale.

Sohio Petroleum Co., Cleveland-Cliffs Iron Co., and The Oil Shale Corp. (TOSCO) announced their joint plans to continue oil shale research which had been conducted through their agent, Colony Development Co., headquartered in Denver. Cleveland-Cliffs Iron Co. was to continue to mine oil shale and to conduct further research in mining and in materials-handling methods for the joint account of the three companies. To obtain more data on extraction processes, TOSCO was to utilize the crushed oil shale and to operate the Grand Valley plant for a limited period.

The first stage of a multimillion-dollar oil shale research program conducted by private industry at the Government experimental oil-shale facilities leased to the Colorado School of Mines Research Foundation, Inc., was successfully completed in the early part of the year. The six oil companies cooperating in the program unanimously agreed to proceed with Stage II and, thus, increased the budget for this work from $3 million to $4.5 million. Total expenditures through December 31, since the project was formulated in April 1964, was $5.2 million; expenditures for 1966 amounted to $3 million.

During the year, studies were made, using the smallest pilot retort (No. 1), to determine the effects of shale richness, to improve understanding of the process mechanism, and to investigate several problems identified during Stage I. The intermediate-size retort (No. 2) was operated to determine the effect of shale-particle size and size range on oil yield, quality, and process operability, and to establish and demonstrate operating conditions and prototype equipment for larger sized retorts. Some runs were made with the No. 2 retort to determine the effects of shale throughput and richness; air, dilution, and recycle gas rates; air-gas distributor configuration; and retort-shell configuration on oil yield and process operability. Mechanical model studies for the design and modification of the largest retort (No. 3) were carried out to determine systems and equipment for shale feed, uniform shale flow, shale drawoff, and air-gas distributor design. Retort No. 3 was placed in operation on November 15; shakedown operations were still in progress at yearend. The Anvil Points mining operation was

[12] Work cited in footnote 10, part IV, p. 4.

Table 9.—Natural gas liquids extraction plants in 1966

Plant	County	Owner	Gas input (million cubic feet)	Products (thousand barrels)
Adena	Morgan	Union Oil Company of Calif	5,389	432
Bijou	do	Associated Oil & Gas Co	825	143
Buck Peak	Moffat	Western Slope Gas Co	28	1
Fort Morgan	Morgan	Natural Gas Producers, Inc	1,063	19
Fruita	Mesa	Continental Oil Co	5,224	103
Little Beaver	Washington	do	1,394	239
Loveland	Larimer	Associated Oil & Gas Co	194	26
McClave	Kiowa	Fleetwood Drilling Co	1,145	25
Minto	Logan	Sunray-DX Oil Co	30	4
Padroni	do	Associated Oil & Gas Co	815	10
Rangely	Rio Blanco	Chevron Oil Co	22,411	968
Roggen-Southwest	Weld	McWood Corp	230	18
San Juan	La Plata	El Paso Natural Gas Co	61,675	861
Vallery	Morgan	Associated Oil & Gas Co	847	69
Yenter	Logan	do	3,580	285

Source: The Oil and Gas Conservation Commission of the State of Colorado. Colorado Oil and Gas Statistics, 1966. Part IV, Gasoline and Extraction Plants, 4 pp.

substantially increased in size and scope. Development of a new mining area on property adjacent to the Naval Oil Shale Reserve was undertaken to supply large tonnages of shale needed for operation of Retort No. 3.

Colorado Corehole No. 1, drilled in Rio Blanco County in 1965 for the Federal Bureau of Mines, in cooperation with AEC, was deepened in May from 2,600 feet to 3,140 feet; oil shale was found to be continuous to approximately 3,050 feet in depth. Because the first oil shale encountered in the hole was at 985 feet, the total continuous section was about 2,065 feet, thus making it one of the thickest known sections of oil shale in the Piceance Creek basin. About 12 miles southwest of the first hole in the SW¼ NW¼ NE¼ sec 14, T1S, R99W, 6th PM, Rio Blanco County, a second hole, Colorado Corehole No. 2, was drilled in June and July. Drilling and coring were terminated at a depth of 2,214 feet, when an explosion of undetermined origin occurred at the bottom of the hole. Continuous oil shale was first found at a depth of 1,120 feet; because the hole was still in oil shale when drilling was stopped, the total oil shale section cored was 1,094 feet.

A third Oil Shale Symposium was held in Denver on April 14 and 15. Sponsoring organizations were the American Institute of Mining, Metallurgical, and Petroleum Engineers; the Colorado School of Mines; and the Colorado School of Mines Research Foundation, Inc. Papers presented at the symposium were published in a Colorado School of Mines report.[13]

The Denver Research Institute, affiliated with the University of Denver, conducted a study on the possible effects of an oil shale industry on the economy of the Rocky Mountain region. From this study, a report entitled "Regional Economic Impact of a U.S. Oil Shale Industry," describing the possible effects, was published by the institute during the year.

Peat.—The 1966 peat output of 37,111 tons was slightly more than 10 times that of 1957. Peat was produced at 15 operations: 4 in Boulder County, 3 in Park County, 2 each in Gilpin and Teller Counties, and 1 each in Alamosa, Chaffee, Lake, and La Plata Counties. Of the total production, 15,675 tons was the moss type; 15,340 tons, humus; and 6,096 tons, reedsedge. Only 20 percent of the output underwent any processing, such as shredding, grinding, pulverizing, and screening. About three-fourths of the peat was used directly for general soil improvement; the balance for making mixed fertilizers.

The average price for processed peat was $9.77 per ton, a drop of $1.73 per ton below the 1965 price. Unprocessed peat sold for $6.92 per ton, an increase of 30 cents.

Petroleum.—The recent downward trend in petroleum output slowed perceptibly during the past 2 years. Production in 1966 was only 19,000 barrels below that of 1965, less than 0.1 percent change; the decline between 1964 and 1965 was 4 percent. By contrast, the average annual decline between 1961 and 1964 was 9.4 percent. Several factors caused the decrease in rate of decline: Pressure-maintenance in fields; new discoveries; and, probably, additional production caused by slight price increases. Petroleum was again the most valuable mineral commodity in the State, comprising 28 percent of the total value. At yearend, of 2,371 productive oil wells, 42 were flowing, 1,649 were pumping, and 680 were shut in.

The Rangely Weber reservoir, the source of 48 percent of the State crude oil output, had a cumulative production of 385 million barrels at yearend. The 1966 yield was 11 percent above that of 1965, the result of increased water injection into the reservoir. Bonanza, Boxer, and Brandon were new oilfield names added to the principal fields in 1966.

The State had a total of 47 fluid-injection projects in 45 fields: 43 of the projects were waterfloods; 1 was gas-injection; and 3 were combined gas- and water-injection. Seven new projects were in six fields; three projects were inactive. The new projects, all waterfloods, were in the Orchard (two units), Pierce, Rake, Roggen-Southwest, Sand River, and Westfork fields; the programs in Aztec Wash, Phegley, and Xenia-West fields were again inactive.

Because of a lower level of development drilling, total drilling was down 39 wells from the 577 drilled in 1965. Exploratory drilling was 7 percent higher and average total depth for the wildcats was 5,079 feet, more than 100 feet deeper than the 1965

[13] Third Symposium on Oil Shale. Quarterly of the Colorado School of Mines. V. 61, No. 3, July 1966, 170 pp.

Table 10.—Crude petroleum production, by counties

(Thousand 42-gallon barrels)

County	1965	1966	Principal fields in 1966 in order of production
Adams	601	434	Badger Creek, Mocassin, Middlemist, Beacon, Deer Trail.
Archuleta	68	64	Prince Gramps.
Baca	166	121	Flank.
Bent	2	1	Bent's Fort.
Boulder	2	2	Boulder.
Fremont	21	20	Florence-Canon City.
Jackson	303	273	McCallum, Battleship.
Kiowa	15	205	Brandon, McClave.
La Plata	30	23	Red Mesa.
Larimer	302	366	Loveland, Wellington, Fort Collins.
Logan	3,510	3,415	Mount Hope, Bonanza, Northwest Graylin, Saber, Divide, West Padroni.
Moffat	808	931	Powder Wash, Mandlin Gulch, Iles, Horse Gulch, Hiawatha.
Montezuma	1,309	825	Cache, Flodine Park.
Morgan	1,488	1,326	Adena, Boxer, Sand River, Zorichak.
Prowers	3	----	
Rio Blanco	17,769	19,273	Rangely, Wilson Creek.
Routt	94	101	Grassy Creek, North Sage Creek, Tow Creek.
Washington	5,381	4,553	Plum Bush Creek, Bison, Rush Willadel, Big Beaver, Lindon, Little Beaver, Blade.
Weld	1,636	1,555	Black Hollow, Pierce, Saber, Loam.
Yuma	3	4	Eastward.
Total	33,511	33,492	

Source: The Oil and Gas Conservation Commission of the State of Colorado. Colorado Oil and Gas Statistics, 1966. Part II: Oil & Gas Production, 85 pp.

Table 11.—Principal oilfields in 1966

Field	County	Production		Cumulative production to Jan. 1, 1967	
		Oil (barrels)	Gas (thousand cubic feet)	Oil (barrels)	Gas (thousand cubic feet)
Rangely (Weber)	Rio Blanco	16,212,520	22,604,836	385,128,580	633,427,972
Wilson Creek	do	2,508,768	3,355,978	60,668,238	35,993,806
Black Hollow	Weld	731,472	31,777	7,851,862	224,547
Plum Bush Creek	Washington	645,146	88,186	16,253,270	1,828,236
Cache	Montezuma	610,268	1,584,073	1,839,563	3,123,625
Adena	Morgan	584,246	4,052,861	58,014,439	67,638,294
Rangely (Mancos)	Rio Blanco	460,942	----------	10,480,784	22
Bison	Washington	370,194	----------	2,646,221	2,467
Rush-Willadel	do	327,982	641	1,838,787	11,406
Mount Hope	Logan	310,759	333	5,825,236	6,837,934
Bonanza	do	301,281	128,027	405,182	142,214
Big Beaver	Washington	291,511	51,128	9,636,044	1,422,637
Lindon	do	278,218	----------	1,987,289	10,462
Graylin, NW	Logan	277,176	45,738	11,151,580	10,991,674
Pierce	Weld	266,871	20,769	5,937,486	164,265
Saber	Logan	240,294	1,150,786	588,173	3,915,182
Little Beaver	Washington	230,623	494,923	15,610,061	17,644,947
Boxer	Morgan	217,879	280,164	251,475	328,759
Loveland	Larimer	215,485	217,806	907,462	857,458
Blade	Washington	202,639	----------	1,512,869	----------
Brandon	Kiowa	199,143	----------	277,132	----------
McCallum	Jackson	188,319	[1] 9,555,063	5,338,787	[1] 439,494,707
Powder Wash	Moffat	182,532	3,122,617	3,975,580	72,783,398
Divide	Logan	180,768	7,200	3,802,672	4,003,114
Padroni W	do	174,741	----------	2,024,005	251,221
Flodine Park	Montezuma	170,647	783,426	1,266,054	3,601,243

[1] Carbon dioxide.

Source: The Oil and Gas Conservation Commission of the State of Colorado. Colorado Oil and Gas Statistics, 1966. Part II, Oil and Gas Production, 85 pp.

Table 12.—Drilling for petroleum in 1966, by counties

County	Oil	Gas	Dry	Total	Footage
Exploratory completions:					
Adams	1	1	6	8	47,241
Arapahoe	---	---	2	2	10,943
Archuleta	---	---	1	1	3,433
Baca	---	4	5	9	40,284
Bent	---	---	1	1	4,886
Delta	---	---	1	1	410
Elbert	---	---	1	1	6,910
Fremont	---	---	1	1	4,240
Garfield	---	1	2	3	22,661
Gunnison	---	---	1	1	1,480
Jackson	---	---	1	1	4,042
Jefferson	---	---	1	1	9,508
Kiowa	1	---	6	7	36,338
Kit Carson	---	---	5	5	30,222
La Plata	---	1	1	2	13,008
Larimer	2	---	2	4	21,001
Las Animas	---	---	1	1	1,938
Lincoln	---	---	3	3	17,200
Logan	4	1	46	51	268,089
Mesa	---	---	1	1	1,540
Moffat	2	1	12	15	82,939
Montezuma	1	---	13	14	61,439
Montrose	---	---	1	1	10,650
Morgan	2	---	14	16	84,457
Prowers	---	---	4	4	19,906
Rio Blanco	2	1	7	10	45,381
Routt	---	---	1	1	5,464
San Miguel	---	---	1	1	7,310
Sedgwick	---	---	1	1	3,982
Washington	6	---	69	75	336,316
Weld	1	---	18	19	123,699
Yuma	---	---	1	1	3,910
Total	22	10	230	262	1,330,827
Development completions:					
Adams	3	2	10	15	84,539
Archuleta	---	1	---	1	8,056
Baca	---	5	5	10	33,734
Boulder	1	---	---	1	1,580
Garfield	---	2	2	4	22,674
Kiowa	3	---	1	4	19,376
La Plata	---	14	4	18	136,562
Larimer	6	---	2	8	40,402
Logan	14	---	28	42	210,895
Mesa	---	1	---	1	5,170
Moffat	10	5	3	18	96,798
Montezuma	3	---	6	9	46,853
Morgan	15	5	8	28	161,734
Pitkin	---	1	---	1	5,350
Prowers	---	---	1	1	5,269
Rio Blanco	35	6	44	85	296,883
Routt	---	---	2	2	12,478
Washington	5	1	9	15	69,434
Weld	6	---	7	13	76,661
Total	101	43	132	276	1,334,448
Total all drilling	123	53	362	538	2,665,275

Source: Committee on Statistics of Drilling, American Association of Petroleum Geologists.

average of 4,967 feet. The success ratio for exploratory wells, 12.2 percent, was considerably better than the previous ratio of 5.3 percent.

The Denver basin encompassed 71 percent of exploratory and 44 percent of development drilling. Washington and Logan Counties were the sites of nearly half (48 percent) of the wildcat drilling. Rio Blanco County again led in development drilling.

Three significant discoveries were made in western Colorado: Horse Gulch field, Nine Mine field, and a new pay zone at Maudlin Gulch field. Horse Gulch field was discovered by Texaco Inc. when its No. 1 Hall-Government, Moffat County, was completed, pumping 405 barrels of oil per day from the Dakota Formation (Cretaceous) in the 5,893-to-5,900-foot interval. In Rio Blanco County, Cobra Oil & Gas Corp. opened the Nine Mile field with its No. 1 McBride-Government, which was completed for a pump gage of 576 barrels of oil per day from the Dakota. A new pay zone was discovered at Maudlin Gulch field, Moffat County, by the Texaco Inc. No. 2 Unit, which was completed, pumping 205 barrels of oil per day from the Dakota; the field previously had produced from the Morrison and Sundance Formations (Jurassic).

Two of eastern Colorado's more promising discoveries were the Cayuse and North Shore fields, both in Logan County and both productive from the "J" sandstone (Cretaceous). Cayuse was discovered by Kimbark Exploration, Ltd., at its No. 1 Padroni which was completed for a daily pump gage of 160 barrels of oil. The No. 1 Roadifer well of South Texas Development Co. and other interests was completed—pumping 140 barrels of oil per day to establish the North Shore field.

Three recently discovered fields had substantial increases in crude oil output: The Bonanza field, with six wells and production of 85,568 barrels of oil in 1965, rose to nine wells with yield of 301,281 barrels in 1966. The Boxer field had 4 wells with 33,596 barrels of production in 1965 and 16 wells that produced 217,879 barrels in 1966. The Brandon field (Mississippian Formation), with one well which produced 11,803 barrels of oil in 1965, had nine wells with a yield of 189,358 barrels in 1966.

The three active crude-oil refineries in the State processed 13.1 million barrels of

Table 13.—Oil and gas discoveries in 1966

County and field	Well	Operator	Location			Producing formation	Gross producing interval (feet)	Total depth (feet)	Initial production		Date of completion	Remarks [1]
			Section	Township	Range				Barrels of oil per day	Thousand cubic feet of gas per day		
Baca:												
Unnamed	No. 1–36 St. John-State.	Falcon Seaboard Drilling Co.-W. C. McBride, Inc.	36	30 S	45 W	Topeka	3,234–3,305	3,432	---	6,160	Sept. 2	Flowed; combined with Vilas field.
Vilas	No. 1–19 Strobel	Davis Drilling, Inc.	19	31 S	44 W	do	3,302–3,312 3,246–3,312	5,605	---	5,400	Mar. 29	Flowed; new field.
Unnamed	No. 1–12 Lantz-D.	Falcon Seaboard Drilling Co.-W. C. McBride, Inc.	12	35 S	45 W	Cherokee	4,208–4,212	5,254	---	2,000	Nov. 15	Flowed; combined with Prairie Dog field.
Kiowa: Unnamed	No. 1 Dawson	Fremont Petroleum Co.	4	19 S	45 W	Mississippian	4,716–4,778	4,840	312	----	July 4	Pumped; combined with Brandon field.
La Plata: Ignacio-Blanco.	No. 1–13 Government.	David G. Gustafson-Chester H. Loveland.	13	32 N	12 W	Gallup	4,251–4,556	4,950	---	302	July 21	Flowed; new pay.
Larimer: Loveland	No. 3 Bunker	Lakota Petroleum Corp.	32	5 N	68 W	Fuson	5,522–5,562	5,675	370	----	May 31	Pumped; new pay.
Logan:												
Chuckwagon	No. 1 Monahan-State.	C. F. Raymond	19	8 N	50 W	"J" Sandstone	4,508–4,516	4,596	---	2,500	July 11	Flowed; new field.
Ford	No. 1 East Padroni.	Stuarco Oil Co., Inc.-B. F. Allison Estate.	26	9 N	52 W	do	4,533½–4,534½	4,611	5	----	Nov. 26	Pumped; new field.
Cayuse	No. 1 Padroni	Kimbark Exploration, Ltd.	30	9 N	52 W	do	4,757–4,762	4,914	160	----	Apr. 13	Do.
North Shore	No. 1 Roadifer	South Texas Development Co., Stuarco Oil Co., Inc., Gary Sandlin, Triangle J. Oil Co.	28	10 N	53 W	do	4,870–4,873	4,950	140	----	Mar. 18	Do.
Noria	No. 1 Propst	R. E. Hibbert	33	11 N	53 W	do		5,350	125	----	Sept. 10	Do.
Moffat:												
Maudlin Gulch	No. 2 Unit	Texaco Inc	27	4 N	95 W	Dakota	5,754–5,760 5,775–5,798	6,409	205	----	July 30	Pumped; new pay; OWWO.
Horse-Gulch	No. 1 Hall-Government.	do	24	5 N	91 W	do	5,893–5,900	6,402	405	----	Jan. 8	Pumped; new field.
Craig Dome	No. 9–1 Craig Dome.	Vaughn Petroleum, Inc.	1	6 N	91 W	Frontier	7,466–7,504	10,003	---	1,148	June 16	Flowed; new pay; OWWO.
Pole Gulch Unit	No. 2 Pole Gulch Unit-State.	HLM Drilling Co.	16	12 N	92 W	Lewis	4,640–4,824	6,500	---	700	Sept. 1	Flowed; new field.

Table 13.—Oil and gas discoveries in 1966—Continued

County and field	Well	Operator	Location			Producing formation	Gross producing interval (feet)	Total depth (feet)	Initial production		Date of completion	Remarks [1]
			Section	Township	Range				Barrels of oil per day	Thousand cubic feet of gas per day		
Montezuma: Unnamed.	No. 2 Ute	L & M Ventures-J. W. Holmes.	10	32 N	17 W	Gallup	1,823–1,828	1,855	8	----	Apr. 4	Pumped; new field.
Morgan:												
Stagecoach	No. 1 Peterson	Cardinal Petroleum Co.	34	2 N	56 W	"D" Sandstone	5,078–5,082	5,220	100	----	May 21	Do.
Sawbuck	No. 1 Funk	A. T. Skaer, Inc.	8	2 N	58 W	do	5,879–5,885	6,100	14	----	Mar. 1	Pumped; new field; OWWO.
Rio Blanco:												
Unnamed	No. 1 SE Douglas Creek-Government	Continental Oil Co.	2	3 S	101 W	Mancos	1,966–2,148	2,354	----	150	Dec. 14	Flowed; new field.
Nine Mile	No. 1 McBride-Government.	Cobra Oil & Gas Corp.	6	2 N	92 W	Dakota	7,266–7,300	7,870	576	----	Sept. 7	Pumped; new field; OWDD.
Rangely	No. 1 UPRR	Pan American Petroleum Corp.	32	2 N	102 W	Morrison B	3,256–	3,485	60	----	Jan. 28	Pumped; new pay.
Washington:												
Ward	No. 1 Ward Ranch	Alfred Ward & Son.	35	1 S	54 W	"J" Sandstone	4,835–4,836½	4,908	87	----	Dec. 22	Pumped; new field.
Epiphany	No. 1 Kloefkorn	Plains Exploration Co.-Sterling Drilling Co.	32	2 S	53 W	do	4,756–4,757	4,915	30	----	July 1	Do.
Stallion	No. 1–B Christianson.	Donzoil, Inc.-Allison Drilling Co., Inc.	22	3 S	50 W	do	3,920–3926	4,000	38	----	Aug. 22	Do.
Concho	No. 1 Kincheloe	Triangle J. Oil Co	11	3 S	51 W	do	3,989–3,994	4,097	60	----	Oct. 29	Pumped; new field; OWWO.
Justice	No. 4 Rudnik	Stuarco Oil Co., Inc.-Carver-Dodge Oil Co.	27	3 S	51 W	do	4,009–4,011	4,110	45	----	Aug. 5	Pumped; new field.
Wampum	No. 1 Anderson	Don M. Rounds Co., et al.	20	3 S	52 W	do	4,383–4,387	4,469	120	----	Aug. 29	Do.
Able	No. 1 Walters	Bob Burch-Mule Creek Oil Co., Inc.	1	3 S	54 W	do	4,636–4,644	4,744	56	----	Nov. 27	Do.
Weld: Vim	No. 1 State	U.S. Smelting, Refining and Mining Co.	16	11 N	58 W	do	7,081–7,087	7,122	47	----	May 20	Pumped; new pay.

[1] OWWO—Old well workover; OWDD—Old well drilled deeper.

Source: Petroleum Information Corp., 1966 Resume, Oil and Gas Operations in the Rocky Mountain Region.

crude oil. Of this, 11.9 million barrels was received from out of State; Wyoming supplied 11.5 million barrels, Montana 377,000, and Utah 26,000. Shipments out of the State totaled 34.8 million barrels: 18 million barrels went to Utah; and the rest to Ohio, Kansas, Indiana, Wyoming, Illinois, and Oklahoma. The active refineries were Continental Oil Co., Denver; Lubco Oil & Refining Co., Rangely; and Tenneco Oil Co., Denver. In April, Lubco expanded its daily crude capacity from 3,500 to 5,000 barrels and its catalytic reforming capacity from 1,000 to 2,000 barrels.

Crude-oil prices in the Denver basin area were raised 5 cents per barrel late in the year, bringing 40.0° to 44.9° API oil to $2.93 per barrel. Prices of Rangely crude oil were raised 7 cents per barrel in February, to bring 40° to 44.9° API oil in that field to $3.05 per barrel.

NONMETALS

Cement.—Shipments of portland and masonry cements decreased 11 and 2 percent, respectively. The cements were produced by Ideal Cement Co. at its Portland plant in Fremont County and its Boettcher plant in Larimer County. This was the first year since 1961 that both plants shipped masonry cement; in the past few years, only the Portland plant had shipped masonry cement, although some masonry cement for company use had been produced at the Boettcher plant. A total of 91 percent of the portland cement and 95 percent of the masonry cement went to consumers in Colorado. Ready-mix concrete companies were the biggest customers, purchasing 59 percent of the portland cement shipments. Other customers in order of purchases were concrete-product manufacturers, building-material dealers, highway contractors, other contractors, and miscellaneous customers.

Rocky Mountain Cement Co., a subsidiary of Martin Marietta Corp., purchased 1,080 acres of land near Lyons as a source of raw material for its proposed multimillion-dollar cement plant to be erected on the site.

Clays.—Clay production was down 10 percent in quantity and 27 percent in value below that of 1965. The increase in production of miscellaneous clay and shale was not enough to offset the decreases in output of bentonite and fire clay. The larger drop in value was caused by the decline in output of the higher priced fire clays.

Of the total clay production, 75.8 percent was miscellaneous clay and shale, 24.1 percent fire clay, and 0.1 percent bentonite, compared with 65.3, 34.5, and 0.2 percent, respectively, in 1965. Of the total output, one-fifth was produced and sold as raw material; the balance was captive production. Bentonite was used for lining reservoir ponds and as a bonding agent for pelletized animal feed. Fire clay was used for making heavy clay products (building brick and sewer pipe) and refractories (firebrick, zinc retorts, and bonding agent for making foundry molds). Miscellaneous clay and shale were used for making heavy clay products (building brick and sewer pipe) and lightweight aggregates.

Production came from 62 operations in 10 counties. With 21 operations, Jefferson

Table 14.—Clay production by counties

County	1965		1966	
	Short tons	Value	Short tons	Value
Bent	250	$3,125	----------	----------
Boulder	13,381	22,186	23,373	$43,033
Custer	1,772	7,974	857	W
Douglas	93,179	267,860	38,564	92,049
Elbert	W	W	W	W
El Paso	W	W	16,317	W
Fremont	26,895	106,650	11,829	45,953
Huerfano	W	W	W	W
Jefferson	393,984	598,341	398,974	586,009
Las Animas	8,765	25,260	11,456	44,381
Mesa	276	552	----------	----------
Pueblo	61,089	303,566	46,087	124,500
Undistributed	30,991	110,874	21,860	117,600
Total	630,582	1,446,388	569,317	1,053,525

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

County had 70 percent of the State output. The Idealite Co., a division of Ideal Cement Co., was the largest producer; its output was shale used for making lightweight aggregates.

Feldspar.—Lockhart & Sons mined feldspar from the Mica Lode in Fremont County; the output, a 370-ton increase over that of 1965, was used for making decorative aggregate.

Fluorspar.—Finished fluorspar production was up 11 percent. Acid-grade fluorspar produced by Allied Chemical Corp. at its mill at Valmont was used for making hydrofluoric acid. Except for a minor quantity purchased from small producers, crude fluorspar for the mill came from the company Burlington mine at Jamestown.

Gypsum.—Gypsum production, down 26 percent, came from five mines in Fremont County and one in Larimer. The drop resulted from decreases in cement production and gypsum board products, the two main uses for gypsum. One-third of the total output was calcined and used for manufacturing gypsum building products, 11,000 tons was for agricultural purposes, and the balance was used as a retarder in portland cement.

Lime.—Lime production increased 8,000 tons, 7 percent above that of 1965. The increase was due mainly to more lime produced at the sugar beet plants because of the increase in the quantity of sugar beets processed. Of the 15 plants that produced lime, 12 were at sugar beet plants. The Great Western Sugar Co. operated nine plants; The National Sugar Manufacturing Co., Holly Sugar Corp., and American Crystal Sugar Co., one each.

Lime was produced at the Pueblo steel plant of CF&I Steel Corp. for use in making steel; most of the lime was used in the basic-oxygen process. Colorado Lime Co., Inc., produced lime at its Colorado Springs plant for use as a soil conditioner and for treatment of sewage and industrial waste. Lime produced by Basic Chemical Corp. at its plant at Glenwood Springs was used as a soil conditioner, for metallurgical purposes, and water treatment.

Perlite.—The only producer, Persolite Products, Inc., mined slightly more crude perlite at its operation at Rosita than in 1965. Part of the output was sold and part sent to the company expanding plant at Florence. Crude perlite from New Mexico was expanded at the Denver plant of Western Mineral Products Co. and at the Antonito plant of Grefco, Inc. The principal uses of expanded perlite were as an aggregate for making plaster, concrete, and insulation; as a filter aid; and for oil-well cementing and soil conditioning.

The Mining and Mineral Products Division of Great Lakes Carbon Corp. was acquired by General Refractories Co.; included in the transaction was the Great Lakes perlite processing plant at Antonito. General Refractories organized the division into a new company subsidiary, Grefco, Inc.

Pumice.—The output of pumice, consisting of scoria and volcanic ash, decreased 10,000 tons. Production came from four operations—two in Eagle County and one each in Costilla and Routt Counties. The main use was as concrete aggregate; other uses were as railroad ballast, for landscaping, and as a pozzolanic admixture to concrete.

Pyrites.—Most of the pyrite was recovered as a byproduct from milling molybdenum ore from the Climax mine of Climax Molybdenum Co. The balance of the output came from the Rico Argentine mine of Rico Argentine Mining Co. Production from both operations was used primarily for manufacturing sulfuric acid.

Salt.—Salt production was the same as that of 1965. The salt, in a brine pumped from a well in Montrose County by Union Carbide Corp., was used by the company in its uranium-vanadium milling operation at Uravan.

Sand and Gravel.—Sand and gravel production, up 7 percent, surpassed the 1959 record output of 20.9 million tons by 1.3 million. The value, the highest of the nonmetal mineral commodities, was the fourth highest of all minerals produced in the State.

Output of sand and gravel consisted of 18.2 million tons of gravel and 4.0 million tons of sand. About 1 million tons of sand and gravel was used as pit-run material; the balance of the output underwent some processing such as washing, crushing, and screening. The average price for pit-run material was $0.50 per ton; that for prepared material $1.08. The overall average price was $1.06.

Table 15.—Sand and gravel production in 1966, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Adams	2,717	$3,200	Larimer	973	$1,000
Alamosa	325	330	Las Animas	W	W
Arapahoe	1,024	1,137	Lincoln	175	168
Archuleta	8	8	Logan	628	644
Baca	75	74	Mesa	803	867
Bent	28	32	Mineral	33	33
Boulder	1,387	1,374	Moffat	591	592
Chaffee	117	108	Montezuma	306	313
Cheyenne	136	126	Montrose	208	196
Clear Creek	W	W	Morgan	611	642
Conejos	11	10	Otero	W	W
Costilla	75	68	Ouray	15	14
Crowley	W	W	Park	43	43
Custer	49	53	Phillips	160	162
Delta	176	199	Pitkin	132	161
Dolores	27	14	Prowers	161	182
Douglas	608	687	Pueblo	2,008	2,215
Eagle	W	W	Rio Blanco	50	55
Elbert	70	70	Rio Grande	59	70
El Paso	1,409	1,506	Routt	W	W
Fremont	231	253	Saguache	74	61
Garfield	260	278	San Miguel	139	135
Grand	323	310	Sedgwick	57	60
Gunnison	141	145	Summit	48	59
Hinsdale	7	4	Teller	W	W
Huerfano	61	64	Washington	311	311
Jackson	76	77	Weld	873	906
Jefferson	2,199	2,212	Yuma	207	176
Kiowa	90	90	Undistributed	900	928
Kit Carson	473	473			
Lake	188	217	Total	22,245	23,485
La Plata	389	373			

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

Sand and gravel used for road construction and maintenance was 15.7 million tons; that for building construction 5.2 million tons—increases of 1 million and 200,000 tons, respectively. The balance of 1.3 million tons was used for fill, railroad ballast, engine sand, and miscellaneous uses.

From the 374 producing operations, output was by 162 commercial producers and 212 Government crews or contractors. Commercial operators produced 10.4 million tons of sand and gravel and Government-crews and -contractors, 11.8 million tons. The five leading commercial operators, in order of output, were Western Paving Construction Co., Cooley Gravel Co., Asphalt Paving Co., The Brannan Sand & Gravel Co., and Boulder Gravel Products, Inc., their combined production was 4.4 million tons, 20 percent of the State output.

Of the 63 counties in the State, 60 had sand and gravel production; only Denver, Gilpin, and San Juan Counties had no production. A total of 58 counties had some Government-and-contractor production; 44 counties had commercial production. Six counties—Adams, Jefferson, Pueblo, El Paso, Boulder, and Arapahoe, ranked in order of output—each had production exceeding 1 million tons; their combined output was 10.7 million tons, 48 percent of the total production. Another 30 counties each produced between 100,000 tons and 1 million tons; 24 counties produced less than 100,000 tons.

About 100 million tons of known sand and gravel reserves along the South Platte River were placed in jeopardy when Congress approved the fiscal 1967 expenditure of $6 million for design studies and land purchases for the proposed Chatfield Dam. The reservoir to be created by the dam would cover the reserves.

Stone.—A new record for stone production was established by the 7-million-ton output in 1966; production exceeded the previous high, set in 1965, by 2.2 million tons. Dam construction in Eagle and Pitkin Counties was the principal reason for the increase. Except for 13,024 tons of dimension stone, production was crushed and broken stone. Granite constituted 39.7 percent of the stone production, limestone 31.2 percent, sandstone 23.6 percent, miscellaneous stone (unclassified as to type) 4.8 percent, basalt 0.6 percent, and marble 0.1 percent.

Table 16.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	2,087	$2,444	2,057	$2,511
Paving	775	896	330	390
Fill	127	87	120	113
Other	-------	-------	15	7
Industrial:				
Engine	[1] 24	[1] 67	11	42
Filtration	(1)	(1)	-------	-------
Other	(1)	(1)	-------	-------
Total	3,013	3,494	2,533	3,063
Gravel:				
Construction:				
Building	2,834	3,656	2,784	3,590
Paving	5,112	5,427	4,447	4,759
Railroad ballast	1	1	1	1
Fill	158	101	540	412
Other	1	5	26	30
Miscellaneous	70	67	65	77
Total	8,176	9,257	7,863	8,869
Total sand and gravel	11,189	12,751	10,396	11,932
Government-and-contractor operations:				
Sand:				
Building	4	4	7	7
Paving	963	934	1,470	1,457
Fill	24	29	22	22
Total	991	967	1,499	1,486
Gravel:				
Building	125	125	374	333
Paving	7,878	7,657	9,436	9,283
Fill	567	481	540	451
Other	60	60	-------	-------
Total	8,630	8,323	10,350	10,067
Total sand and gravel	9,621	9,290	11,849	11,553
All operations:				
Sand	4,004	4,461	4,032	4,549
Gravel	16,806	17,580	18,213	18,936
Total	20,810	22,041	22,245	23,485

[1] Engine, filtration, and "other" (industrial) sand combined to avoid disclosing individual company confidential data.

Crushed granite was used mostly for dam embankment, concrete and road aggregate, and riprap; small quantities were used as poultry grit and for making precast slabs. Dimension granite was used for monuments. Principal uses of crushed limestone were for making cement, concrete and road aggregate, flux for producing steel, and lime; other uses were as an asphalt filler, coal dust, and riprap. Some rough-construction building stone was made from the dimension limestone produced. Crushed sandstone was used mainly for fill in dam construction and for making cement; other uses were as an abrasive, aggregate for precast panels, decorative stone, foundry purposes, landscaping, refractory material, riprap, and stone sand. Dimension sandstone went mostly for making flagging and rough building stone. Crushed miscellaneous stone was used mostly for concrete and road aggregate and riprap; other uses were as an aggregate for precast panels, as a filter media, and roofing granules. Dimension miscellaneous stone was used in building construction. Crushed marble was used as an aggregate and as terrazzo chips; dimension marble was used for interior dressed building stone. Crushed basalt was used as concrete and road aggregate and riprap.

Table 17.—Stone production in 1966, by counties

County	Short tons	Value	County	Short tons	Value
Adams	2,211	$3,317	Jefferson	25,470	$105,368
Alamosa	1,203	1,804	Kit Carson	198	297
Arapahoe	14,369	21,554	Lake	12,712	15,890
Archuleta	24,715	48,500	La Plata	14,278	27,929
Baca	1,734	2,601	Larimer	671,617	1,347,075
Bent	9,143	13,714	Lincoln	34	51
Boulder	44,940	121,388	Logan	8,736	11,129
Chaffee	W	W	Mesa	2,534	19,424
Cheyenne	381	572	Mineral	142	213
Clear Creek	W	W	Montezuma	13,147	26,417
Conejos	399	798	Montrose	249	374
Costilla	1,598	2,397	Morgan	9,192	13,788
Crowley	132	198	Otero	1,300	1,950
Custer	2,037	W	Ouray	6,284	9,426
Delta	37,208	34,650	Park	165	376
Dolores	123,879	96,847	Pitkin	2,704,500	4,050,000
Douglas	86,067	191,160	Prowers	1,708	2,562
Eagle	1,485,430	1,858,625	Pueblo	11,953	12,930
Elbert	1,737	2,606	Saguache	2,032	3,048
El Paso	450,458	663,747	San Miguel	2,374	3,561
Fremont	764,505	1,426,984	Teller	450	6,600
Garfield	W	W	Weld	10,780	21,989
Grand	1,696	2,302	Undistributed	437,066	1,083,063
Gunnison	39,538	72,659			
Huerfano	816	1,224	Total	7,031,117	11,331,107

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

Table 18.—Stone sold or used by producers, by kinds

Year	Basalt and related rocks (traprock)		Granite		Limestone		Marble	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1962	------	------	20,872	$161,315	2,164,513	$4,395,440	9,094	$79,960
1963	72,915	$83,173	73,580	199,984	2,139,431	4,170,148	8,749	64,063
1964	5,535	5,535	483,361	858,884	2,272,932	4,412,764	10,105	72,666
1965	(1)	(1)	2,058,617	3,089,379	2,203,606	4,066,926	2,230	32,597
1966	44,768	47,895	2,789,362	4,357,513	2,191,457	3,910,903	3,474	35,039

Year	Sandstone		Other stone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1962	67,378	$493,597	90,854	$467,000	2,352,711	$5,597,312
1963	107,731	635,054	107,271	540,743	2,509,677	5,693,165
1964	95,155	733,577	350,204	721,883	3,217,292	6,805,809
1965	189,329	832,623	[1] 335,065	[1] 616,028	4,788,847	8,637,553
1966	1,663,858	2,443,467	338,198	536,290	7,031,117	11,331,107

[1] Basalt and related rocks (traprock) included with "Other stone" to avoid disclosing individual company confidential data.

Stone production came from 47 of the 63 counties. Pitkin and Eagle Counties, respectively, had the most production; the combined output from these two counties was 4.2 million tons, 60 percent of the State production.

Vermiculite.—At its plant in Denver, Western Mineral Products Co. processed crude vermiculite from Montana. The exfoliated product was used for loose-fill insulation, as an aggregate in plaster, and for acoustical purposes.

Table 19.—Stone sold or used by producers, by uses

Use	1965		1966	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction and rubble, short tons	5,978	$67,230	2,595	$37,781
Rough architectural, cubic feet	45,165	75,180	(1)	(1)
Dressed architectural, do	105,105	240,727	[1] 67,377	[1] 138,679
Rough monumental, do	4,798	26,000	10,079	34,525
Dressed monumental, do	1,190	10,000	------	------
Curbing and flagging, do	59,076	59,635	55,268	60,227
Total (approximate, in short tons)	22,900	478,772	13,000	271,212
Crushed and broken stone:				
Concrete and roadstone, short tons	913,175	1,188,043	852,489	1,152,402
Lime, do	193,067	402,030	181,193	415,375
Metallurgical, do	254,832	609,362	297,316	703,008
Riprap, do	156,076	327,714	210,049	417,689
Other, do	[2] 3,248,831	[2] 5,631,632	[3] 5,477,046	[3] 8,371,421
Total, do	4,765,981	8,158,781	7,018,093	11,059,895
Total stone (approximate, in short tons)	4,788,900	8,637,553	7,031,100	11,331,107

[1] Rough architectural and dressed architectural stone combined to avoid disclosing individual company confidential data.

[2] Includes stone used in abrasives, architectural aggregate, asphalt filler, cement, coal dust, concrete aggregates, dam embankment, decorative building, erosion control, filter beds, foundry, ground cover, landscaping, mineral food, poultry grit, precasting, roofing granules, stone sand, and terrazzo.

[3] Includes stone used in abrasives, aggregates, asphalt filler, cement, coal dust, concrete aggregates, dam fill, decorator rock, erosion control, filter media, foundry, landscaping, poultry grit, precasting, rock gardens, roofing granules, rotary drilling, stone sand, terrazzo, and traffic control barricades.

REVIEW BY COUNTIES

Of the 63 counties in the State, only Denver had no mineral production. Thirty-three counties had increases in value of mineral production; 29 had decreases. Thirty-two counties each had a value of mineral production exceeding $1 million. Only those counties with significant production or mineral industry activity are discussed. See table 20 for the value of individual counties and the mineral commodities produced.

Adams.—The value of mineral production decreased $314,000. The combined value of sand and gravel and petroleum output accounted for 92 percent of the county total value.

The county was ranked first in the State in sand and gravel production with output from 23 commercial and 7 Government-crew and -contractor operations. Commercial output totaled 2.3 million tons and represented 86 percent of the county production. Western Paving Construction Co. was the principal commercial operator, followed by The Brannan Sand & Gravel Co., Boise Cascade Sand & Gravel Co., Cooley Gravel Co., Tower Construction Co., Superior Sand & Gravel Co., Albert Frei & Sons, Inc., and Jones Fine Sand Co. Maintenance crews and a contractor for the Adams County Highway Department and contractors for the Colorado Department of Highways produced 377,000 tons of sand and gravel. Gold and silver were recovered as byproducts at four of the commercial sand and gravel operations.

Petroleum and marketed natural gas accounted for 32 percent of the value of mineral output, an 8-percent decline, caused by depletion of the older fields. Badger Creek, the largest field wholly within the county, had production of 125,100 barrels compared with 157,020 in 1965. The waterflooding in Badger Creek and Middlemist fields continued. The Great Western Sugar Co. produced quicklime at its Brighton plant for making sugar from sugar beets. Contractors for the Colorado Department of Highways used the output of miscellaneous stone for riprap and aggregate in road construction.

Arapahoe.—Sand and gravel accounted for 98 percent of the county mineral production value; the output, sixth highest in the State, came from eight commercial operations and eight Government-crew-and-contractor operations.

Table 20.—Value of mineral production in Colorado, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Adams	$5,168,704	$4,854,704	Sand and gravel, petroleum, natural gas, lime, gold, stone, silver.
Alamosa	182,430	332,791	Sand and gravel, stone, peat.
Arapahoe	1,292,896	1,158,554	Sand and gravel, stone.
Archuleta	397,734	240,500	Petroleum, stone, sand and gravel.
Baca	1,011,990	1,252,601	Natural gas, petroleum, sand and gravel, stone.
Bent	162,515	71,714	Sand and gravel, natural gas, stone, petroleum.
Boulder	2,198,011	2,273,336	Sand and gravel, fluorspar, lime, stone, peat, clays, tungsten concentrate, petroleum, lead, zinc, silver, gold, uranium ore.
Chaffee	656,422	812,439	Stone, sand and gravel, peat.
Cheyenne	W	126,572	Sand and gravel, stone.
Clear Creek	127,831	668,566	Sand and gravel, stone, silver, lead, zinc, gold, copper.
Conejos	126,992	37,929	Gold, silver, sand and gravel, stone, lead.
Costilla	W	116,578	Sand and gravel, pumice, stone.
Crowley	W	63,948	Lime, sand and gravel, stone.
Custer	159,465	91,181	Sand and gravel, perlite, stone, clays, lead, copper, silver, uranium ore.
Delta	1,367,032	2,248,247	Coal, sand and gravel, lime, stone.
Dolores	W	872,585	Lead, zinc, stone, silver, copper, sand and gravel, gold, pyrites, iron ore.
Douglas	1,050,137	970,209	Sand and gravel, stone, clays.
Eagle	9,526,590	10,269,058	Zinc, stone, lead, silver, copper, sand and gravel, gold, pumice.
Elbert	W	114,862	Sand and gravel, clays, stone.
El Paso	2,255,125	2,412,395	Sand and gravel, stone, lime, clays, beryllium concentrate.
Fremont	11,131,698	10,727,142	Cement, stone, coal, sand and gravel, gypsum, petroleum, clays, uranium ore, feldspar, beryllium concentrate, iron ore.
Garfield	2,521,829	3,081,810	Vanadium, natural gas, sand and gravel, lime, stone, coal, uranium ore.
Gilpin	113,559	10,695	Peat, gold, silver, lead.
Grand	W	312,302	Sand and gravel, stone.
Gunnison	5,482,542	4,752,730	Coal, zinc, lead, silver, copper, sand and gravel, stone, gold.
Hinsdale	13,755	32,752	Lead, sand and gravel, silver, zinc, gold.
Huerfano	463,117	271,926	Coal, sand and gravel, clays, stone.
Jackson	958,790	892,000	Petroleum, sand and gravel, natural gas.
Jefferson	3,120,805	2,948,301	Sand and gravel, clays, stone, uranium ore, gold, copper, silver, lead.
Kiowa	436,000	1,034,000	Petroleum, natural gas, sand and gravel, natural gas liquids.
Kit Carson	119,105	473,297	Sand and gravel, stone.
Lake	81,001,305	92,932,806	Molybdenum, tungsten concentrate, sand and gravel, tin, pyrites, peat, stone, rare-earth metal concentrate, gold, silver.
La Plata	8,669,923	9,534,216	Natural gas, natural gas liquids, sand and gravel, coal, petroleum, stone, peat, gold, silver, uranium ore, copper.
Larimer	11,896,256	10,265,868	Cement, stone, petroleum, sand and gravel, lime, natural gas liquids, natural gas, gypsum, uranium ore.
Las Animas	5,951,626	5,571,654	Coal, sand and gravel, clays.
Lincoln	86,000	168,051	Sand and gravel, stone.
Logan	12,003,400	11,985,129	Petroleum, natural gas liquids, natural gas, sand and gravel, lime, stone.
Mesa	6,903,154	8,472,144	Uranium ore, vanadium, natural gas, sand and gravel, coal, natural gas liquids, stone.
Mineral	1,590,385	1,449,094	Zinc, lead, silver, copper, sand and gravel, gold, stone.
Moffat	5,825,404	6,281,631	Petroleum, natural gas, coal, sand and gravel, natural gas liquids, gold.
Montezuma	4,584,283	3,145,470	Petroleum, natural gas, sand and gravel, stone, carbon dioxide, uranium ore.
Montrose	11,539,155	12,481,811	Vanadium, uranium ore, coal, sand and gravel, salt, stone, gold.
Morgan	7,835,000	7,222,788	Petroleum, natural gas liquids, natural gas, sand and gravel, lime, stone.
Otero	W	445,256	Sand and gravel, lime, stone.
Ouray	1,956,414	2,287,982	Zinc, lead, copper, silver, gold, sand and gravel, stone.
Park	397,944	203,238	Peat, sand and gravel, lead, silver, zinc, copper, gold, stone, uranium ore.
Phillips	156,000	162,000	Sand and gravel.
Pitkin	9,781,447	10,954,847	Coal, stone, iron ore, natural gas, sand and gravel, silver, lead, zinc, copper.
Prowers	136,000	184,562	Sand and gravel, stone.
Pueblo	W	3,040,333	Sand and gravel, lime, clays, zinc, stone, lead, silver, copper, gold.

See footnotes at end of table.

Table 20.—Value of mineral production in Colorado, by counties[1]—Continued

County	1965	1966[2]	Minerals produced in 1966 in order of value
Rio Blanco	$55,582,130	$60,582,469	Petroleum, natural gas liquids, natural gas, vanadium, sand and gravel, uranium ore, coal.
Rio Grande	83,800	70,000	Sand and gravel.
Routt	4,458,507	5,627,187	Coal, petroleum, pumice, sand and gravel.
Saguache	W	92,303	Sand and gravel, lead, zinc, silver, copper, stone, gold, uranium ore.
San Juan	4,553,906	4,554,802	Zinc, lead, silver, copper, gold, uranium ore.
San Miguel	15,244,780	16,933,288	Vanadium, zinc, lead, uranium ore, copper, silver, gold, sand and gravel, iron ore, stone.
Sedgwick	200,400	165,000	Lime, sand and gravel, natural gas.
Summit	167,002	60,622	Sand and gravel, lead, copper, gold, silver.
Teller	94,850	77,000	Peat, sand and gravel, stone.
Washington	16,728,040	14,383,000	Petroleum, natural gas liquids, sand and gravel, natural gas.
Weld	8,541,143	8,876,991	Petroleum, coal, sand and gravel, natural gas, lime, natural gas liquids, stone.
Yuma	202,000	188,000	Sand and gravel, petroleum.
Undistributed	r 4,953,052	80,000	
Total	r 331,168,000	352,005,000	

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

[1] Denver County not listed because no production was reported.

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

Three-fourths of the county output, 1 million tons, came from commercial operations. Miscellaneous stone, accounting for the remaining 2 percent of the county value, was produced by contractors of the Colorado Department of Highways for use as riprap.

The Arapahoe District Court ruled null and void zoning regulations approved by the Arapahoe County Commissioners; these regulations would have allowed sand and gravel operations within 300 feet of the Columbine Hills residential area. Columbine Homeowners, Inc., Columbine Hills, Inc., and Robert H. Koran, Inc., had brought suit against the commissioners.

Baca.—Natural gas and petroleum again contributed most, 94 percent, of the mineral output value. Production of natural gas increased 71 percent because of pipeline facilities built in 1965; crude oil yield, however, was down by 45,000 barrels. The Morrow Formation (Pennsylvanian) in the Flank field was the source of 99 percent of the petroleum output of the county; that field, including its four other productive formations, contributed 58 percent of the natural gas production.

A new field discovery, Davis Drilling, Inc., No. 1–19 Strobel, sec 19, T31S, R44W, opened the Vilas field, with a completion gage of 5.4 million cubic feet of gas per day from the Topeka Formation (Pennsylvanian). In September, Falcon Seaboard Drilling Co. and W. C. McBride, Inc., discovered gas in the Topeka at their No. 1–36 St. John-State well, 4 miles north of the Davis discovery; it was included in the Vilas field. At yearend, no pipeline outlets were available to the field.

Crews and contractors for the Colorado Department of Highways produced sand and gravel for road building; one contractor also produced miscellaneous stone. Some sand and gravel was produced by F & G Concrete & Construction Co.

Boulder.—Mineral production increased only $75,000 above that of 1965. Of the 13 mineral commodities produced, sand and gravel comprised 60 percent of the total county mineral production value. Sand and gravel output, fifth highest in the State, was up 218,000 tons. Commercial producers, according to output, were Boulder Gravel Products, Inc., Golden Transfer Co., Asphalt Paving Co., Western Paving Construction Co., Turnpike Gravel Co., and Pastore Gravel Co.; the combined output of these producers was 1,258,000 tons, 91 percent of the total. Crews of the Boulder County Highway Department and a contractor for the Federal Bureau of Public Roads produced 129,000 tons, the balance of the sand and gravel output.

Canyon Mining Corp. mined tungsten ore from the Eureka mine and produced concentrates. This was the first tungsten production in the county since 1959. Output of uranium ore again was reported after a lapse of 1 year. Production was by

East Range Mining Co. from the Lady Bug mine.

Silver, lead, and zinc were recovered from ore mined by Hope Mining Corp. at the J. Albion mine. Some silver came from the Clipper and Clipper No. 2 property operated by Clipper Mining Enterprise. Small quantities of gold, silver, and lead came from unknown mines.

Stone production dropped from 131,214 to 44,940 tons. Five companies, one individual, and the University of Colorado produced sandstone and three companies, including two contractors for the Colorado Department of Highways, produced miscellaneous stone.

Clay production, up 10,000 tons, came from five operations. Miscellaneous clay was produced by Colorado Brick Co. (two operations) and by Denver Brick & Pipe Co., and fire clay by Kaiser Aluminum & Chemical Corp. and Stroud Whisenhunt. Allied Chemical Corp. produced acid-grade fluorspar at its Valmont mill from crude ore mined at its Burlington mine.

Quicklime was produced by The Great Western Sugar Co. at its Longmont plant for making sugar.

Peat production, about the same as in 1965, came from deposits operated by Beaver Lake Peat Co., Caribou Ranch and Country Club, McCoy & Jensen, and Western Peat Co. McCoy & Jensen mined humus peat; the other three mined moss peat. The petroleum output, less than 2,000 barrels, came from the Boulder field, the only one in the county.

Clear Creek.—The value of mineral production rose to $668,566 primarily because of substantial increases in stone and sand and gravel production stimulated by more road construction. Nine underground mines, a mine-dump recovery operation, and an assay office cleanup accounted for the production of gold, silver, copper, lead, and zinc. The value of these five metals was $47,670, compared with $106,824 in 1965; gold was the only metal that increased in quantity and value.

Climax Molybdenum Co. continued development of its Urad molybdenum mine. Scheduled for production in mid-1967, the operation was designed to produce 5,000 tons of ore per day and 7 million pounds of molybdenum annually. Additional exploration, primarily diamond drilling, was conducted on the Henderson molybdenum deposit found in 1965 near the Urad mine. To obtain necessary data for mine planning and cost estimating, the company planned to sink a 23-foot-diameter shaft to a depth of 2,350 feet for access to this new ore body.

Delta.—Mineral production increased $881,000 in value because of 63 percent more coal mined than in 1965. Coal producers, in order of output, were United States Steel Corp. from that part of the Somerset mine in the county, Green Valley Coal Co. from the Green Valley No. 2, The Juanita Coal & Coke Co. from the King mine, Red Canon Coal Mine from the Red Canon, Emmons Coal Co. from the Emmons, and States Coal Co. from the Top. Production by United States Steel was captive; that from the other five producers was sold in the open market.

Holly Sugar Co. produced quicklime at its Delta plant for making sugar. The output of sand and gravel came from six operations. Delta Sand and Gravel Co. and Paonia Ready Mix were the only commercial producers. Maintenance crews of the Colorado Department of Highways and the Delta County Highway Department also produced sand and gravel. Crushed granite for road construction was produced by a contractor for the U.S. Forest Service.

Dolores.—The value of mineral production was below that of 1965. Output of gold, silver, copper, lead, and zinc came from the Rico Argentine mine of Rico Argentine Mining Co. and the Payroll mine of Helen Hicks; production value of these metals was $231,000 below the 1965 value because less gold, silver, lead, and zinc were recovered at the Rico Argentine operation. In addition to selling some previously stockpiled brown iron ore (limonite), Rico Argentine Mining Co. mined and sold a small quantity of pyrite.

Sand and gravel and crushed basalt and granite were produced by contractors for the Federal Forest Service. Maintenance crews of the Dolores County Highway Department produced crushed sandstone and miscellaneous stone.

Eagle.—After a lapse of 1 year, mineral production, rising $742,000 in value, again exceeded $10 million. Increases in stone and sand and gravel production more than offset declines in gold, silver, copper, lead, zinc, and pumice. The New Jersey Zinc Co. produced zinc and copper ores at its Eagle

mine in Gilman. The mine was ranked first in the State in output of zinc, second for copper and silver, and third for gold and lead. County stone production was the second highest in the State. Except for 1,430 tons, the 1.5 million ton output was crushed sandstone used for fill in the construction of the Ruedi Dam of the Bureau of Reclamation. Some dimension sandstone used as flagging was produced by R. E. Gordon. A contractor for the Colorado Department of Highways quarried miscellaneous stone for riprap. Volcanic cinders, classed as pumice, were mined by Dotsero Block Co. and Roaring Fork Pumice Co. The output of sand and gravel was produced by contractors for the State and county highway departments, Federal Forest Service, and cities of Aurora and Colorado Springs, and by maintenance crews of the State highway department.

El Paso.—The value of mineral production increased $157,000. Sand and gravel production, up 238,000 tons, amounted to 62 percent of the county total value. The output from 10 Government-crew and -contractor operations of the State and county highway departments and the Colorado Springs Street Department accounted for 57 percent of the county sand and gravel production; that from 7 commercial operations amounted to 43 percent. The principal commercial producers, in order of output, were Transit Mix Concrete Co., Broderick & Gibbons, Inc., and Castle Concrete Co.

Colorado Lime Co., Inc., quarried limestone and produced quicklime at its Colorado Springs operation. Crushed sandstone was produced by Springs Silica Sand Co. and Colorado Quartz & Minerals Corp. Contractors for the State highway department quarried miscellaneous stone for riprap. Fire clay mined by A. P. Green Refractories Co. was used for making firebrick and sewer pipe; that mined by Robinson Brick & Tile Co. from two operations was used for making building brick. The National Clay Products Co. mined miscellaneous clay for making building brick. Smith Brothers obtained beryl from the Lone Pine Hill Top mine.

Fremont.—Mineral production value decreased $452,000. Gains in value of beryllium concentrate, coal, feldspar, and sand and gravel were not enough to offset the losses in cement, clays, gypsum, petroleum, stone and uranium ore.

Portland and masonry cement shipments from the Ideal Cement Co. plant at Portland declined. The company, in conjunction with its cement operation, quarried limestone and sandstone. Other stone producers and the kind of stone quarried were Lockhart & Sons (granite, marble, and sandstone); Rocky Mountain Aggregates, Inc. (sandstone and miscellaneous stone); Colorado Granite Co. (granite); CF&I Steel Corp. (limestone); Colonna & Company of Colorado, Inc., and Cowan Bros. (marble); A. P. Green Refractories. Smith Bros., and Ray B. Sturbaum (sandstone); and O. L. Braly and the Colorado Department of Highways (miscellaneous stone).

Clay production decreased 15,000 tons, 56 percent; four of the five producers had reduced outputs. Silver Rocker Bentonite Co. produced bentonite for pelletizing animal feed and lining reservoir ponds. Fire clay was mined by George O. Stroup (three operations) and Notaeb Development Co. for making building brick; by Harbison-Walker Refractories for making firebrick; and by Irvin Clay Co. for making firebrick and sewer pipe.

The output of coal, up 18,000 tons, came from 1 auger, 2 strip, and 14 underground operations. The output from the auger and strip operations was 23,639 tons; that from the underground operations, 277,041 tons. At one mine, the Beer No. 2 of Beer Coal & Construction, Inc., recovery of coal was by both auger and stripping operations. The other strip operation was that of Annex Coal Co. Underground operators, in order of output, were The Corley Co., Canon Black Diamond Coal Co., Vento Coal Co., Cedar Canon Coal Co., Golden Quality Coal Co., Twin Pines Coal Co., Rex Carbon Fuel Co., Canon Monarch Coal Co., Last Chance Coal Co., Canon National Coal Co., Canon Liberty Coal Co., Coal Creek Canon Mining Co., Double Dick Coal Co., and Nick J. Moschetti.

Part of the gypsum produced by Fibreboard Corp. was calcined for making gypsum building products at the company plant at Florence; part was sold uncalcined for use as a portland-cement retarder. Colorama Rock Products Co., L & L Trucking, and U.S. Conditioning Co. produced and sold uncalcined gypsum for agricultural purposes.

The only output of feldspar in the State was produced by Lockhart & Sons from the

Mica Lode mine. Ralph J. Pierce and some unknown operators produced some beryllium concentrate. Heisen & Earl mined uranium ore from the Dicksen Lease, Knob Hill, and Last Chance properties. A small quantity of iron ore (magnetite) was mined and sold by Dewight Sims for use as a heavy aggregate. Production at the old Florence-Canon City oilfield was continued at about the same level as in 1965. Sand and gravel production, up 142,000 tons, consisted of 85,000 tons from four commercial operations and 146,000 tons from Government-crew and -contractor operations.

Garfield.—With an increase of $560,000, mineral production value surpassed $3 million. Of the seven mineral commodities produced, only coal and uranium ore had decreases in value. Uranium and vanadium were recovered from ores mined at the North Star and Rifle mines of Union Carbide Corp. and the Garfield mine of Climax Uranium Co. Coal production came from three small underground mines operated by Bendetti Brothers, Bradley Bros. Enterprise, and Four Mile Coal Co., Inc. Most of the limestone quarried by Basic Chemical Corp. was used to make lime at the company plant at Glenwood Springs. Limestone production by Frank H. Norberg Co. was sold for making lime at a beet sugar plant. A contractor for the Colorado Department of Highways mined miscellaneous stone for riprap and for use as an aggregate in concrete and in road construction.

Sand and gravel was produced by three commercial operators: Brasiers Brothers Construction, Carmack Construction Corp., and Zemlock & Sons, Inc.; one contractor working for the U.S. Forest Service; and one for the Colorado Department of Highways. Marketed natural gas was up 6 percent because of new pipeline outlets in the county.

Oil shale research was carried on throughout the year at the Federal Bureau of Mines Anvil Points mine and plant leased to the Colorado School of Mines Research Foundation, Inc.

Gunnison.—Although coal production increased in value, the seven other mineral commodities decreased resulting in an overall decline of $730,000 in the county mineral production value. Although there was one less operation than in 1965, coal production from six underground mines increased 60,000 tons. Producers and their mines, in order of output, were United States Steel Corp. (that part of the Somerset mine situated in the county), Bear Coal Co. (Bear), Champion Coal Mining Co. (Hawk's Nest), Nu-Mine Coal Co., Inc. (Nu-Mine No. 2), Ellis Coal Co. (Black Beauty), and Baldwin Coal (Baldwin).

The combined output value of gold, silver, copper, lead, and zinc decreased, even though more mines were operated. This was due to a drop in production from the principal mine, the Keystone operated by McFarland & Hullinger; this mine, however, still accounted for 95 percent of the total combined value of these five metals. Other producing mines were the Daisy and Micawber mines operated by Elk Mountain Mining & Milling Corp.; Clipper, Lucas, and Shakespeare (one mine) by M. C. Double B Mining Corp.; Ruby mine by Ruby Mining & Drilling Co.; and Virginia mine by Lacy Elfin Construction Co.

Stone and sand and gravel production had value decreases of $372,000 and $284,000, respectively, mainly because the Bureau of Reclamation Blue Mesa Dam project was completed. Stone output consisted of crushed granite produced by the Gunnison County Highway Department and a contractor for the U.S. Forest Service and crushed miscellaneous stone by two contractors for the Colorado Department of Highways. Sand and gravel production came from two commercial and three Government-crew and -contractor operations.

Jackson.—Petroleum and natural gas comprised 91 percent of the value of mineral production. The South McCallum field was shut in throughout the year, leaving three productive fields in the county. McCallum, the leading field, with output of 188,319 barrels of oil, was followed by Battleship (80,523 barrels) and Canadian River (4,733 barrels) fields. The small quantity of marketed natural gas produced from the Lakota (Cretaceous) reservoir in the Canadian River field was sold to the town of Walden and to Continental Oil Co. for fuel in the McCallum field. Sand and gravel output was by a contractor for the U.S. Forest Service and by the Jackson County Highway Department.

Jefferson.—Three-fourths of the county mineral production value was derived from sand and gravel. Down 56,000 tons, but still

the second largest in the State, output came from 17 commercial and four Government-crew and -contractor operations. Commercial operations accounted for 81 percent of the sand and gravel production. The principal commercial producers (those with over 100,000 tons of output), in order of output, were Asphalt Paving Co., Rio Grande Gravel Co., Western Paving Construction Co., and Lee Sand and Gravel Co.

With 70 percent of the State output, the county was the major source of clays. Production, up 5,000 tons, came from 21 operations, 3 more than in 1965. Fire clay production was 26,742 tons or 7 percent of the county output; that of miscellaneous clay was 372,232 tons, 93 percent.

Fire clay producers, in order of output, were Robinson Brick & Tile Co. (two operations), Leland Doughty, Denver Brick & Pipe Co., Garnett C. Bennetts & Sons (two operations), and Kaiser Aluminum & Chemical Corp. (three operations). Miscellaneous clay producers, in order of output, were The Idealite Co., Clalite Concrete Products, Inc., George W. Parfet Estate, Inc., Colorado Brick Co., Robinson Brick & Tile Co., H. M. Rubey Clay Co., The Lakewood Brick & Tile Co. (three operations), and Denver Brick & Pipe Co. (three operations).

Stone production increased 12,000 tons. The output—consisting of granite, sandstone, and miscellaneous stone—came from eight commercial and two Government-contractor operations. The principal producers were Hamilton Mining Co. (two operations), Table Mountain, Inc., and a contractor for the State highway department (Western Paving Co.); the combined output of these three producers was 24,500 tons, 96 percent of the county output.

Gold and silver were recovered as byproducts at four commercial sand and gravel operations. Gold, silver, copper, and lead were recovered from ore mined at the Augusta mine operated by C & S Mining Co., Inc. After a lapse of 1 year, uranium ore was produced; the output came from the Grapevine mine operated by E. E. Lewis, Inc. The Schwartzwalder uranium mine, acquired by Cotter Corp., was reopened in July, ore mined was stockpiled and, therefore, not reported as production.

Kiowa.—Except for 90,000 tons of sand and gravel, all mineral production in the county was mineral fuels. Because of rapid development of the Brandon field Mississippian reservoir, petroleum output increased nearly eightfold; output rose from 11,803 barrels in 1965 (from one well in 3 months) to 189,358 barrels in 1966 (from nine wells). Output of natural gas liquids from the Fleetwood Drilling Co, plant at McClave field nearly tripled. Sand and gravel production was only one-half that of 1965, and was produced by the State and county highway departments and a contractor for the State highway department.

Lake.—The county not only had the highest value of mineral production in the State but also the largest increase over that of 1965, $11.9 million. This was due primarily to an increased molybdenum output of 6.6 million pounds (worth $10.2 million) at the Climax mine of Climax Molybdenum Co. Of the 10 mineral commodities produced in the county, molybdenum accounted for 96 percent of the total value. Besides molybdenum, the Climax mine was also the source of pyrites, rare-earth minerals (in monazite concentrate), and tin and tungsten concentrates; these four mineral products were recovered as byproducts from the molybdenum ore.

Less than 1 percent of the county value was derived from the five mineral commodities not obtained from the Climax mine. A few troy ounces of gold and silver were recovered from a placer deposit operated by Fred W. Garner & Harry O. Nylene. Peat production, the same as the 1965 output, came from a moss-peat deposit mined by Mt. Elbert Peat Moss Co., Inc.

A contractor for the Colorado Department of Highways produced miscellaneous stone for riprap. Two-thirds of the sand and gravel output was produced by C. Ryan & Son, Inc., mainly for mine-development work at the Climax mine. The balance of the sand and gravel was produced by contractors for the Bureau of Reclamation and State highway department and by crews of the State and county highway departments.

Resurrection Mining Co., a wholly owned subsidiary of Newmont Mining Co., and American Smelting and Refining Co. continued work in a joint venture to develop at depth the Ibex-Sunday-Helena lead-zinc-silver property near Leadville. After the Irene shaft at the property had been dewatered, development work was done on the 1,800-foot level, lowest of the mine.

La Plata.—Marketed natural gas and natural gas liquids, largely from the Ignacio-Blanco gasfield, comprised 94 percent of the total value of mineral production. Natural gas, valued at $7 million, amounted to 39 percent of the value of marketed natural gas in the State. Production from the three reservoirs in the Ignacio-Blanco field were[13] Dakota pool, 15.1 billion cubic feet; Fruitland-Pictured Cliffs pool, 315.5 million cubic feet; and Mesaverde pool, 22.5 billion cubic feet. The San Juan gasoline plant of El Paso Natural Gas Co., largest in the State, processed 61.7 billion cubic feet of gas and recovered 861,000 barrels of liquids.

After 9 years, uranium ore production was again reported in the county; however, the output, all from the Stearns property operated by Bailey & Fife, was small. Gold, silver, and copper were recovered from the Bessie G. mine dump by Mineral Concentrates & Chemical Co., Inc. Peat production, about one-half that of 1965, came from one operation, whereas there were two in 1965; the moss peat was mined by Art's Truck Service. Although there was one more coal operation than in 1965, coal production decreased 4,300 tons. It was produced from six small underground operations by Hesperus Coal Co., King Coal Mine, Morning Star Coal Co., Oren A. Pilcher (two operations), and Victory Coal Co. Crushed granite was produced by a contractor for the U.S. Forest Service and crushed and broken miscellaneous stone by a contractor for the Colorado Department of Highways. Sand and gravel output came from three commercial and four Government-and-contractor operations.

Larimer.—Mineral production decreased $1.6 million in value, resulting from substantial declines in the production values of cement, stone, and sand and gravel. These decreases were due mostly to less road construction than in 1965, especially on Interstate Highway 25.

Portland and masonry cement shipments were from the Boettcher plant of Ideal Cement Co. Regardless of the decline in the output of cement, this commodity still accounted for most of the county mineral production value.

Gypsum produced by Ernest W. Monroe was sold for use as a portland-cement retarder. The Great Western Sugar Co. produced lime at its Loveland sugar beet plant for use in the plant operation. A small quantity of uranium ore was shipped from the Red Hill mine; the previous reported uranium ore production was in 1964.

Stone production, up 3,000 tons, came from 22 operations, 3 less than in 1965. Ideal Cement Co., the leading stone producer, quarried limestone for making cement. Frank H. Norberg Co. obtained limestone from two operations and sold the output for making cement and lime. Limestone quarried by Pinon Grove Lime Co. went for making cement. Phillips Stone Co. produced dimension limestone in the form of rough-construction building stone. Crews of the Bureau of Reclamation quarried granite and sandstone for riprap. Rocky Mountain Aggregates, Inc., produced crushed sandstone for precasting. A contractor for the Colorado Department of Highways quarried some miscellaneous stone for riprap. Dimension sandstone was obtained by 9 producers from 11 operations; the output was used as building stone and flagging. The producers, in order of output, were Colorado Stone Co. (three operations), Arkins-Olin Quarry, Weaver Stone Co., Arthur Ohline, Berthoud Pink Stone Co., Jacobson-Lyons Stone Co., Inc., Lyons Native Stone, Inc., Colorado Quarries, and King & F. R. Koenig.

Output of sand and gravel totaled 973,000 tons, a decrease of 459,000 tons from that of 1965. Commercial production was 552,000 tons. The principal commercial producers, those with outputs over 100,000 tons, were Flatiron Paving Co. of Greeley and Sterling Sand & Gravel Co. Six commercial operators had production of less than 100,000 tons. Crews of the U.S. Forest Service and the Federal Bureau of Reclamation and contractors for the Colorado Department of Highways produced 421,000 tons of sand and gravel.

Because of additional development in the Loveland and Wellington fields, petroleum yield was 64,000 barrels greater than in 1965. Output from the Lakota reservoir in the Loveland field increased 61,000 barrels to a total of 90,000. Production of natural gas liquids from the Associated Oil & Gas Co. plant at Loveland was twice that of 1965.

Las Animas.—Only three mineral com-

[13] Work cited in footnote 10, Part II, Oil and Gas Production, pp. 12–22.

modities, two less than in 1965, were produced in the county; however, coal alone was enough to raise the value of county mineral production above $5 million. The county had the second-highest coal production in the State; the output, down 27,000 tons, came from six underground mines, three less than in 1965. Of all coal operations in the State, the Allen mine of CF&I Steel Corp. had the highest production; the output was shipped to the company steel plant at Pueblo and converted to coke for use in the steel process. The other coal producers, in order of output, were Eugene Lopez, Albert Iuppa & Son Coal Co., Sonchar Coal Co., Maschio Coal Co., and Guadagnoli Bros. Clay production, all fire clay for making firebrick, came from mines operated by A. P. Green Refractories Co., Harbison-Walker Refractories Co., and Scott Mining Co. Sand and gravel was produced by Frank Leone Sand & Gravel and by the State and county highway departments.

Logan.—The mineral fuels—natural gas, natural gas liquids, and petroleum—constituted 94 percent of the value of mineral production. Although all three were down in quantity, natural gas liquids registered a small increase in value because of higher unit prices. Produced from 338 wells in 76 fields, petroleum, valued at $10 million, was the most valuable mineral commodity. Six fields in the county were ranked among the 25 principal oilfields in the State. Five of the 1966 discovery wells were in the county. Initial potentials for the oil discoveries ranged from 5 to 160 barrels per day; and the gas discovery was completed for 2.5 million cubic feet per day. The three gasoline plants—at the Minto, Padroni, and Yenter fields—had a total gas input of 4.4 billion cubic feet yielding 299,000 barrels of liquids. No new pressure-maintenance projects were initiated; the number was unchanged: 1 gas-injection and 10 waterfloods.

Lime was produced by The Great Western Sugar Co. at its Sterling beet sugar plant for use at the plant.

Crushed miscellaneous stone was produced by a commercial operator and a contractor for the Colorado Department of Highways. Three commercial operators produced 78,000 tons of sand and gravel; contractors for the Colorado Department of Highways produced 550,000 tons.

Mesa.—Gains of nearly $1.1 million and $500,000, respectively, in the production of marketed natural gas and vanadium, resulted in an increase of $1.6 million in the value of county mineral production. Increases in the value of uranium ore and natural gas liquids were offset by decreases in coal, stone, and sand and gravel production, and the loss of clay production.

Uranium ore production, up 20,000 tons, came from 65 operations. Only one operation, the Bonanza No. 2 operated by Climax Uranium Co., had production exceeding 10,000 tons. Of the 18 shippers, Climax Uranium Co., Union Carbide Corp., Beaver Mesa Uranium, Inc., Shipman Mining and Exploration Co., Foster and Sons, and Vanadium Corporation of America were, in the order given, the major firms. Combined output of these six companies was 94 percent of the county production. Vanadium oxide was recovered from the uranium ore during milling operations. Climax Uranium Co. operated its uranium mill at Grand Junction throughout the year; ores from company operations and from some independent producers were treated at this mill for recovery of uranium and vanadium.

Primarily because of the pipeline outlet to the Divide Creek field made in November 1965, marketed natural gas in the county tripled. In its first full year of operation, the field yielded 7.4 billion cubic feet of gas. The Divide Creek field was unusual in that its location, nearly 10,500 feet above sea level, imposed operating handicaps: deep snows necessitated use of special vehicles; severe cold required heavily insulated facilities; and the remoteness required constant radio communication with personnel in the field. The Fruita gasoline plant of Continental Oil Co. processed 5.2 billion cubic feet of gas to recover 103,000 barrels of liquids. Late in the year, Western Slope Gas Co. commenced construction of a pipeline outlet for the 4-well Hunters Canyon field. The line, about 11 miles long, was to be on very steep slopes—some even vertical; facilities were to include four dehydrators and a compressor station.

Coal production, down 4,000 tons, came from six underground mines operated by Willis Barstow, Eagle Head Coal Co., Rudolph & Alta M. Fontanari, The Juanita Coal & Coke Co., H. B. Phillips, and Relia-

ble Coal and Mining Co. Of the coal output, 81 percent was produced by The Juanita Coal & Coke Co. Kelly Stone Co., from two operations, and the State Home & Training School produced dimension sandstone used either as flagging or as building stone. Crushed miscellaneous stone was produced for road construction. Sand and gravel output decreased 254,000 tons. Fruita Ready Mix Sand & Gravel, United Sand & Gravel Co., and Whitewater Building Materials Co. produced the commercial output of 293,000 tons. A contractor for the Colorado Department of Highways and crews of the Mesa County Highway Department produced 510,000 tons.

Mineral.—Except for $33,213 worth of stone and sand and gravel, the county value was derived from the production of gold, silver, copper, lead, and zinc. These metals came from two mines, the Emperius of Emperius Mining Co. and the Equity of Equity Mines, Inc. The Emperius mine accounted for 96 percent of the county value of mineral production. Homestake Mining Co. continued exploration work at its Bulldog silver property.

Miscellaneous stone was quarried for riprap by contractors for the Colorado Department of Highways. Sand and gravel was produced by and for the State highway department.

Moffat.—Of the value of mineral output 91 percent was created by coal, natural gas, natural gas liquids, and petroleum. Although petroleum displaced marketed natural gas as the most valuable mineral commodity, the latter remained a significant factor; the county was again ranked second in marketed natural gas. The leading gasfields were West Hiawatha, with output of 5.9 billion cubic feet, and Powder Wash, with output of 3.1 billion cubic feet. Petroleum production was up 123,000 barrels. Output from the new field discovery at Horse Gulch field and the new pay discovery at Maudlin Gulch (the Dakota horizon) more than offset the normal decline in the older fields. Horse Gulch yielded 92,976 barrels and Maudlin Gulch (Dakota) 93,512. Western Slope Gas Co. processed 28 million cubic feet of wet gas at its new Buck Peak gasoline plant and recovered 1,000 barrels of liquids.

Coal production, virtually the same as in 1965, came from two underground mines operated by Colowyo Coal Co. and Silengo Coal Co. A small amount of gold was recovered from the Amazon placer operated by 3–B Mining Co., Inc. The output of sand and gravel increased 361,000 tons. Five commercial operators produced 67,000 tons. Crews of the State and county highway departments and contractors for the State highway department and the Bureau of Public Roads produced 514,000 tons. Road construction for the Bureau of Public Roads required 341,000 tons. A substantial number of placer claims for platinum were staked in the northwest part of the county. The boom was shortlived, however, after the U.S. Geological Survey reported that samples taken at the richest "find" contained platinum worth only a few cents per ton.

Montezuma.—Output of carbon dioxide from the McElmo field was 4 percent below that of 1965. Colorado Carbonics, Inc., continued to use the total output for manufacturing dry ice and liquid carbon dioxide.

Petroleum production decreased 484,000 barrels, a $1.4 million loss in value; most of the decline occurred at Cache field (down 422,000 barrels) and Flodine Park field (down 53,000 barrels). Although output decreased, Cache field was ranked fifth in the State in production. Marketed natural gas was 3.1 billion cubic feet.

Small quantities of uranium ore were shipped by Elree Young from the Blue Eagle 1 mine and by W. D. Tripp from the C B claims. Stone—granite, sandstone, and miscellaneous—was produced by contractors for the U.S. Forest Service, the Bureau of Public Roads, and the Colorado Department of Highways. Three commercial operators produced 85,000 tons of sand and gravel; a contractor for the Bureau of Public Roads and crews of the State and county highway departments produced 221,000 tons.

Montrose.—With an increase of nearly $1 million in mineral production value, the county rose from seventh to fifth place in the State. All mineral commodities except sand and gravel and stone had gains in value over those of 1965; in addition to the commodities produced in 1965, gold was also produced this year. Uranium ore and vanadium accounted for most of the county value. The output of uranium ore, largest in the State, increased 12 percent in

quantity but less than 1 percent in value because more lower priced ores were mined than in 1965. Average grade of the uranium ore was 0.22 percent uranium oxide (U_3O_8), 0.02 percent lower than that of 1965. Uranium ore production came from 195 operations, 60 more than in 1965. Of the operations 45 had production of less than 100 tons, 86 between 100 and 1,000 tons, 60 between 1,000 and 10,000 tons, and 4 with over 10,000 tons. The largest operation was the Eula Belle mine operated by Union Carbide Corp. Of 29 operators, Union Carbide Corp., Climax Uranium Co., and Vanadium Corporation of America had, in the order given, the largest production, cumulatively accounting for 95 percent of the county output. Union Carbide Corp. operated its Uravan uranium mill throughout the year.

The county was also the principal source of vanadium in the State. The vanadium was recovered from uranium-vanadium ores. Although more ore was produced, less vanadium was recovered because the vanadium content of the ores processed was slightly below that of 1965. However, because of an increase in price, the value of the vanadium was substantially higher than in 1965.

Coal production from the Nucla strip mine operated by Peabody Coal Co., increased 11 percent. A small quantity of gold, mined in 1965 from a placer deposit, was reported as production. Union Carbide Corp. obtained salt brine from a well for use at its Uravan uranium mill. Contractors for the Colorado Department of Highways produced miscellaneous stone for riprap. The output of sand and gravel, down 37,000 tons, was produced by one commercial operator, Montrose Concrete Products Co., and by crews and contractors for the State and county highway departments.

Morgan.—Mineral fuels comprised 89 percent of the value of mineral production in the county. However, all of the three fuel commodities decreased in quantity and value: Marketed natural gas was down 20 percent in volume and 21 percent in value; natural gas liquids was down 17 percent and 7 percent, respectively; and petroleum was down 11 percent in quantity and value. Petroleum, worth $3.8 million, was the most valuable mineral commodity; natural gas liquids, valued at $1.5 million, was second; and natural gas, valued at $1.1 million, was third.

The Adena field was again the leading field in the county; although oil production was down 29 percent, the field was ranked sixth in the State. A total of 5.2 million barrels of water was injected into the "J" sandstone to maintain pressure in the reservoir. Because of development in the Boxer field, discovered in 1965, it was ranked second in the county with output of 217,879 barrels of oil.

Four new waterflood projects begun during the year raised the county total to 10. In the Orchard field, two units were established in the "D" sandstone reservoir. Water injection in the West Unit was begun on June 3; by yearend, 91,489 barrels had been injected. Injection was begun in the East Unit on June 15; by yearend, 159,040 barrels of water had been injected. Waterflooding began in the "D" sandstone at the Rake field on December 24. Water injection began in the "D" sandstone of the Sand River on September 15 totaled 80,155 barrels by yearend.

The four gasoline plants processed 8.1 billion cubic feet of natural gas from which 662,000 barrels of liquids was recovered. Three of the plants processed less gas and had lower output; the Vallery plant, however, had slightly higher yield of liquids from virtually the same volume of gas.

Lime for use in making sugar was produced at The Great Western Sugar Co. plant at Fort Morgan. Crews and contractors for the Colorado Department of Highways produced miscellaneous stone for road construction. Four commercial operators produced 106,000 tons of sand and gravel; contractors for the State highway department and crews of the State and county highway departments produced 505,000 tons.

Ouray.—Gold, silver, copper, lead, and zinc—from six underground mines—accounted for 99 percent of the county mineral production value. Most of the metals came from ores produced from that part of the Idarado mine in the county. A large part of the mine, operated by Idarado Mining Co., was situated in San Miguel County. The other producers and the mines they operated were Federal Resources Corp. (Camp Bird and Revenue

Tunnel), San Juan Mines, Ltd. (Little Mike), Willreed Mining & Milling, Inc. (Seniorita), and Kuykendall Mines, Inc. (Wewissa).

The only other mineral production was crushed miscellaneous stone and sand and gravel valued at $23,426. Stone was produced by a crew and a contractor for the Colorado Department of Highways, and sand and gravel by the State and county highway departments.

Park.—The county had the largest peat production in the State. Harvey F. Kemp mined moss peat; McCoy & Jensen and Universal Peat mined humus peat. A small quantity of uranium ore production, the first reported since 1963, was obtained by W. D. Tripp from the Goermer 1 mine. The value of gold, silver, copper, lead, and zinc production dropped from $113,676 in 1965 to $71,417, and came from two underground mines, one cleanup operation, and one placer mine. A contractor for the U.S. Forest Service produced crushed limestone. Sand and gravel was produced by and for the Colorado Department of Highways.

Pitkin.—The value of mineral production increased $1.2 million, thereby surpassing the $10 million mark. The gain was due to more stone being produced for the Homestake Dam than in 1965. Coal was still the leading mineral commodity in the county in terms of value, although output declined 49,700 tons. Three underground operations of Thompson Creek Coal and Coke Corp. and one of Mid-Continent Coal and Coke Co. provided the entire output. The Dutch Creek mine, operated by Mid-Continent, had the third highest production in the State. Near yearend, Thompson Creek closed down its operations for lack of sufficient markets.

Iron-ore production, all from the Pitkin Iron Corp. magnetite deposit operated by Morrison-Knudsen Co., Inc., increased substantially. Silver, copper, lead, and zinc came from the Smuggler mine dump. Aspen Consolidated Mining Co., a subsidiary of McCulloch Oil Corporation of California, erected a flotation mill for processing this and other old mine dumps at its Smuggler Mountain property near Aspen.

The county led the State in stone production. Most of the output was granite quarried by Morrison-Knudsen, Inc., the contractor for the cities of Aurora and Colorado Springs, for building the Homestake Dam. Hemann Sand & Gravel produced sand and gravel and miscellaneous stone and Charles M. Evans produced sand and gravel for road construction. The balance of the sand and gravel output was provided by contractors for the Bureau of Reclamation, U.S. Forest Service, and Colorado Department of Highways.

A new gas well was drilled by Sunray DX Oil Co. in the Wolf Creek gasfield, bringing the total to four; yield from the field was 1.7 billion cubic feet, 17 percent higher than in 1965.

Pueblo.—The value of mineral production increased over 1965; sand and gravel, with a production increase of 798,000 tons, accounted for nearly three-fourths of the total value. The 2-million-tons produced ranked the county third in the State in output of sand and gravel. Road construction on Interstate Highway 25 and U.S. Highway 50 was the principal reason for the production increase.

Contractors for the Colorado Department of Highways produced 1.1 million tons and crews of the Pueblo County Highway Department produced 52,000 tons. The commercial output of 818,000 tons was by Broderick & Gibbons, Inc., Certified Concrete Co., Fountain Sand & Gravel Co., Pueblo Sand & Gravel Co., and Yaron Sand & Gravel.

Clay production, down 15,000 tons, was from eight operations. The output, entirely fire clay, was by A. P. Green Refractories Co., Colorado Fire Clay Co., Denver Brick & Pipe Co., Garnett C. Bennetts & Sons, Harbison-Walker Refractories Co., Kaiser Aluminum & Chemical Corp. (two operations), and Red Mountain Clay Co. Miscellaneous stone production was by contractors for the Colorado Department of Highways and crews of the Pueblo County Highway Department. Granite for riprap was produced by crews of the Pueblo County Highway Department.

Gold, silver, copper, lead, and zinc were recovered from lead-zinc and lead concentrates obtained from cleanup operations of railroad cars.

Lime production, about the same as in 1965, was by CF&I Steel Corp. at its steel plant at Pueblo.

The company changed its name on August 1 from The Colorado Fuel & Iron Corp. to CF&I Steel Corp. Congressional legislation passed during the year per-

mitted CF&I to use the 25,105 tons of metallurgical grade fluorspar and 6,667 tons of ferromanganese stockpiled by the Federal Government at the steel plant for emergency use. However, these materials could only be used as they were replaced by the company with new materials at a new storage area at the plant. The exchange permitted CF&I to expand its facilities into the area where the stockpiles of fluorspar and ferromanganese were located.

Rio Blanco.—The county had the second highest value of mineral production in the State and the second greatest increase, $5 million. Mineral fuels—coal, natural gas, natural gas liquids, and petroleum—again accounted for virtually all the output value. Petroleum, valued at $56.2 million, comprised 93 percent of the total; Rangely and Wilson Creek fields dominated the output. Production from the Rangely Weber reservoir was 48.4 percent of the State yield of crude oil; if the Mancos reservoir was included, the percentage would be 49.8. The combined water- and gas-injection project in the Rangely Weber Reservoir had more water and less gas injected than in 1965; crude-oil output was 11 percent higher. Total water injected was 66.5 million barrels, compared with 64 the previous year; gas injected was 12.9 billion cubic feet, compared with 20.9 billion. The Rangely gasoline plant, owned by Chevron Oil Co., processed 22.4 billion cubic feet of gas for a yield of 968,000 barrels of liquids.

The two secondary-recovery projects at the Wilson Creek field were operated at a slightly higher level of activity in 1966. The waterflood program in the Sundance Formation used 12.3 million barrels of water, compared with 8 million; the combined water- and gas-injection project in the Morrison Formation used 770,000 barrels of water and 2.3 billion cubic feet of gas, compared with 687,000 barrels and 1.5 billion cubic feet, respectively.

Cascade Natural Gas Co. reported construction of a $500,000 compressor station at the Piceance Creek field. The station increased the capacity of the gas pipeline from the Divide Creek field, Mesa County, to Bonanza, Utah.

Coal production, down 800 tons, came from two underground mines operated by Jenkins & Mathis Coal Co. and Staley-Gordon Coal Co., Inc. The output of sand and gravel, one-third that of 1965, was produced by Albert Kirkpatrick, Robert T. Herman Construction, and contractors for the U.S. Forest Service. Uranium and vanadium were recovered from uranium ores mined by Climax Uranium Co., Deveraux Bros., and Harry H. Harp, Jr.

Routt.—Mineral production increased $1.2 million in value. The output of coal, up $1.1 million, comprised 93 percent of the county value. Most of the coal came from three strip mines: Edna of The Pittsburg & Midway Coal Mining Co., Energy of Energy Coal Co., and Seneca of Seneca Coals, Ltd. The Edna strip mine had the second highest coal production in the State, Seneca the fifth, and Energy the sixth. Dry Creek Coal Co. and Routt Mining Corp. produced coal from underground operations.

McCoy Aggregate Co. mined and sold scoria (classed as pumice) from a deposit near McCoy for use as concrete aggregate and for railroad ballast. The output of sand and gravel was by Jake Bettger & Son's and Bear River Sand & Gravel.

Petroleum production increased 7 percent, entirely because of improved performance at the Grassy Creek field where output was 67 percent higher than in 1965.

San Juan.—Base metal mining showed an increase in activity as 13 mines and one cleanup operation reported production compared with 9 mines in 1965. However, the value of county mineral production was not affected as it remained virtually the same as that of 1965. The Belle Creole, Brenneman, and Sunnyside mines of Standard Metals Corp. and the Osceola mine of Two-Bit, Inc., were the principal sources of the metal production; the combined output of the four mines accounted for 98 percent of the total county value. The Sunnyside mine had the second highest production of gold, lead, and zinc in the State. A small quantity of uranium ore was shipped by Loren E. Smith; the last reported uranium production in the county was in 1959.

San Miguel.—The county had the third highest mineral production value in the State, the highest combined value of gold, silver, copper, lead, and zinc production, and the second highest value of uranium ore and vanadium production. Three mines accounted for the gold, silver, copper, lead, and zinc production; however, one operation, that part of the Idarado

mine in the county, was responsible for most of the metal production. The Idarado mine of Idarado Mining Co. led the State in the production of gold, silver, copper, and lead and was second in the output of zinc. According to the 1966 annual report of Newmont Mining Corp. which owned 80.1 percent of Idarado, the production of metals was the highest ever recorded by the firm. The report stated that the ore grade—0.06 ounce of gold, 2.01 ounces of silver, 0.71 percent copper, 2.58 percent lead, and 4.18 percent zinc—was somewhat higher than that for 1965 because of increased production from the new higher grade "Cross Vein."

Although there were 72 operations compared with 56 in 1965, uranium ore production was about the same. Three operations, with production exceeding 10,000 tons, were the Deremo Lease and Burro mines of Union Carbide Corp. and the Sunrise mine of Vanadium Corporation of America. Of the 30 operators, Union Carbide Corp., Vanadium Corporation of America, and Climax Uranium Co. had the most production; the combined output of the three companies was 90 percent of the county production.

Vanadium was recovered from uranium-vanadium ores. Vanadium production was down 19 percent in quantity but less than 1 percent in value. An increase in price was responsible for the smaller decrease in value. Chas. Pfizer & Co., Inc., mined some brown iron ore (limonite) from the Iron Springs placer. The output of sand and gravel, down 53,000 tons, was by crews and contractors for the State Highway Department and San Miguel County Highway Department.

Washington.—The county had the largest decrease, $2.3 million, in value of mineral production in the State and dropped from third to fourth place. Of the value of mineral production 98 percent was contributed by the mineral fuels: Natural gas, natural gas liquids, and crude oil. Petroleum output, valued at $13.3 million, was 15 percent less than in 1965. Marketed natural gas declined 17 percent and natural gas liquids 24 percent. Although the county had the largest number of exploratory wells and of discoveries, all were relatively small in initial production; only one had an initial gage of over 100 barrels of oil per day.

Nine active waterflood projects were in operation in the county at yearend; the projects in the Phlegley and Xenia-West fields were inactive. A new project in the "J" sandstone reservoir at the Westfork field was initiated; injection beginning February 19 reached 979,680 barrels of water by yearend. The county had one natural gas liquids-extraction plant, that at Little Beaver owned by Continental Oil Co. The plant extracted 239,000 barrels of liquids from a throughput of 1.4 billion cubic feet of wet gas.

The output of sand and gravel was by contractors for the Colorado Department of Highways and crews of the Washington County Highway Department.

Weld.—Value of marketed natural gas was slightly higher than in 1965; conversely, values of natural gas liquids and crude oil were lower. The mineral fuels, however, comprised 88 percent of the value of mineral production. Petroleum, valued at $4.5 million, was the most valuable commodity, followed by coal. Two fields, Black Hollow and Pierce, were ranked among the principal fields in the State; Black Hollow was ranked third (after Rangely Weber and Wilson Creek) and Pierce was fifteenth. With commencement of two new waterflood programs, the county had six such projects in operation at yearend. The new projects were in the Lyons Formation (Permian) at Pierce field where water injection, begun June 28, totaled 356,933 barrels by yearend; in the "D" sandstone reservoir in the Southwest Roggen field, 475,589 barrels of water was injected between April 26 and yearend. The McWood Corp. plant at Southwest Roggen processed 230 million cubic feet of gas for a yield of 18,000 barrels of liquids. Gas input was down 22 percent; recovered liquids were down 48 percent.

Coal production decreased 19,000 tons. The output was from five mines operated by Boulder Valley Coal Co., Clayton Coal Co. (two mines), and The Imperial Coal Co. (two mines). The Great Western Sugar Co. produced lime at its plants in Eaton, Greeley, and Windsor for making sugar. Stone output increased from 888 tons to 10,780 tons. Most of the output was miscellaneous stone produced by a commercial operator and a contractor for the Colorado Department of Highways. A small quantity

of granite was produced by crews of the Bureau of Reclamation. Sand and gravel production was slightly more than twice that of 1965. The increase, 470,000 tons, was due primarily to construction work on Interstate Highways 25 and 80S. Five commercial operators produced 332,000 tons of sand and gravel and contractors for the Colorado Department of Highways and crews of the Weld County Highway Department and city of Greeley produced 541,000 tons.

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 Eugene C. Baker [1]

Value of mineral production in Connecticut increased slightly compared with that of 1965. The increase was attributed primarily to higher unit prices for stone products. The selling price of stone products increased 5 percent and the revenue from feldspar, lime, mica, and peat increased 18 percent over that of 1965. Hartford County mineral value was the greatest in the State, followed in order of magnitude by New Haven, Litchfield, and Middlesex.

The Connecticut Geological and Natural History Survey published one bedrock report of the Hamburg Quadrangle and one surficial report of the Hartford South Quadrangle was in press at the end of 1966.

The Federal Geological Survey published five quadrangle reports. Fifteen aeromagnetic maps were published during the year and the flying of the State was completed.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of portland cement into Connecticut amounted to 4.3 million barrels; masonry cement shipped from other States amounted to 150,400 barrels. Most of the cement was shipped from Pennsylvania and New York, with limited quantities coming from Maine and Maryland.

Clays.—Production from Hartford, Middlesex, and New Haven counties decreased 19 percent, compared with that of 1965, and value was 8 percent less. Most of the output was consumed for building brick; small quantities were utilized by the ceramic and specialty clay industry and for manufacturing lightweight aggregate.

[1] Industry economist, Bureau of Mines, Pittsburgh, Pa.

Table 1.—Mineral production in Connecticut [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays----------short tons--	237,251	$322	192,240	$296
Gem stones----------	NA	8	NA	8
Sand and gravel----thousand short tons--	9,940	9,106	9,561	8,963
Stone----------do--------	5,871	10,444	5,618	10,482
Value of items that cannot be disclosed:				
Feldspar, lime, mica (scrap), and peat---	XX	1,354	XX	1,597
Total----------	XX	21,234	XX	21,346

NA Not available. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

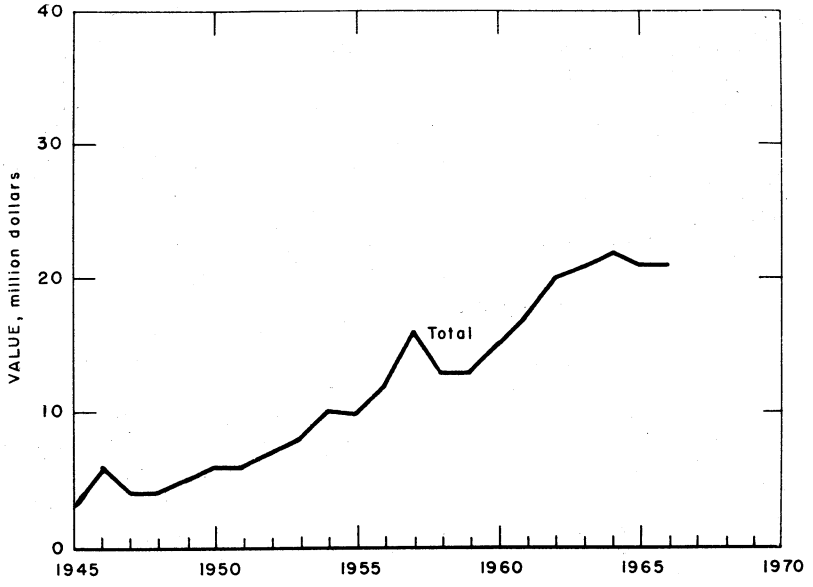

Figure 1.—Value of mineral production in Connecticut.

Feldspar.—Production of crude feldspar was limited to two operations in Middlesex County. Total output and value were greater than in 1965. From one mine, recovery was by flotation, with quartz and flake mica recovered as byproducts. Crude feldspar from the other mine was processed by dry grinding. The ground feldspar was sold primarily to glass and ceramic manufacturers in New Jersey, Rhode Island, and Pennsylvania. Limited quantities were exported. There was an additional dry grinding plant that operated using purchased material, and its output was consumed in sweeping compounds.

Gem Stones.—Amateur collectors, mineralogical societies, and gem dealers were active in collecting a variety of materials and mineral specimens from quarries, pegmatite deposits, and abandoned mine dumps throughout the State. Value of recovered minerals was estimated to be about the same as that of 1965.

Gypsum.—National Gypsum Co. produced calcined gypsum at New Haven for use in manufacturing finished building products. The plant's crude gypsum supply was shipped from out of State.

Lime.—There was 28 percent less lime produced in 1966, compared with the output in 1965, but the unit value was $0.92 per ton greater. The one operation was in Litchfield County. Its output of quicklime

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1957	r $16,231	1962	r $19,304
1958	r 13,208	1963	r 20,289
1959	r 12,828	1964	r 21,441
1960	r 14,896	1965	r 21,090
1961	r 16,251	1966	p 20,966

r Revised.
p Preliminary.

Table 3.—Employment 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
1965:								
Nonmetal and peat	106	282	30	240	---	2	8.33	125
Sand and gravel	576	228	131	1,071	---	21	19.60	330
Stone	414	262	108	913	1	11	13.14	6,938
Total	1,096	245	269	2,224	1	34	15.74	3,022
1966: p								
Nonmetal and peat	145	292	42	343	---	7	20.41	303
Sand and gravel	580	231	134	1,092	1	27	25.64	6,264
Stone	415	249	103	894	---	28	31.32	494
Total	1,140	245	279	2,329	1	62	27.05	3,171

p Preliminary.

was sold to processors of calcium metal and for use in paper manufacture; the hydrated lime output was marketed for masonry construction. A contributing factor to the decrease in lime consumption was the closing of Nelco Metals, Inc., magnesium metal plant in 1966 which operated nearby in Litchfield County.

Mica.—The State had one feldspar flotation plant in Middlesex County that recovered scrap mica (flake mica) as a byproduct. The mica was ground for use as a roofing material.

Sand and Gravel.—Commercial and Government-and-contractor sand and gravel output declined for the third straight year from the record high of 10.5 million tons established in 1963. Production totaled 9.6 million tons of which 73 percent was consumed commercially and 27 percent was utilized by Government-and-contractor operations. The value of production amounted to about $9 million, which also was a decrease of 1.6 percent from the 1965 value.

Commercial operators processed 86 percent of their production compared with 81 percent processed in 1965. Of the 7 million tons of commercial aggregate produced, about 46 and 37 percent were consumed in building and paving, respectively, and 10 percent was used as fill. Only 3 percent of the commercial sand and gravel was transported to market by railroad; the balance was moved by truck.

Of the 86 commercial operations, 24 produced 63 percent of the total output. Average production of the 24 operations was about 183,000 tons. The greatest production of over 2.6 million tons was mined from Hartford County; New Haven and Fairfield Counties contributed significant amounts of 1.4 million tons and 0.7 million tons, respectively.

There were 73 operating plants, 65 stationary and 8 portable.

Stone.—Total stone production was 4 percent below that of 1965 but total value was slightly greater. The value increase was attributed to the higher selling price of dimension granite, limestone, and crushed sandstone. Crushed basalt (traprock) accounted for 87 percent of total stone production. Its unit value of $1.60 per ton remained the same as in 1965. Of the 4.9 million tons of basalt produced, 98 percent was consumed as concrete aggregate and roadstone. The balance was sold for riprap and railroad ballast. All basalt production came from Hartford, New Haven, and Litchfield counties. Twelve operations reported an output ranging from 50,000 to over 1 million tons per year. The second most important stone produced from the standpoint of value was limestone. The total output of 226,000 tons, all of which was mined in Litchfield County by four producers, was primarily utilized for soil neutralization and in manufacturing lime. Other uses were for filler, whiting, and metallurgical flux. Sandstone was next in rank according to value, with its production increased 59 percent over that of 1965. A small amount of dimension sandstone was

Table 4.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Structural	1,975	$2,309	1,823	$2,071
Paving	1,578	1,497	1,716	1,757
Fill	302	152	183	107
Other [1]	208	161	285	286
Total	4,063	4,119	4,007	4,221
Gravel:				
Structural	1,380	2,336	1,412	2,202
Paving	1,064	1,055	882	1,072
Fill	622	306	541	260
Other	191	251	162	199
Total	3,257	3,948	2,997	3,733
Total sand and gravel	7,320	8,067	7,004	7,954
Government-and-contractor operations:				
Sand:				
Paving	108	38	102	37
Other	18	13	27	13
Total	126	51	129	50
Gravel:				
Building	7	3	----	----
Paving	2,438	955	2,362	916
Fill	49	30	66	43
Total	2,494	988	2,428	959
Total sand and gravel	2,620	1,039	2,557	1,009
All operations:				
Sand	4,189	4,170	4,136	4,271
Gravel	5,751	4,936	5,425	4,692
Total	9,940	9,106	9,561	8,963

[1] Includes molding, filter, grinding and polishing, and other sand.

produced in Windham County for coarse masonry. Some quartz was processed and sold for abrasives, glass, and fillers. Virtually all of the granite was produced in Windham County, and was marketed by five producers as concrete aggregate and dimension granite for building construction. Two companies in New London County stopped production. One operation's resources were depleted; the other dismantled its facilities.

MINERAL FUELS

Coke.—Connecticut Coke Co. continued to operate the only merchant coke plant in the State consisting of 70 slot-type ovens. In addition to coke, ammonium sulfate, coal tar, crude and intermediate light oil were produced as byproducts.

Peat.—The one supplier of peat in Middlesex County produced a reed-sedge variety which was shredded and marketed in bulk form for use as soil conditioner. Production was less than that of 1965.

METALS

Nelco Metals, Inc., a subsidiary of Chas. Pfizer & Co., Inc., at Canaan, Litchfield County, introduced a process for the production of high-purity barium metal. Its output was marketed to the Nation's electronics, metals, and chemical industries. Also, Nelco was the only calcium metal producer in the United States. The company ceased production of magnesium metal in 1966.

Carpenter Steel of New England, Inc., was the only processor and fabricator of steel shapes in the State. However, there were more than 20 metal foundries. Scrap metal collection and distribution was very active throughout the State. Practically all of the scrap tonnage was exported, principally to Japan, with small amounts sold to eastern United States steel mills.

REVIEW BY COUNTIES

Sand and gravel tonnage which cannot be credited to a county source amounted to 2,874,000 tons valued at $1,403,000.

Fairfield.—Over 655,000 tons of sand and gravel was produced in the county, the third largest county production in the State. However, this output was 12 percent below 1965 production. Commercial sand and gravel was produced by nine companies, the largest of which were John Lamazzo & Sons Corp., Weston, and Daddario Sand & Gravel, Newton. Most of the processed material was utilized in building and highway construction, with lesser quantities used as fill.

Harford.—On the basis of output and value, the county was the leading mineral producing area for the second consecutive year. However, its total production of sand and gravel, stone, and clay was 5 percent lower than that of 1965, a decrease from 5.7 million tons to 5.4 million tons. Stone production remained about the same as in 1965 while that of sand and gravel and clay decreased 7 and 22 percent, respectively.

Crushed basalt (traprock) production (2.4 million tons) constituted about 50 percent of the State output, most of which was consumed as concrete aggregate. Small quantities were sold as riprap and railroad ballast. There were six operating quarries of which The Balf Co., Newington, was the largest. Other sizeable operators were Roncari Industries, Inc., East Granby; The New Haven Trap Rock Co., Plainville; and Sherman-Tomasso Concrete, Inc., Plainville. All employed stationary mining equipment. Most of the product was hauled to users by truck. Some dimension granite was produced by Tower Hill Granite Co. and P. A. Armando & Sons of Glastonbury, operating a portable plant, and P. A. Armando & Sons of Glastonbury, operating a stationary plant.

Sales of commercial sand and gravel totaled 2.6 million tons, a 7-percent decrease from the 2.8-million ton output in 1965. Government-and-contractor sand and gravel purchased amounted to 226,000 tons, a slight decrease from that consumed in 1965. Both commercial and Government-and-contractor sand and gravel were consumed primarily by the building and paving industries. Also, quantities were used as fill material. There were 26 commercial operations. Seven of these produced slightly over 1.5 million tons, on 53 percent of the total output. A few of the larger companies were The Balf Co., Glastonbury; Dunning Sand & Gravel Co., Inc., Farmington; Connecticut Sand & Stone Corp. with plants at Plainville and Burlington; and Roncari Industries, Inc., East Granby.

The Kelsey Ferguson Brick Co., operating at Suffield, was the largest producer of clay and shale and its subsequent processing into building brick in the State. The Windsor Clay Products Co., formerly Carpenter Brick & Clay Products Corp., stopped mining and processing operations in late 1966. The Plasticrete Corp., processor of lightweight aggregate, ended operations for economic reasons. Prior to the shutdown of these two plants, there was some production of lightweight aggregate and building brick. The Keller Pottery Co.,

Table 5.—Value of mineral production in Connecticut, by counties

County	1965	1966	Minerals produced in 1966 in order of value
Fairfield	$1,104,000	$1,087,000	Sand and gravel.
Hartford	6,844,409	7,005,605	Stone, sand and gravel, clays.
Litchfield	2,801,319	2,543,236	Stone, sand and gravel, lime.
Middlesex	1,129,523	1,580,067	Feldspar, sand and gravel, clays, stone, mica, peat.
New Haven	6,603,902	5,463,267	Stone, sand and gravel, clays.
New London	807,008	1,097,000	Stone, sand and gravel.
Tolland	W	W	Sand and gravel.
Windham	W	W	Stone, sand and gravel.
Undistributed [1]	1,944,175	2,570,197	
Total	21,234,000	21,346,000	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes sand and gravel and gem stones that cannot be assigned to specific counties, and values indicated by symbol W.

Kensington, produced clay which was processed into flower pots.

Litchfield.—Quantities of limestone were produced and processed into quicklime and hydrated lime by Minerals, Pigments, and Metals Division, Chas. Pfizer & Co., Inc., Canaan. Most of the quicklime was used in the processing of high-purity calcium by Nelco Metals, Inc.; the hydrated lime was used primarily for construction and agricultural purposes. The company used a sizeable amount of limestone in the processing of plastics and lesser quantities for stucco and rubber filler material. The Conklin Limestone Co., Inc., Canaan, and Allyndale Corp., East Canaan, produced and sold limestone for agricultural purposes. United States Gypsum Co., Falls Village, produced limestone, about half of which was used by them as paint filler; the balance was sold as agricultural material, stucco, industrial fillers, and for metallurgical uses. Basalt was produced by Oneglia & Gervasini Building Materials, Inc., Woodbury, for use as concrete aggregate. The company also mined sand and gravel near Torrington.

Output of commercial sand and gravel at eight operations was 537,000 tons, slightly below that of 1965. This production was fourth greatest among the sand and gravel producing counties. Sega Sand & Gravel, Inc., New Milford; Connecticut Sand & Stone Corp., North Canaan; and Oneglia & Gervasini Building Materials, Inc., produced 78 percent of the county output. The eight plants marketed the material by truck for use in paving, building, and fill. Quantities of sand were used for road ice control.

Middlesex.—The Feldspar Corp., Middletown, produced marketable feldspar by the flotation process which was shipped to glass and pottery manufacturers in other States, over one-half of which went to New Jersey. Scrap mica was recovered as a byproduct and processed by dry grinding for use as roofing material. The other feldspar producer was the Eureka Feldspar Mining & Milling Co., Inc., which mined and processed the material at its Portland plant for use in the pottery industry. A small amount was sold to R & S Enterprises, Inc., Cobalt, for use in sweeping compounds.

Five operations produced 309,000 tons of sand and gravel. This was an increase of 12 percent over that of 1965 and it was the only increase recorded by any county. The commodity was consumed primarily by the paving industry. Quantities were used as fill and some sand was utilized for highway ice control. The C. W. Blakeslee & Sons, Inc., plant at Killingworth produced a sizeable amount of the county output. Clay was mined and manufactured into building brick by the Michael Kane Brick Co., Middletown. A small quantity of reed-sedge peat was recovered by the Cedar Swamp Peat Co., Saybrook.

New Haven.—The county ranked second in the production of stone, sand and gravel, and clay. Output of each of the three commodities was less than that of 1965. Basalt (traprock) production was down 13 percent, from 2.7 million tons to 2.3 million tons. There were five traprock operations. The New Haven Trap Rock Co., North Branford and Wallingford, produced most of the total stone output. Other producers were York Hill Traprock Quarry Co., Meriden; Charles W. Blakeslee & Sons, Inc., Hamden; and A. N. Farnham, Inc., New Haven. The bulk of the traprock was consumed as concrete aggregate; some was used as riprap and railroad ballast. Castellucci & Sons, Inc., was the only producer of dimension granite, all of which was consumed by the building industry.

Output of commercial sand and gravel was 1.4 million tons which was a decrease from the 1965 tonnage of 1.6 million tons and a 30-percent drop from the 1964 high of 2.0 million tons. Government-and-contractor sales remained about the same. The two largest companies, Waterbury Sand & Gravel Co., Waterbury, and Beard Sand & Gravel Co., Inc., Milford, produced 38 percent of the output reported by the county's 12 commercial operations. Most of the county production was used in building and for fill. Other sizeable operators were The D. J. Carten Sand & Gravel Co., Devon; The Hamden Sand & Gravel Co., Beacon Falls; Meriden-Wallingford Sand & Stone Co., Inc., Wallingford Sand & Stone Co., Inc., Wallingford; and Cinque Brothers Co., and Guilford Sand & Gravel Co., East Haven. Clay was mined and processed into building brick by Stiles Brick Division of Plasticrete Corp. near Hamden.

New London.—On the basis of value, quartz stone was the most important mineral produced. Connecticut Silica Co. at

North Stonington mined and processed seven grades of quartz. More than half the production was sold to the glass industry. Quantities were consumed as plaster sand, exposed aggregate in building blocks, roofing granules, foundry material, abrasives, and filler material. Unlike previous years, there was no production of granite. Production from eight commercial sand and gravel operations was 276,000 tons, an 11-percent decrease from that of 1965. Government-and-contractor sales showed an increase of 51 percent over the 35,000 tons consumed in 1965. One plant with sizeable production in 1965 closed down after producing 11,000 tons. Another company curtailed output from 47,000 tons in 1965 to 11,000 in 1966. Most of the county's production went into buildings and highways. One company sold quantities of sand to the local government for oil-sand cover and ice control of the highways. The largest operators were L. H. Bond Sand & Gravel Co., Montville; John J. Doyle Sand & Gravel Co., Inc., Montville; and The Westerly Ready-Mixed Concrete Co., Inc., Pawcatuck.

Tolland.—E. Foster Hyde, Ellington, and Richard Lee, Andover, produced sand and gravel which was sold for building material and fill. Output was below that of 1965.

Windham.—Stone production in 1966 was greatly altered. Contrary to previous years, there was no basalt produced and sizeable amounts of crushed granite were processed. The output of sandstone and quartzite remained about the same as in 1965. Total stone value increased four times over the value of 1965. The Wauregan and Wilsonville plants of The New Haven Trap Rock Co. produced all of the crushed granite in the county which was sold for concrete aggregate and roadstone. R. B. Marriott & Sons, Sterling, produced dimension granite which was used in construction and curbing. Quantities of cut sandstone for use in rough and finished building construction were produced by Helene Stone Corp. in Sterling, and Hughes Stone Co. and Robert V. Olson, both near Killingly. There was a slight decrease of sand and gravel production compared with that of 1965. The three producers, Dunning Sand & Stone Co., Inc., Wauregan; R. A. Rawson Sand & Gravel, Inc., Putnam; and Ernest Joly & Sons, Danielson, marketed the commodity to the building and paving industry.

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 Samuel A. Gustavson [1]

Production of minerals in Delaware in 1966 was valued at nearly $2 million. The net increase of 4 percent over 1965 was chiefly the result of greater output of crushed stone. Minerals produced in the State include miscellaneous clay, sand and gravel, stone, and a small quantity of mineral specimens. The State also obtains these minerals or their products from adjacent States.

[1] Physical science administrator, Bureau of Mines, Pittsburgh, Pa.

Table 1.—Mineral production in Delaware [1]

Mineral	1965		1966	
	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	1,545	1,441	1,610	1,443
Stone—do	180	450	210	525
Total	XX	1,903	XX	1,980

NA Not available. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957–59 dollars
(Thousands)

Year	Value	Year	Value
1956	r $1,256	1961	r $1,030
1957	r 1,054	1962	r 1,495
1958	r 1,149	1963	r 1,321
1959	r 1,264	1964	r 1,711
1960	r 959	1965	r 1,892
		1966	p 1,947

r Revised. p Preliminary.

Table 3.—Employment 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
1965:								
Nonmetal	13	317	4	33	------	------	------	------
Sand and gravel	52	214	11	89	------	1	11.27	45
Stone	10	218	2	20	------	------	------	------
Total	75	227	17	142	------	1	7.04	28
1966: p								
Nonmetal	15	317	4	33	------	1	30.30	545
Sand and gravel	65	207	13	106	------	------	------	------
Stone	10	218	2	20	------	------	------	------
Total	90	211	19	159	------	1	6.30	113

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Clays.—Delaware Brick Co. continued to produce clay at its open pit operation near New Castle. The clay, classed as miscellaneous clay, was used by the company in manufacturing common red building brick. Annual output has been stable for several years.

Gem Stones.—Individuals and members of mineral clubs collected a variety of mineral specimens. The estimated value of $1,000 credited each year to the gem stone collection is based on a consensus of several local dealers and the Bureau of Mines.

Sand and Gravel.—Sand and gravel was produced in each of the three counties of the State and continued to be the State's principal mineral product. Output was reported by 11 companies operating a total of 14 pits. The Henry G. Graves & Sons, Inc., Sussex County, discontinued business during the year. Pit-run material only was produced at five operations; eight operations had stationary processing plants and one had a dredge. Of the total production, 730,000 tons of sand and gravel was processed while 880,000 tons was sold as pit run. This compares with 752,000 tons processed and 793,000 tons unprocessed in 1965.

Sand produced totaled 558,000 tons valued at $592,000, compared with 579,000 tons valued at $624,000 in 1965, a decrease of 4 percent in quantity and 5 percent in value. The average overall value, f.o.b. plant, was $1.07 per ton compared with $1.08 the previous year. Values ranged from $0.75 to $1.50 per ton for building and paving uses to a low of $0.29 per ton for some fill material. Reports in 1966 indicated that about 343,000 tons of sand was sold for building purposes, 200,000 tons for highway use, 7,000 tons for engine traction sand, and the remainder for fill and other uses. Most of the sand was washed and screened. Most of the sand sold as "pit run" was used as fill or traction sand. Nearly all of the sand was trucked to destination.

Gravel production in 1966 was 1,052,000 tons valued at $851,000 compared with 966,000 tons valued at $817,000 in 1965. Reports indicated that gravel sold in 1966 was used as follows: For building use 85,000 tons; for paving use 925,000 tons; and for fill and other uses 42,000 tons. This compares with 87,000, 815,000, and 64,000 tons, respectively, in the previous year. The overall value of gravel in 1966 was $0.81 per ton, 4 cents less than in 1965. The price decline for the third year continued to reflect an increase in percentage of unprocessed material, chiefly for highway use. Most of the washed gravel was sold within the range of $2 to $3 per ton, while the average for pit-run gravel was about $0.60, f.o.b. plant. All the gravel sold was reported as being trucked to its destination.

Stone.—State production of stone was

about 17 percent greater in 1966 than in 1965. Production was from gabbro deposits in New Castle County, which for statistical purposes have been classed as granite. In addition to State sources, crushed stone, chiefly for highway construction was purchased from producers with quarries in Maryland and Pennsylvania. State production was chiefly crushed stone for highway and concrete aggregate use or for use as stone sand. About 6 percent of the output was sold as uncrushed material for riprap.

REVIEW BY COUNTIES

Kent.—Sand and gravel was produced by St. Jones River Gravel Co. at Dover, Clough & Caulk Sand & Gravel at Wyoming, and Barber Sand & Gravel at Harrington. All producers operated stationary plants. Demand and production were changed little from 1965, with output down about 5,000 tons while total value increased about $56,000 as the result of sale of a higher percentage of washed material. Most of the washed product was for building or highway use, while unprocessed material was sold for fill. No other mineral production was reported for the county.

New Castle.—New Castle, the northern county of the State, produced clay, stone, and sand and gravel. Stone was produced near Wilmington from a gabbro deposit. Sales totaled 210,000 tons valued at $525,000 in 1966, compared with 180,000 tons valued at $450,000 in 1965. In 1966, about 12,000 tons was sold for riprap, 162,000 tons for concrete and roadstone and 36,000 tons as stone sand. The increase over 1965 was chiefly for concrete and roadstone use.

Miscellaneous clay was mined by the Delaware Brick Co. and there has been little change in the annual production rate for several years. The clay was used in manufacturing common building brick.

Sand and gravel production in the county totaled 1,288,000 tons valued at $1,086,000 compared with 1,223,000 tons valued at $1,150,000 in 1965, an increase in tonnage but a decline in value due to a higher percentage of the sales as unprocessed material. Of the total 1966 production, 460,000 tons were processed and 828,000 tons unprocessed.

Sand production was 316,000 tons valued at $371,000 about two-thirds for building and one-third for paving or highway use. Gravel production was 972,000 tons valued at $715,000, most of which was for highway use. Producers of sand and/or gravel included the following: Delaware Sand & Gravel Co., and Parkway Gravel, Inc., near New Castle; Whittington's Sand & Gravel Co. at Bear; John C. Green, Jr., at Middletown; and Petrillo Bros., Inc., at Wilmington. Production of Parkway Gravel, Inc. (from 3 pits), and John C. Green, Jr., was all pit-run material. Delaware Sand & Gravel Co. operated at two locations, one with a stationary plant and the other a dredging operation. The other two producers had stationary plants. All material was reported as trucked to point of use.

Sussex.—Sand was produced at two pits and sand with a minor percentage of gravel at a third. Total output was only slightly greater than in 1965. Lewes Sand Co. produced bank-run sand for engine traction use from a pit near Lewes. Railroad demand for traction sand decreased. Henry G. Graves & Sons, Inc., operated a stationary wash plant at its pit near Lewes that produced sand chiefly for building construction. The corporation closed its sand and gravel operations during the year. Atkins Brothers operated a stationary wash plant and pit near Millsboro producing sand and a small tonnage of gravel for building and paving use.

The Mineral Industry of Florida

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

By Lawrence E. Shirley [1] and Robert O. Vernon [2]

Florida produced a record-breaking $295 million worth of mineral commodities in 1966—an increase of 19 percent compared with 1965 total mineral production value. During the last decade, mineral production value for the State has more than doubled, and the future outlook is promising for both increased mineral production and corresponding value increases. Large gains in phosphate rock output coupled with small increases in the production of clays, lime, sand and gravel, and crude petroleum more than offset losses in production of cement, magnesium compounds, peat, rare-earth, titanium, and zirconium minerals.

For the 73d consecutive year Florida led the Nation in phosphate rock output; total marketable production increased considerably over that of 1965, setting a record high.

The State also continued to lead the Nation in fuller's earth production and value; in the production of zircon; ranked second in production of ilmenite, and was the only producer of staurolite.

Leading companies in value of mineral production were International Minerals & Chemical Corp., Agrico Chemical Co., and Mobil Chemical Co., all land-pebble phosphate rock producing companies.

Florida continued to supply national, international, and local markets with its

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Table 1.—Mineral production in Florida [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays----thousand short tons	651	$9,752	762	$11,408
Lime----do	101	1,558	135	1,966
Natural gas----million cubic feet	107	14	212	30
Peat----short tons	19,253	109	11,500	91
Petroleum (crude) thousand 42-gallon barrels	1,464	W	1,799	W
Phosphate rock----thousand short tons	21,563	141,258	W	W
Sand and gravel----do	7,298	6,377	7,403	6,417
Stone----do	35,730	41,148	35,023	38,167
Value of items that cannot be disclosed: Cement, magnesium compounds, natural gas liquids, rare earth metal concentrates, staurolite, titanium concentrates, zirconium concentrates, and values indicated by symbol W	XX	49,104	XX	237,368
Total	XX	249,320	XX	295,474

W Withheld to avoid disclosing individual company confidential data. XX Not applicable.
[1] Production as measured by mine shipments, sales or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957–59 dollars
(Thousands)

Year	Value
1957	$139,193
1958	145,989
1959	166,311
1960	180,228
1961	191,887
1962	185,282
1963	199,829
1964	218,658
1965	r 244,956
1966	p 284,767

r Revised. p Preliminary.

chief mineral commodity—phosphate rock. Exports of phosphate from Florida ports increased considerably during 1966, and shipments were made to 34 foreign countries, notably Japan, Italy, West Germany, and Canada, all receiving in excess of 1 million short tons of phosphate rock. World demand for this important agricultural commodity, both as crude ore and as processed fertilizer material, has been growing at a record rate. This increased demand has created incentives for new exploration and discovery in Florida and the Southeastern States.

Gypsum, perlite, and vermiculite were brought in from other States and foreign sources and processed for consumption in Florida and nearby States. Increased quantities of fuller's earth mined and processed in the State continued to be shipped as processed materials to foreign countries as well as to expanding domestic markets.

Electric power production increased 13 percent over that of 1965, the largest gain since 1959. Total output of both public and private plants during the year amounted to 36.7 billion kilowatt hours; to

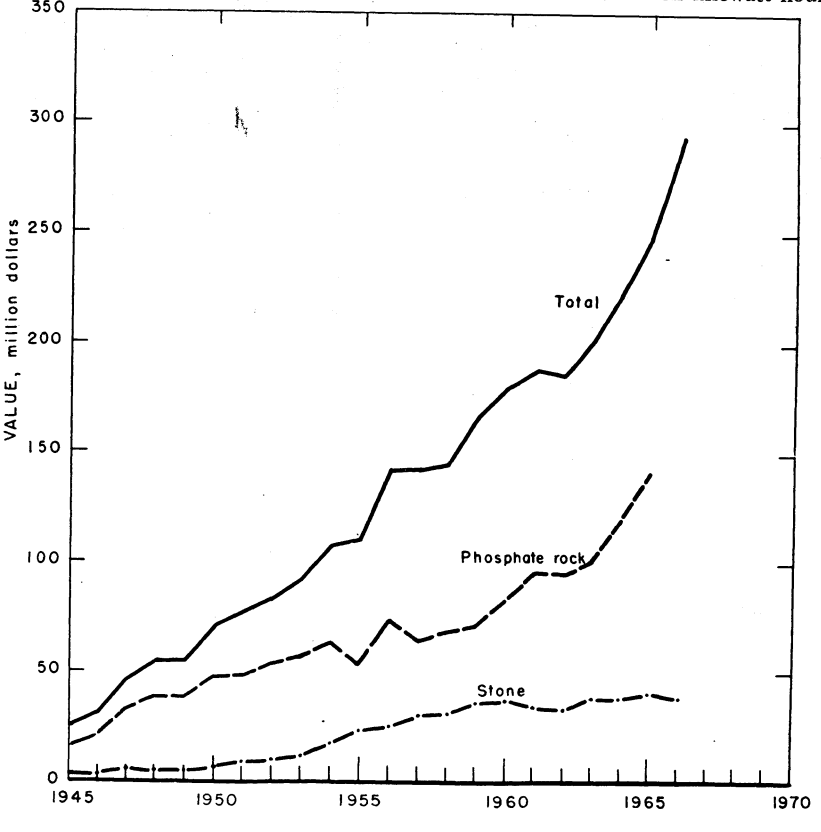

Figure 1.—Value of phosphate rock, stone, and total value of mineral production in Florida.

Table 3.—Employment 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
1965:								
Metal	170	338	57	461	---	---	---	---
Nonmetal	3,267	341	1,114	8,957	4	60	7.14	2,924
Sand and gravel	449	257	115	1,002	---	20	19.96	937
Stone	2,868	287	822	7,014	2	114	16.54	3,141
Peat	22	238	5	42	---	---	---	---
Total	6,776	312	2,113	17,476	6	194	11.44	2,813
1966: p								
Metal	165	342	57	454	---	---	---	---
Nonmetal	3,675	388	1,241	9,969	4	143	14.75	2,860
Sand and gravel	440	251	111	986	---	22	22.31	1,166
Stone	2,810	285	802	7,022	---	136	19.37	1,337
Peat	14	264	4	29	---	---	---	---
Total	7,104	312	2,215	18,460	4	301	16.52	2,115

p Preliminary.

produce this power, plants used a total of more than 3 million short tons of coal, 30 million barrels of fuel oil, and 98 billion cubic feet of natural gas. During the year, Florida Power & Light Co. made application to the Atomic Energy Commission (AEC) to build two atom-powered reactors at its Turkey Point site in Dade County. The reactors would have a capacity of 760,000 kilowatts of electricity and would cost an estimated $133 million.

To cope with the increased traffic in both imports and exports through Florida ports large port expansion programs were planned. Port Everglades announced a $30 million 20 year expansion program; the 4-phase program would include land acquisition, extensive dredging, and other features that would help the port keep abreast of projected traffic during the period. Petroleum movements at Port Everglades represented a large percentage of total traffic during the year. The Port of Jacksonville, in its second year of operation by the Jacksonville Port Authority, adopted a long-range harbor development program for additional deep-water docks and bulk shipping terminals. Jacksonville, as the eastern terminus of the Cross-Florida Barge Canal now under construction, anticipates a steadily increasing upsurge in barge traffic and demand for handling bulk cargo in the future.

Trends and Developments.—Since 1950 Florida, in terms of population has been the most rapidly growing State in the Southeast, and in 1966, it ranked third in the Nation in population percentage increase. New construction during this period of growth continued to be a major activity, and this placed continuing demands on construction materials, such as crushed stone, sand and gravel, cement, clays, and other nonmetallic minerals. Heavy demands also were made for other materials and services required by an expanding population. These trends continued throughout the year and were reflected by industrial expansion in nearly all areas of the State.

During the year, 553 new plants or major expansions were announced in 49 of Florida's 67 counties, representing a gain of approximately 24,000 exployees in all industries.

At yearend, Florida had completed 49 percent of its total designated system mileage of 1,154 miles of Interstate Highways in the State. Total mileage open to traffic was 565 miles compared with 472 miles in 1965. Total Interstate mileage under construction at yearend was 412, and the remaining mileage was in preliminary status. The State highway department announced about midyear completion of major construction projects on primary and secondary roads in at least 12 counties in the State.

New developments in the land pebble phosphate district and other areas occurred during the year. Several companies, including New Jersey Zinc Co., Monsanto Company, and others, announced plans for entering the field and continued their

exploration programs. The Occidental Corporation of Florida, already a large producer of phosphate in the northern part of the State, obtained the mineral rights to lands owned by Owens-Illinois Company in the vicinity of Occidental's mining operations in Hamilton County. It is anticipated that the rate of production will be greatly accelerated because of this acquisition. Exploration programs continued in Hardee and Manatee Counties as lands containing phosphate in the principal field of Polk and Hillsborough Counties became harder to acquire.

Legislation and Government Programs.—Programs on construction of the Cross Florida Barge Canal project continued at a high level during the year. Contracts awarded during 1964 for dredging and excavation were completed, and 1965 contracts were well underway, including the St. Johns and Inglis Locks. Contracts awarded during the current year included the Rodman Dam and Eureka Lock and Dam to be constructed at a combined cost of nearly $11 million. It will take several years to complete this project which is administered by the U.S. Army Corps of Engineers.

Legislation designed to permit Florida to enter the Interstate Mining Compact was considered by the State Legislative Bureau. The Bureau recommended that it be adopted, but the legislation was not introduced into the Florida legislature this year, and no further progress on joining the Compact was obtained. The Interstate Mining Compact is principally concerned with uniform land reclamation standards and was modeled to a great extent by its creators, an ad hoc committee appointed by the Council of State Governments, on the Interstate Oil Compact Commission. The Compact, itself, serves more in an advisory capacity than a regulatory one.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Nonmetals accounted for 95 percent of the State's total mineral production value, compared with 93 percent in 1965. The principal nonmetals, listed in order of value, were phosphate rock, stone, cement, clays, and sand and gravel.

Cement.—Cement ranked third in value in the State's mineral production, however total shipments declined 3 percent, and value 4 percent. Portland cement shipments declined 3 percent, and value 5 percent, whereas masonry cement shipments increased 2 percent, and value 1 percent.

Three plants operated during the year. General Portland Cement Co. operated plants near Tampa and Miami, and Lehigh Cement Co. operated a plant near Miami. Lehigh also shipped the remaining stocks of cement from its Bunnell Plant in Flagler County, which was closed in 1965.

Most of the cement shipments were made within the State, but shipments were also made to Georgia, Alabama, Tennessee, North Carolina, and other States. A small quantity of cement was shipped to Puerto Rico.

Raw materials used in the manufacture of cement were mined principally within the State and included limestone and clay; other material needs were supplied principally from out-of-State sources. Of the total cement shipments, 78 percent was shipped by truck and 22 percent by rail. The principal consumers were ready-mixed concrete companies, concrete products manufacturers, and building material dealers.

Clays.—Clays ranked fourth in value in the State's mineral production. Total clay output increased 17 percent in tonnage and value because of increased production of fuller's earth and miscellaneous clay. Kaolin output remained about the same as in the previous year. Florida, for the 9th consecutive year, continued to lead the Nation in fuller's earth production and again established an alltime high record for the State.

Fuller's earth output increased 14 percent in tonnage and 18 percent in value over that of 1965. Production came principally from Gadsden County, but a new operation in Marion County, established during 1965, also produced a small quantity. Gadsden County producers were the Floridin Co. (Quincy mine), Dresser Magcobar, formerly Magnet Cove Barium Corp. (Havana mine), and Minerals & Chemicals

Philipp Corp. (LaCamelia, Midway, and McElvey mines). Mid-Florida Mining Co. (Lowell mine) reported first year output from its mine in Marion County. The principal uses of the material, listed in order of tonnage used, were in insecticides, absorbents, drilling muds, and mineral oils; 95 percent of the material was used for these purposes; 3 percent was exported, and the remainder was used in paper, soil, and vegetable uses.

Minerals & Chemicals Philipp Corp., in its 1966 Annual Report, reported that progress was made in the distribution of products developed for gelling, thickening, and emulsion stabilizing uses. Soil stabilizing experiments were continued in cooperation with various agricultural institutions and agencies. The company also reported increases in petroleum uses and record sales of the material for use as floor absorbents and pet litter products.

Kaolin was produced by two firms, both in Putnam County; Cyprus Mines Corp., formerly United Clay Mines Corp., and Edgar Plastic Kaolin Corp. The principal uses for the kaolin were in whiteware and pottery.

Miscellaneous clay output increased 22 percent to a new record because of increased use of this product in cement and lightweight aggregate products.

Producers, listed in order of output, were General Portland Cement Co., Citrus County; Florida Solite Co., Clay County; Taylor Brick and Tile Co., Escambia County; and Appalachee Correctional Institute, Gadsden County.

Gypsum.—Three companies calcined imported gypsum for use in gypsum building products. Producers, listed in order of output, were U.S. Gypsum Co., Duval County; National Gypsum Co., Hillsborough County; and Kaiser Gypsum Co., Inc., Duval County. Total capacity of the three companies was in excess of 500,000 tons of calcined product. Most of the crude ore for the operations was brought in by ship from Nova Scotia deposits owned by the companies.

Lime.—Primary lime sold increased 34 percent in tonnage and 26 percent in value compared with 1965 figures. Producers were Chemical Lime, Inc., Hernando County, and Dixie Lime & Stone Co., Sumter County. Dixie Lime, about mid-year, placed in operation a new 200-ton-per-day rotary hearth lime calcining plant near Sumterville, Sumter County. This plant replaced an old wood-fired shaft-kiln operation, near Reddick, which had become obsolete. The new plant produced a high-quality chemical grade pebble quicklime for use in neutralizing waste materials and for other chemical and industrial uses. Six companies in six counties recovered 462,000 tons of regenerated lime valued at $7.5 million, an increase of 9 percent in quantity and 15 percent in value compared with 1965 figures. It was used principally in manufacturing paper and alkalies and for water treatment. The largest producers were Buckeye Cellulose Corp., near Foley; Hudson Pulp and Paper Corp., near Palatka; and International Paper Co., near Panama City.

Magnesia. — Michigan Chemical Corp., near Port St. Joe, produced magnesium compounds from sea water. Production and value declined slightly. The principal uses of the compounds were for refractories, insulation, and fertilizer.

Phosphate Rock.—Marketable production of phosphate rock again established an all-time high, and accounted for the major portion of the State's total mineral production value. For the 73d consecutive year, Florida led the Nation in output and value of this commodity.

Florida's 1966 production is combined with that of North Carolina to conceal the latter's output as there is only one producing company in North Carolina. Combined marketable output from both States in 1966 was 29.8 million short tons valued at $195.1 million representing 76 percent of the total national production. In 1965, Florida's marketable production totaled 21.6 million short tons valued at $195.1 million and accounted for 73 percent of the total national output. North Carolina reported no marketable production in 1965. Exports from Florida were made to 34 countries and totaled 8.1 million short tons valued at $71 million. The largest shipments, all in excess of 1 million tons, were made to Japan, Italy, West Germany, and Canada, listed in order of tonnage received.

Land-pebble phosphate rock was produced at 21 mines by 11 companies in three counties. Leading producers were In-

ternational Minerals & Chemical Corp. (IMC), Agrico Chemical Co., and Mobil Chemical Co. These three firms operated nine mines in Polk County and one mine in Hillsborough County.

Soft-rock phosphate production decreased considerably below the 1965 production level. Total output from four mines in three counties was 44,000 short tons valued at $288,000. The material was used for direct application to the soil and for stock and poultry feed.

Hard-rock phosphate was produced during the first half of the year, at which time the only operating hard-rock mine in the State was closed. Kibler-Camp Phosphate Enterprise, Marion County, mined 44,200 tons valued at $394,000, a decrease of 37 percent in tonnage and 43 percent in value compared with 1965 figures. The leading land-pebble phosphate producer, IMC operated four mines—the Achan, Noralyn, Dredge, and Kingsford mines—all in Polk County. The latter mine was placed in operation during the year and increased the company's overall production considerably. The new mine and plant, located on a 160-acre site about 3 miles west of Bradley Junction, is the first operation of its type to use computerized controls. It is reported that IMC controls about 10,000 acres of phosphate ore reserves in the immediate area and that it will use a dragline with a 49 cubic yard bucket to mine these reserves. The firm announced about midyear that it had withdrawn from the Concentrated Phosphate Export Association (CPEA), an export marketing group formed to handle domestic shipments of phosphate rock overseas. Marketing requirements of the company will now be handled by its international sales department. About 1,700 employees of the company's Florida phosphate operations, consisting of all mines, plants, offices, and a terminal company, reportedly worked more than 2 million man-hours during the year without a disabling injury.

Agrico Chemical Co., Division of Continental Oil Co., was the second largest land-pebble producer. The company operated the Boyette mine in Hillsborough County and the Palmetto and Payne Creek mines in Polk County. The Palmetto washer and processing facilities in Pierce and South Pierce as three interrelated complexes were described.[3]

The third largest producer in the land-pebble field, Mobil Chemical Co., formerly V–C Chemical Co., operated two mines, the Clear Springs and Homeland, and late in the year placed a third mine, the Ft. Meade mine, in operation. In addition to opening the mine, related facilities including a washer and flotation plant, were constructed.

W. R. Grace & Co., Agricultural Products Division, ranked fourth in phosphate production and operated its Bonny Lake mine. About midyear the company announced that three new chemical groups were formed within the company to manage its expanding business. Phosphate activities were in the new Agricultural Chemical group, formerly Davison Chemical Division.

American Cyanamid Co., the fifth largest producer of phosphate rock, continued operation of its Orange Park and Sydney mines and plants; the new Chicora mine and plant was nearing completion at year-end and will provide new phosphate rock capacity in 1967.

Armour Agricultural Chemical Co. operated its Bartow and Lake Hancock mines and plants. Late in the year, it was announced that Armour and Freeport Sulphur Co. had set up a joint venture to mine and treat phosphate rock from properties near Ft. Meade. The agreement calls for Armour to install and operate mining and beneficiating facilities; Freeport would buy one-half of Armour's rock reserves in the area, and each company would take one-half of the output from the new operation. Estimated to cost $20 million, the installation will process more than 2 million tons of rock per year, when operational in 1968. Freeport is presently constructing a $40 million phosphate chemical complex near Convent, La., which reportedly will receive its phosphate rock supply from this joint Florida operation.

Borden Chemical Co. continued construction of its new fertilizer complex near Port Manatee. The plant, slated for completion early in 1967, was to have new scrubbing devices to contorl air pollution.

[3] Taeler, David H. Three-Plant Operation for Agrico. Minerals Processing, v. 7, No. 6, June 1966, pp. 14–17.

The company continued operation of its Tenoroc mine during the year.

Occidental Corp. of Florida operated its Suwannee mine in Hamilton County and continued expansion that would double capacity. The company's chemical plants and related fertilizer facilities were completed and placed in operation. Commercial shipments of diammonium phosphates, phosphoric acid, and triple superphosphate were reported late in the year. The first export shipment of phosphate rock from the firm's new $3 million port facility at Jacksonville was made to West Germany. The company obtained mineral rights on 10,000 acres of land owned by Owens-Illinois Co. and adjacent to mining operations of Occidental. Also covered in the lease are 30,000 additional acres that may contain phosphate deposits. It was reported that Monsanto Co. was actively exploring in the North Florida area and may establish a mining and processing operation in the near future.

Swift and Company operated the Watson and Silver City mines and plants during the year; and continued expansion of the latter mine and related facilities that reportedly would double its capacity.

Kerr-McGee Oil Industries, Inc., which previously announced plans for a large mining operation in Polk County apparently delayed construction of the mine and plant for the present.

Other companies mining in the land-pebble district included Hydromines, Inc., and Minerals Recovery Corp., both processing tailings from past operations.

U.S. Phosphoric Products Division, Tennessee Corporation (a subsidiary of Cities Service Co.) which previously purchased its rock requirements, announced it intended to begin mining of properties owned in the Ft. Meade area. The company with a processing plant near Tampa, Hillsborough County has been for many years one of the largest processors of phosphate rock in the area. F. S. Royster Guano Co., another prominent fertilizer processing company announced plans for a multimillion dollar expansion of present facilities near Mulberry, Polk County, scheduled for completion in mid-1967. The new installation will use a modified TVA granulator to produce at least 90,000 tons per year of diammonium phosphate, 110,000 tons per year of granular triple superphosphate and 450 tons per day of run-of-pile superphosphate.

Sulfuric acid manufacture in the Florida land-pebble field continued to climb, as increased production of phosphate rock and subsequent acidulation of the rock created new demands for acid. Practically all of the fertilizer producers were increasing acid plant capacities to cope with these needs. In the past 2 years, at least seven companies in the Florida field have completed or have in the planning stage new sulfuric acid plants with total capacity of 9,500 tons per day. Individual plant capacities range from 900 to 2,000 tons per day. Several companies were looking for alternate sources other than Frasch sulfur as a means of supplying sulfur needs. Freeport Sulphur Co., about midyear, announced completion of a $1 million expansion of its liquid sulfur storage facility near Tampa, with the addition of two 15,000-ton storage tanks. This facility is served by two tankers carrying liquid sulfur from Freeport's 3 mines in Louisiana and one tanker off the Louisiana Coast. This is the second expansion since the terminal was established in 1961. Chemicals, Inc., a joint venture of Interantional Minerals & Chemical and Wellman-Lord Engineering, Inc., announced completion of new plants, bringing total daily capacity up to 3,600 tons per day.

Perlite.—Three companies expanded perlite in three counties from imported crude ore. Total output was 8,000 tons valued at $602,000, a considerable increase over that of 1965. Producers, listed in order of output, were Chemrock Corp., Duval County; W. R. Grace & Co., Dade County; and Airlite Processing Corp., Indian River County. Uses of the expanded material were for building plaster, concrete aggregate, insulation, soil conditioning, and other uses.

Sand Gravel.—Sand and gravel ranked fifth in value in the State's mineral production. The total of 7.4 million tons valued at $6.4 million was slightly above 1965 figures and halted the decline of the past 2 years. Of the total tonnage, 94 percent was produced by commercial operators and 6 percent by Government-and-contractor producers. There were 45 commercial sand and gravel operations during the year; of these, 13 produced from 200,000 to 600,000

tons; 19 produced from 50,000 to 200,000 tons; and 13 plants produced up to 50,000 tons. Sixty-eight percent of the output was transported by truck, and 32 percent by rail. The value per ton of the commercial sand and gravel ranged from $0.59 to $6.90 and averaged $0.87 per ton.

Sand and/or gravel was mined in 24 counties, the same as in 1965. Leading counties were Polk, Lake, and Clay. The materials were primarily for structural, paving, fill, and other purposes.

Staurolite.—Staurolite was recovered as a byproduct of ilmenite production by E. I. du Pont de Nemours & Co., Inc., at its Highland and Trail Ridge plants in Clay County. Output and value increased compared with 1965 figures. The material has found use as an abrasive and as an additive in cement. Florida is the only State with recorded production of the mineral.

Stone.—Stone ranked second in value in the State's mineral production. Total stone output, including crushed limestone, dimension limestone, and crushed oystershell, was 35 million tons valued at $38.2 million, a decrease of 2 percent in tonnage and 7 percent in value compared with 1965 figures. Reduced output of crushed limestone was responsible for the decline as both dimension limestone and crushed oystershell production increased in tonnage and value.

Crushed limestone output was 33.5 million tons valued at $35.8 million, decreases of 2 percent in tonnage and 8 percent in value from 1965. Output came from 18 counties with 73 quarries, 4 fewer quarries and counties than in 1965. The three leading producing counties were Dade, Hernando, and Broward, which supplied 59 percent of the total crushed limestone tonnage and 60 percent of the value. The three leading quarries in the State were Seminole Rock Products, Inc., Dade County; Maule Industries, Inc., Dade County; and Center Hill Rock Co., Sumter County. Twelve quarries produced over 1 million tons of crushed limestone each. Of the total crushed limestone produced, 88 percent was used for concrete and roads, 2 percent for agriculture, less than 1 percent for railroad ballast, and 9 percent for miscellaneous uses. Crushed limestone was transported 65 percent by truck, 33 percent by rail, and 2 percent by water. During the year, one of the top safety awards in the National Safety Competition, conducted by the Bureau of Mines, U.S. Department of the Interior, was won by the Suwannee Quarry of Florida Rock Products Corp., Suwannee County. The firm operated 430,400 man-hours during the year without a disabling work injury.

Oystershell was dredged and crushed by five companies in five counties on State leases. Total output was 1.5 million tons valued at $2.4 million, an increase of 5

Table 4.—Sand and gravel sold or used by producers, by counties
(Thousand short tons and thousand dollars)

County	1965		1966	
	Quantity	Value	Quantity	Value
Brevard	21	$26	27	$27
Broward	328	320	469	338
Escambia	439	420	426	397
Gadsden	245	512	238	W
Glades	W	W	154	W
Hendry	W	W	205	W
Indian River	28	28	20	19
Lake	1,382	974	1,588	1,124
Marion	13	32	11	32
Orange	152	103	135	93
Palm Beach	130	72	130	72
Pinellas	6	5	7	5
Polk	2,369	2,125	2,076	1,886
Putnam	527	378	526	461
Wakulla	20	17	80	68
Washington	---	---	13	12
Undistributed [1]	1,638	1,365	1,298	1,883
Total	7,298	6,377	7,403	6,417

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Bay, Clay, Dade, Franklin (1965), Hillsborough, Leon, St. Lucie, Volusia, and Walton Counties, and counties indicated by symbol W.

Table 5.—Sand and gravel sold or used by producers, by uses
(Thousand short tons and thousand dollars)

Use	1965			1966		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	5,650	$4,373	$0.77	5,689	$4,319	$0.76
Fill	485	277	.57	514	302	.59
Paving	465	390	.84	445	361	.81
Blast	W	W	W	62	428	6.90
Other sands [1]	385	746	1.94	399	W	W
Total	6,985	5,786	.83	7,109	W	W
Gravel:						
Structural	W	W	W	294	W	W
Paving	W	W	W	----	----	----
Total	313	591	1.89	294	W	W
Total sand and gravel	7,298	6,377	.87	7,403	6,417	.87

W Withheld to avoid disclosing individual company confidential data.
[1] Includes glass, molding (1965), engine, filtration, and other sands.

and 9 percent, respectively, compared with 1965 figures. Producers listed in order of output were Radcliff Materials, Inc., Walton County; Benton & Co., Pinellas County; Bay Dredging and Construction Co., Hillsborough County; Ft. Myers Shell and Dredging Co., Lee County; and Houdaille-Duval-Wright Co., Duval County. Most of the shell was used for roads and in concrete and a smaller tonnage was used for poultry grit and other uses. Sixty-five percent of the oystershell was transported by truck, 34 percent by water, and 1 percent by rail.

Brandenton Stone Co., Manatee County was the only dimension limestone producer reporting production during the year. The company produced a small tonnage of rough construction stone and cut stone for decorative uses.

Vermiculite.—Output of exfoliated vermiculite, all from imported crude ore, increased slightly in tonnage and value. W. R. Grace & Co. operated plants in Duval, Hillsborough and Palm Beach Counties, and Surco Manufacturing Co. operated a plant near Tampa, Hillsborough County. The exfoliated product was shipped principally to consumers within the State and was used for concrete aggregate, loose-fill insulation, agricultural use, building plaster, and miscellaneous uses.

Table 6.—Crushed limestone sold or used by producers, by counties

County	1965		1966	
	Short tons	Value	Short tons	Value
Alachua	1,744,237	$1,310,445	2,151,202	$1,804,101
Broward	4,615,924	5,103,206	4,432,861	5,222,322
Collier	606,052	532,475	678,000	531,192
Dade	9,431,795	9,858,759	10,025,662	10,016,888
Hendry	6,600	5,000	---------	---------
Hernando	6,786,076	8,930,339	5,418,505	6,158,091
Jackson	20,200	60,700	21,000	63,000
LaFayette	W	W	21,000	24,000
Lee	W	W	707,133	W
Levy	355,872	673,899	497,611	657,238
Marion	1,721,432	1,764,671	1,684,089	1,373,675
Palm Beach	W	W	796,402	776,716
Sumter	3,876,241	2,966,103	3,498,251	2,461,777
Undistributed [1]	5,160,294	7,767,249	3,610,729	6,678,824
Total	34,324,723	38,972,846	33,542,445	35,767,824

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes Brevard (1965), Citrus, Columbia, Flagler, Manatee, Monroe, Sarasota, Suwannee, and Taylor (1965) Counties, and counties indicated by symbol W.

Table 7.—Crushed limestone sold or used by producers, by uses

Use	1965			1966		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	30,258,300	$33,405,119	$1.10	29,514,572	$30,712,720	$1.04
Agstone	660,970	2,136,057	3.23	880,381	2,048,052	2.33
Fill	576,381	294,887	.51	W	W	W
Railroad ballast	508,700	785,849	1.54	W	W	W
Other uses [1]	2,320,372	2,350,934	1.01	3,147,492	3,007,052	.96
Total	34,324,723	38,972,846	1.14	33,542,445	35,767,824	1.07

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."
[1] Includes cement, lime, riprap, and other uses, and uses indicated by symbol W.

METALS

Metals accounted for only a small percentage of the State's total mineral production value. Principal metals produced were rare-earth minerals, titanium concentrates, and zirconium concentrates. Output and value of all mineral concentrates decreased considerably because of declining mining activity. Ferroalloys were produced by two companies, but value is not included in the State total.

Ferroalloys.—Ferroalloy shipments consisting only of ferrophosphorus increased 15 percent over those of 1965. Mobil Chemical Co. at Nichols and Agrico Chemical Co. at Pierce produced ferrophorus as a byproduct of elemental phosphorus manufacture.

Rare-Earth Minerals.—National Lead Co., the only rare-earth mineral producer in the State, recovered monazite at its Jacksonville mine. Shipments of concentrates decreased considerably below those of 1965.

Titanium Concentrates.—Shipments of ilmenite concentrate decreased considerably below those of 1965. E. I. du Pont de Nemours & Co., Inc. operated during the year, making shipments from its Highland and Trail Ridge mines in Clay County.

Zirconium Concentrates.—Zirconium concentrates (zircon) were recovered from ilmenite mining by E. I. du Pont de Nemours & Co. Inc. at its Trail Ridge operation in Clay County.

FUELS

Mineral fuels accounted for 2 percent of the State's total mineral production value. Crude petroleum and natural gasoline production increased; natural gas and liquefied petroleum gas output decreased slightly below that of 1965. Peat output declined considerably below that of 1965.

Natural Gas.—All natural gas production came from the Humble Oil Co., Sunniland Field, Collier County, and was used in company operations as fuel for pumping crude petroleum. Preliminary production reports indicate a slight decrease in output below 1965. Consumption of natural gas, obtained from Louisiana gasfields, continued to increase. More than 98 billion cubic feet of gas was reportedly used by electric generating stations throughout the State. Florida Hydrocarbon Co., near Brooker, Bradford County, continued to be the only natural gas processing plant in the State.

Peat.—Peat production and value declined considerably compared with 1965 figures. Five companies in four counties produced 12,000 tons of reed-sedge and/or humus peat valued at $91,000. Leading producers were Traxlers Peat Co., near Florahoma, and Raymond Johnson, near Plymouth. Most of the material was shredded and sold in bulk for soil improvement purposes.

Petroleum.—Crude petroleum production from the State's two oilfields increased 23 percent over that of 1965. Cumulative production to yearend 1966 totaled more than 11.5 million barrels. Both fields are located in the South Florida basin and produce from a depth of about 11,500 feet. In the Sunniland Field, Collier County, no new wells were drilled during the year. In the Sunoco-Felda Field, a total of 34,585 feet were drilled in three edge wells producing a combined yield on initial production tests of 148 barrels of oil per day, and

23,131 feet were drilled in two unsuccessful offset wells.

A total of 130,984 feet were drilled in 11 exploratory wells in the State during the year. Eight of these wells were wildcats, with four located in Collier County, two in Hendry County, one in Santa Rosa County, and one in Okeechobee County. A ninth well, 3.5 miles west of the Sunoco-Felda Field was completed as a producer of 56 barrels of oil per day; additional control is required to determine if this is a new field discovery or an extension of the Sunoco-Felda Field. In addition, 23,195 feet were drilled in two unsuccessful Sunoco-Felda outpost wells.

Interest in offshore geophysical activity, begun in 1964, continued throughout the year; geophysical crews were engaged in work principally along the west coast of the State. In 1966 offshore State leases totaled more than 3.9 million acres and all were located off the west coast of the State. Current figures on mainland acreage held under oil and gas lease are not available, but in 1965 this acreage totaled more than 3 million.

REVIEW BY COUNTIES

Mineral production was recorded in 44 of the State's 67 counties, 1 county less than in 1965. The five leading counties, ranked according to value were Polk, Hillsborough, Dade, Gadsden, and Clay, which accounted for 82 percent of the State's total value.

Land-pebble phosphate rock, the major mineral commodity in the State, was mined in Polk, Hillsborough, and Hamilton Counties. Sand and gravel, the most widespread commodity produced in the State, was mined in 24 counties; crushed limestone in 19; clays (including fuller's earth, kaolin, and miscellaneous clay) in 7; crushed oystershell in 5; peat in 4; lime and soft-rock phosphate in 3; cement and petroleum in 2; and the remaining commodities in 1 county each.

Alachua.—Five companies crushed limestone for road and concrete uses; total output was 2.2 million tons valued at $1.8 million, increases of 23 percent in tonnage and 38 percent in value compared with 1965 output and value. Producers, listed in order of output, were Limestone Products, Inc. (Haile Quarry); Clalroc, Inc., formerly Williston Shell Rock Co. (Buda Quarry); Houdaille-Duval-Wright Co. (Haile Quarry); Ocala Limerock Corp. (Haile Quarry); and Alachua Corp. (High Springs Quarry). Sixty-seven percent of the limestone was transported by railroad and the remainder by truck.

Bay.—Calloway Sand Co. (Silver Creek Mine) and Cato Sand Co. (Mill Bayou Mine) mined building, paving, and lawn dressing sand for local markets; combined output of the two companies increased. All of the sand was transported by truck. International Paper Co. produced regenerated lime at its plant near Panama City for use in the manufacture of paper products; output and value increased.

Bradford.—Florida Hydrocarbons Co., a subsidiary of Houston Corp., the only natural gas processing plant in the State, produced natural gasoline and liquefied petroleum gas at its operation near Brooker. Natural gas for the plant was obtained from Louisiana gasfields.

Brevard.—Valkaria Sand Co. mined building sand for local consumption; output and value increased. All of the sand was transported by truck.

Broward.—Eleven quarries crushed limestone for roads and concrete; the leading individual quarries listed in order of output were Maule Industries, Inc. (Prospect Quarry); Houdaille-Duval-Wright Co. (Green Quarry); and Houdaille-Duval-Wright Co. (Deerfield Quarry). Gold Coast Mining Corp. reported for the first year.

Sand was mined by four companies for building, fill, and lawn dressing uses. Sand producers listed in order of output were Dania Fill and Silica Sand Corp.; Florida Silica Sand Co. (Pegram Mine); Davie-Des Rocher Sand Co. (Ft. Lauderdale Mine); and Bennie F. Matthews (Pompano Beach Mine). All of the sand was produced at stationary plants and transported by truck.

Citrus.—Three companies crushed limestone at three quarries; total output increased slightly. General Portland Cement Co. crushed limestone and mined miscellaneous clay for use in manufacturing cement at its Tampa plant. Florida Lime Works, Inc. (Dunnellon Quarry), and Crystal River Quarries, Inc. (Red Level

Table 8.—Value of mineral production in Florida, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Alachua	W	$1,804,101	Limestone.
Bay	W	W	Sand and gravel.
Bradford	W	W	LP gas and natural gasoline.
Brevard	W	27,000	Sand and gravel.
Broward	$5,423,206	5,560,322	Limestone, sand and gravel.
Citrus	W	W	Limestone, phosphate rock, miscellaneous clay.
Clay	W	W	Ilmenite, zircon, sand and gravel, staurolite, miscellaneous clay, peat.
Collier	W	W	Petroleum, limestone, natural gas.
Columbia	W	W	Limestone.
Dade	W	W	Cement, limestone, sand and gravel.
Duval	W	W	Oystershell, monazite.
Escambia	450,000	W	Sand and gravel, miscellaneous clay.
Flagler	W	W	Cement, limestone.
Franklin	W	-----	
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	27,344,444	26,497,868	Cement, phosphate rock, oystershell, sand and gravel, peat.
Indian River	W	19,000	Sand and gravel.
Jackson	60,700	63,000	Limestone.
LaFayette	W	24,000	Do.
Lake	974,000	1,124,000	Sand and gravel.
Lee	W	W	Limestone, oystershell.
Leon	W	W	Sand and gravel.
Levy	673,899	657,238	Limestone.
Manatee	W	W	Limestone.
Marion	W	W	Limestone, phosphate rock, fuller's earth, sand and gravel.
Monroe	W	W	Limestone.
Orange	W	W	Sand and gravel, peat.
Palm Beach	W	848,716	Limestone, sand and gravel.
Pinellas	W	579,000	Oystershell, sand and gravel.
Polk	127,241,900	171,471,900	Phosphate rock, sand and gravel.
Putnam	W	W	Kaolin, sand and gravel, peat.
St. Lucie	W	W	Sand and gravel.
Sarasota	W	W	Limestone.
Sumter	2,966,103	W	Limestone, lime.
Suwannee	W	W	Limestone.
Taylor	W	-----	
Volusia	W	W	Sand and gravel.
Wakulla	17,000	68,000	Do.
Walton	W	W	Oystershell, sand and gravel.
Washington	-----	12,000	Sand and gravel.
Undistributed [2]	84,168,748	86,690,855	
Total	249,320,000	295,447,000	

W Withheld to avoid disclosing individual company confidential data.

[1] The following counties are not listed because no production was reported: Baker, Calhoun, Charlotte, Desoto, Dixie, Hardee, Highlands, Holmes, Jefferson, Liberty, Madison, Martin, Nassau, Okaloosa, Okeechobee, Osceola, Pasco, St. Johns, Santa Rosa, Seminole, and Union.

[2] Includes value of natural gas liquids, and counties indicated by symbol W.

Quarry), crushed limestone for agricultural purposes. Ninety-four percent of the crushed limestone was transported by rail and the remainder by truck. Soft-rock phosphate was produced by three companies; total marketable production was 34,000 tons valued at $231,000 compared with 19,000 tons valued at $163,000 in 1965. The phosphate rock was used for direct application to the soil and for stock feed supplement.

Clay.—The county ranked fifth in value of mineral production. E. I. du Pont de Nemours & Co., Inc. (Trail Ridge and Highland Mines) mined ilmenite, zircon, and staurolite; zircon and staurolite output and value increased but ilmenite production decreased considerably. Florida Solite Corp. (Russell Mine), near Green Cove Springs, mined miscellaneous clay for use in manufacturing lightweight aggregate products; output and value were at record highs. Tomes Peat Humus Co. mined peat near Keystone Heights for soil improvement uses. All-Florida Sand Co. (Keystone Heights Mine) produced building sand;

output and value increased. The sand was produced at a stationary plant and transported by truck.

Collier.—The county is one of the State's two petroleum-producing counties. Humble Oil and Refining Co. produced crude petroleum and natural gas from the Sunniland Field. The limestone crushed at three quarries was used for roads and concrete and was transported principally by truck. Crushed limestone producers listed in order of output were Fuller Industries, Inc. (Sunniland Quarry); Leon McCormick (Naples Quarry); and Naples Limerock Co. (Belle Meade Quarry).

Columbia.—White Construction Co. (Columbia City Quarry) crushed limestone for roads and concrete; output and value decreased. All of the stone was transported by truck.

Dade.—The county again ranked third in value of mineral production and led the State in production of crushed limestone. Thirteen quarries, the same as in 1965, crushed limestone; total output and value increased slightly over the previous year. Eighty-five percent of the stone was used for roads and concrete, and the remainder for railroad ballast and other uses. Fifty-seven percent of the material was transported by rail and 7 percent by water. The four leading producers of crushed limestone, listed in order of output, were Seminole Rock Products, Inc. (Medley Quarry); Maule Industries, Inc. (Pennsuco Quarry); Lehigh Portland Cement Co. (Dade County Quarry); and Oolite Industries, Inc. (Richmond Quarry).

Masonry and portland cement output increased. Lehigh Portland Cement Co. (Miami mill) and General Portland Cement Co. (Everglades mill) shipped portland and masonry cement; both companies crushed limestone at nearby quarries for use in cement manufacture.

Sand was mined by two companies; total output and value declined considerably. T. J. James Construction Co., Inc. (Miami Mine), and Des Rochers Sand Co. (Cape Florida Mine) produced building, paving, and fill sand for local consumption. All of the sand was transported by truck. W. R. Grace & Co. expanded crude perlite at its plant near Hialeah for building plaster, insulation, concrete aggregate, soil conditioning and filler uses. Expanded perlite production and value increased considerably. The City of Hialeah produced and used 21,000 tons of regenerated lime valued at $320,000, compared with 28,000 tons used in 1965.

Duval.—National Lead Co. (Jacksonville Mine) reported shipments of rare-earth concentrates. Houdaille-Duval-Wright Co. dredged and crushed oystershell, output and value of which decreased, at its White Shell plant near Jacksonville. The material was used for roads and poultry grit. U. S. Gypsum Co. and Kaiser Gypsum Co., Inc., calcined crude gypsum ores from Nova Scotia at plants near Jacksonville. The output and value of the calcined product, used in the manufacture of building products decreased. W. R. Grace & Co. exfoliated crude vermiculite from out-of-State sources; output and value increased. It was used for loosefill insulation, building plaster, concrete aggregate and other uses. Chemrock Corp. expanded crude perlite at its plant near Jacksonville; output and value increased. The expanded product was used for building plaster, concrete aggregate, soil conditioning and as filler material. Alton Box Board Co. regenerated lime for use in the manufacture of paper; total lime used was 55,000 tons valued at $848,000.

Escambia.—Sand and/or gravel was mined at five locations; sand output was 336,000 tons valued at $298,000 and gravel output 90,000 tons valued at $108,000. The leading sand producer was Edward M. Chadbourne, Inc. (Pensacola Mine), and the leading gravel producer was Escambia Materials, Inc., formerly Ward Gravel Co. (Century Mine). Most of the sand was used for building, paving. and fill purposes. Taylor Brick and Tile Co. (Barth Mine) mined miscellaneous clay for use in brick manufacture and other heavy clay products; output and value were lower.

Flagler.—Lehigh Portland Cement Co. shipped masonry and portland cement from its Bunnell plant prior to its permanent closure. The firm also shipped a small tonnage of crushed limestone from its Coquina Quarry for use in cement manufacture.

Gadsden.—The county ranked fourth in value of mineral production. Most of the fuller's earth production, in the State comes from this county, and a new alltime high was recorded. Producers listed in

order of output were Pennsylvania Glass Sand Co. (Quincy Mine); Minerals & Chemicals Philipp Corp. (Midway, La Camelia and McElvey Mines); and Dresser Magcobar (Havana Mine), formerly Magnet Cove Barium Corp.

Florida Gravel Co. (Chattahoochee Mine) mined building sand and paving gravel; total output and value decreased. Appalachee Correctional Institute (Chattahoochee Mine) mined miscellaneous clay for use in the manufacture of building brick; output and value increased.

Gulf.—Michigan Chemical Corp. (Port St. Joe plant) produced magnesium compounds from sea water and produced lime for use in its recovery; lime used increased. St. Joe Paper Co. (Port St. Joe limekiln) produced 77,000 tons of regenerated lime valued at $1.2 million, for paper manufacture, compared with 75,000 tons in 1965.

Hamilton.—Occidental Corp. of Florida increased its output of phosphate rock considerably during the year. The company completed plant construction and began producing and shipping processed materials. The first exports of phosphate rock from the company terminal, on the St. Johns River near Jacksonville, were announced. During the year, Occidental obtained a lease from Owen-Illinois Company for mineral rights on lands near mines now being operated; it is anticipated that phosphate rock production will be greatly accelerated in the near future.

Hendry.—The county is one of the State's two counties producing crude petroleum, the other being Collier County. Sun Oil Co. continued operation of the Sunoco-Felda field, discovered in 1964, and at yearend cumulative production was 1.7 million barrels of oil. The entire field, including the portion in Collier County, had 26 producing wells, drilled on 160-acre spacing, at yearend. The yield of the better wells in the field ranged from 320 to 370 barrels of oil per day. Ortona Sand Co., Inc. (LaBelle Mine), mined building and paving sand for local consumption; output and value increased. The sand was produced from a stationary plant and transported by truck.

Hernando.—The county ranked second in crushed limestone output. The three leading quarries were Florida Rock Products Corp. (Diamond Hill Quarry); Camp Concrete Rock Co. (Gay Quarry); and Brooksville Rock Co. (Broco Quarry). W. L. Cobb Construction Co. operated the Aripeka Quarry, formerly operated by Lansing Rock Co. Ninety-eight percent of the stone was used for roads and concrete, and the remainder for railroad ballast and other uses. Fifty-seven percent of the stone was transported by truck and 43 percent by rail. Chemical Lime, Inc. (Brooksville limekiln), produced primary lime from rock supplied from Camp Concrete Rock Co.'s Gay Quarry; lime output and value increased considerably.

Hillsborough.—The county was second in value of mineral production. Marketable production of phosphate rock decreased slightly in both tonnage and value. American Cyanamid Co. (Sydney Mine) increased output but production from Agrico Chemical Co. (Boyette Mine) decreased. Shipments of both portland and masonry cements from the Tampa mill of General Portland Cement Co. increased. Cement raw materials were shipped from other counties and nearby States. Bay Dredging and Construction Co. dredged and crushed oystershell from State Lease No. 1703; output and value decreased. The crushed shell was used for roads and concrete. Edgar Plastic Kaolin Co. (Plant City Mine) mined sand for construction and industrial uses; output and value remained about the same. A. J. Stearns produced humus peat for soil improvement purposes; output and value remained at the same level. National Gypsum Co. calcined crude gypsum from Nova Scotia at its Tampa plant for use in wallboard, plaster, and other building products. W. R. Grace & Co., and Surco Manufacturing Co., exfoliated crude vermiculte from out-of-State sources at plants near Tampa.

Indian River.—Airlite Processing Corp. of Florida expanded crude perlite from out-of-State sources for use in building plaster, concrete aggregate, and other uses; output and value of the expanded product increased.

Jackson.—Green Valley Lime Co. crushed limestone for direct soil application at its plant near Marianna; output and value increased.

Lake.—The three leading sand producers listed in order of output were Orange Sand Co. (Jacksonville Mine); Eustis Sand Co.; and E. R. Jahna Industries, Inc. (Cler-

mont Mine). Most of the sand was produced at stationary plants and transported by truck.

Lee.—Limestone was crushed at three quarries; total output and value decreased. Producers listed in order of output were West Coast Rock Co., Inc. (Fort Myers Quarry); Harper Brothers, Inc. (Estero Quarry); and a new producer reporting for the first year, Lee County Mining Co., Inc. Fort Myers Shell and Dredging Co. dredged and crushed oystershell from State leases. The crushed shell output and value of which increased over 1965 was used principally for roads and concrete.

Leon.—Two companies mined building, paving, and fill sand for local consumption, at about the same level as in 1965. Producers were Roberts Sand Co. (Norfleet Mine) and Middle Florida Sand Co., Inc. (Tallahassee Mine). The sand was transported by truck.

Levy.—Producers of crushed limestone from three quarries listed in order of output were Dixie Lime & Stone Co. (Lebanon No. 4 Quarry); V. E. Whitehurst and Sons, Inc., formerly W & M Construction, Inc. (Raleigh Quarry); and Connell & Shultz (Williston Quarry). Sixty-four percent of the crushed stone was transported by truck and 36 percent by rail. Principal uses were for agricultural purposes, roads, and concrete.

Manatee.—Three companies crushed limestone compared with two in 1965; total output and value increased considerably. Producers listed in order of output were Chris Wheeler Rock Co. (Manatee Quarry), reporting for the first time since 1963; Florida Southern Dolomite, Ltd. (Palmetto Quarry); and Lee A. Thorpe Construction Co. (Bradenton Quarry). Bradenton Stone Co. produced a small tonnage of dimension limestone. The crushed limestone was used for roads, concrete, and agricultural purposes. Eighty-five percent of the crushed stone was transported by truck and 15 percent by railroad.

Marion.—Three companies crushed limestone at five quarries; the largest single producer was Ocala Lime Rock Corp. (No. 7 Quarry). Dixie Lime & Stone Co. operated the Lehigh, Zuber, and Reddick Quarries and Southern Materials Corp. continued operation of its Lowell Quarry. The City of Ocala crushed a small tonnage of limestone. Eighty-nine percent of the crushed stone was used for roads and concrete, and the remainder for agricultural purposes. Ninety percent was transported by trunk and 10 percent by rail. Mid-Florida Mining Co. (Lowell Mine) mined fuller's earth. Loncala Phosphate Co. (Minehead Mine) mined an increased tonnage of soft-rock phosphate. Kibler-Camp Phosphate Enterprise (Section 26 mine), the only hard-rock phosphate mine in the State, mined 44,000 tons of phosphate valued at $394,000. The company closed the mine during the year, ending a long period of production. National Silica Corp. (Lynn Mine) mined a small tonnage of building and industrial sand; output and value decreased. The sand was produced at a portable plant and was transported by truck.

Orange.—The Orange County Highway Department mined 135,000 tons of paving and fill sand, valued at $93,000 for use in its road maintenance program; output and value decreased. Daetwyler Peat Mine, near Orlando, and Raymond Johnson, at Plymouth, mined peat at reduced outputs. The humus and reed-sedge peat was used principally for general soil improvement purposes.

Palm Beach.—Three commercial operators and one county operation crushed limestone. Commercial producers, in order of output were P. C. Smith Co., Inc. (Palm Beach Quarry); Palm Beach Mining Co., Inc. (West Palm Beach Quarry); and Belle Glade Rock Co. (Belle Glade Quarry). The Palm Beach County Highway Department crushed 156,000 tons of limestone valued at $125,000, and also mined 130,000 tons of paving sand valued at $72,000, both for use in its road maintanance program. W. R. Grace & Co. exfoliated crude vermiculite at its Boca Raton plant at an increased rate.

Pinellas.—Benton & Co., Inc., dredged and crushed oystershell from State Lease No. 1788; output and value decreased. The crushed shell was used principally for roads and concrete and was transported from the docks by truck. Florida Washed Sand Co. (St. Petersburg Mine) produced a small tonnage of building sand from a stationary plant, which was transported to local markets by truck.

Polk.—Polk County continued to lead the State in value of total mineral production as well as in production of marketable

phosphate rock and sand and gravel. Total mineral value was $171.5 million, an increase of 35 percent, and represented 58 percent of the State total.

The increase was due principally to greater output of marketable land-pebble phosphate rock, as sand and gravel output decreased slightly. Land-pebble phosphate rock was produced by 10 companies at 18 mines as follows: International Minerals & Chemical Corp. operated four mines (Achan, Noralyn, Kingsford, and Dredge mines); Mobil Chemical Co. operated three mines (Homeland, Clear Springs, and Ft. Meade mines); Agrico Chemical Co. operated two mines (Palmetto and Payne Creek mines); Armour Agricultural Chemical Co. operated two mines (Bartow and Lake Hancock); Swift & Company operated two mines (Watson and Silver City); American Cyanamid Co. operated the Orange Park mine; W. R. Grace & Co. operated the Bonny Lake mine; Borden Chemical Co. the Tenoroc mine; Hydromines, Inc., the Eaton Park mine, and Minerals Recovery Corp., the Sand Mountain mine. The leading producers were International Minerals & Chemical Corp., Agrico Chemical Co., and Mobil Chemical Co.

Sand was mined by eight companies at eight mines, all but one company, Standard Sand & Silica Co., mined sand for building purposes; Standard produced both building and industrial sand. The three leading producers listed in order of output were Standard Sand & Silica Co. (Standard Mine), Mammoth Sand Co. (Lake Wales Mine), and Gall Silica Mining Co., Inc. (Lake Wales Mine). Sixty percent of the sand was transported by rail and 40 percent by truck.

Putnam.—Two companies mined kaolin for whiteware and pottery uses; output and value remained the same as in 1965. Producing companies were Cyprus Mines Corp. (No. 4 mine) and Edgar Plastic Kaolin Co.; Cyprus and Edgar also produced building and industrial sand. Leading producers of sand listed in order of output were Diamond Interlachen Sand Co. (Interlachen Mine), and Southern Materials Co., Inc., of Florida (Putnam Hall Mine). Most of the sand was used for building purposes, but a small tonnage was used for industrial purposes. Sixty percent of the sand was transported by truck and 40 percent by rail. Traxler's Peat Co., near Florahoma, produced humus peat for soil improvement purposes; output remained at about the same level as in 1965. Hudson Pulp and Paper Corp. (Palatka limekiln) produced 88,000 tons of regenerated lime valued at $1.3 million for paper manufacture.

St. Lucie.—Sand was produced by two companies at three mines; Indian River Minerals, Inc., who reported for the first year and Fort Pierce Sand and Materials, Inc. (White City and Ft. Pierce Mines). Total output and value increased considerably compared with 1965, and was used principally for building and fill with a small tonnage used for industrial purposes. All of the sand was transported by truck.

Sumter.—Three firms, Center Hill Rock Co. (Center Hill Quarry), one of the largest producers in the State; Dixie Lime & Stone Co. (Coleman No. 2 Quarry); and St. Catherine Rock Co. (St. Catherine Quarry); produced 3.5 million tons of crushed limestone valued at $2.5 million, compared with 3.9 million tons in 1965. The material was used for roads, concrete, and primary lime production. Dixie Lime & Stone Co. completed and placed in operation about midyear a new 200 ton per day rotary limekiln; the first of its kind in the southeast.

Suwannee.—Three quarries crushed limestone for roads, concrete, and agricultural purposes; output and value increased compared with 1965. Producers listed in order of output were Florida Rock Products Corp. (Suwannee Quarry), Southern Dolomite & Hical Co. (Live Oak Quarry), formerly Suwannee Valley Dolomite & Lime Co., and Ocala Lime Rock Corp. (Lanier Quarry). Sixty-six percent of the crushed stone was transported by rail and the remaining 34 percent by truck.

Taylor.—Buckeye Cellulose Corp. (Foley limekiln) used 138,000 tons of regenerated lime valued at $2.5 million for alkalies and water uses; a considerable increase compared with 1965 figure. Williston Shell Rock Co. formerly operating the Perry Quarry did not report production of crushed limestone during the year.

Volusia.—White Sand and Materials Corp. (New Smyrna Beach Mine) pro-

duced a small tonnage of sand for building and fill purposes; output and value decreased below 1965 levels. All of the sand was produced at a stationary plant and transported by truck.

Walton.—Southern Materials Corp. dredged and crushed oystershell from State Lease No. 1718; output was 506,000 tons valued at $506,000, a considerable increase over that of 1965. The crushed shell was used for roads and concrete. Adams Sand Co. (Mossy Head Mine) mined building sand for local consumption; output and value increased compared with 1965. All of the sand was produced from a stationary plant and transported by truck.

Washington.—Miller & Jerkins (Wausau Mine) produced 13,000 tons of sand valued at $12,000 for building, paving, fill, and for use in manufacturing concrete block; the sand was all produced from a portable plant and transported by truck.

The Mineral Industry of Georgia

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, United States Department of the Interior, and the Geological Survey of Georgia.

By James L. Vallely [1] and A. S. Furcron [2]

Georgia's mineral industry continued to expand in 1966, and production reached a total value of $148.6 million, an increase of 10 percent. Nonmetallics made up 97 percent of the value of the State's mineral production, and metals and mineral fuels accounted for 3 percent. Increases were recorded for most minerals; notable exceptions were cement, which decreased 2 percent in quantity and 5 percent in value, and talc, which decreased 8 percent in tonnage and 19 percent in value. Production of iron ore and stone, although higher in quantity, showed little change in value. Crushed stone rose 6 percent in tonnage and 4 percent in value, while dimension stone decreased 22 percent in quantity and 15 percent in value. Rare-earth concentrates (monazite sand) were recovered in 1966 as a byproduct of titanium and zircon concentrates production, which began in 1965. Sheet mica and coal were not produced during the year.

Georgia ranked first among the States in output of kaolin, second in fuller's earth and rare-earth concentrates, third in bauxite and kyanite, fourth in barite and ilmenite, and fifth in feldspar. Leading companies in the mineral industries were American Industrial Clay Co. (kaolin), Freeport Kaolin Co. (koalin), Georgia Marble Co. (granite, marble, and feldspar).

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Table 1.—Mineral production in Georgia [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	4,607	$63,158	5,128	$73,685
Iron ore (usable) thousand long tons, gross weight	r 430	r 2,208	447	2,200
Mica:				
Scrap—thousand short tons	13	W	17	380
Sheet—pounds	2,793	(2)	------	------
Sand and gravel—thousand short tons	3,675	3,588	3,915	4,185
Stone—do	23,421	48,265	24,690	48,193
Talc—short tons	44,800	313	41,000	255
Value of items that cannot be disclosed: Barite, bauxite, cement, feldspar, kyanite, peat, rare-earth metal concentrates, titanium concentrates, zircon concentrates, and values indicated by symbol W	XX	17,688	XX	19,699
Total	XX	r 135,220	XX	148,597

r Revised. W Withheld to avoid disclosing individual company confidential data. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Less than ½ unit.

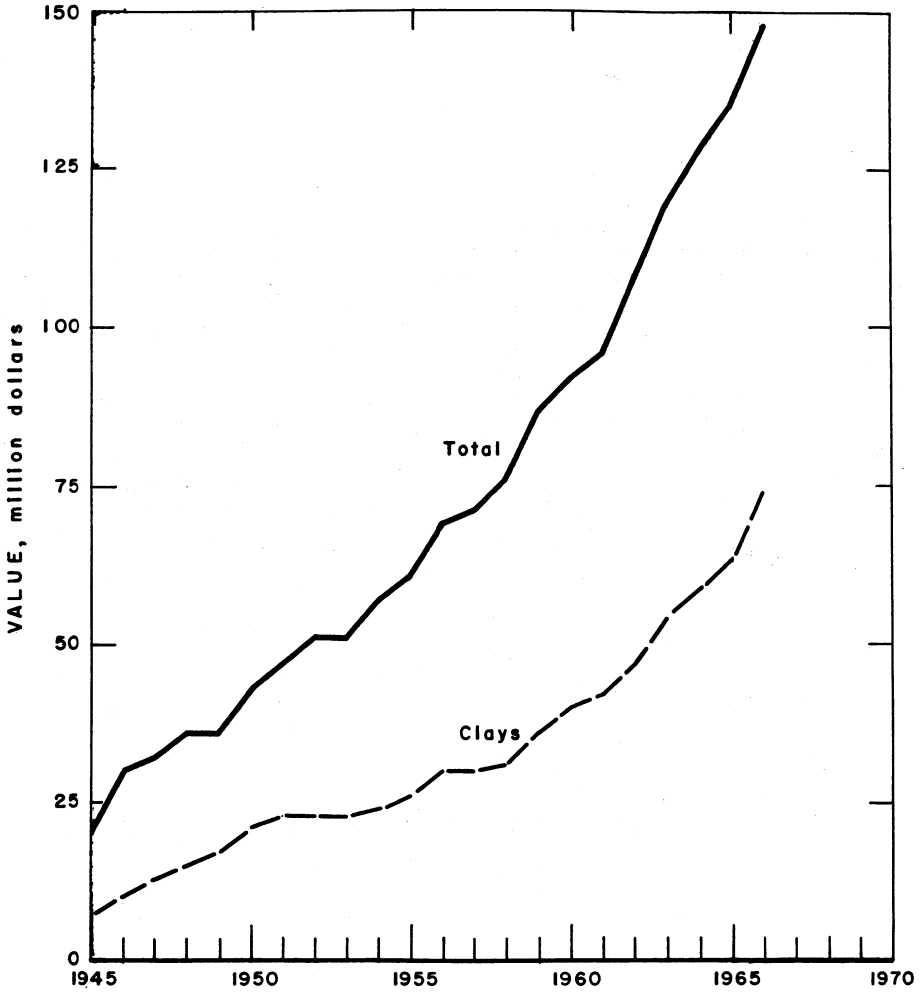

Figure 1.—Value of clays, and total value of mineral production in Georgia.

Table 2.—Value of mineral production in constant 1957–59 dollars
(Thousands)

Year	Value
1957	$71,648
1958	76,575
1959	86,007
1960	90,817
1961	93,686
1962	101,528
1963	118,410
1964	120,063
1965	r 132,237
1966	p 144,308

r Revised. p Preliminary.

J. M. Huber Corp. (kaolin), Minerals & Chemicals Philipp Corp. (kaolin and fuller's earth), and Vulcan Materials Co. (granite).

Trends and Developments.—Several new mines and quarries were opened during the year, including five each brown iron ore and kaolin, two bauxite, and one each fuller's earth, miscellaneous clay, sand and gravel, and crushed granite. J. M. Huber Corp. began operating a kaolin mine and processing plant at Wrens. Minerals & Chemicals Philipp Corp. continued construction and expansion of their kaolin

Table 3.—Employment 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
1965:								
Metal	188	251	47	366	---	2	5.46	106
Nonmetal and peat	3,108	300	932	7,498	2	173	23.34	2,830
Sand and gravel	212	221	47	383	1	4	13.05	15,891
Stone	2,671	260	694	5,877	2	113	19.57	3,157
Total	6,179	278	1,720	14,124	5	292	21.03	3,250
1966: p								
Metal	235	275	65	536	---	14	26.12	576
Nonmetal and peat	3,710	316	1,171	9,364	---	256	27.34	1,755
Sand and gravel	240	261	62	549	1	12	23.68	11,361
Stone	3,305	260	858	7,173	2	193	27.19	3,350
Total	7,490	288	2,156	17,622	3	475	27.13	2,668

p Preliminary.

and fuller's earth operations. Freeport Kaolin Co. continued its expansion and modernization program at Gordon, and Cyprus Mines Corp. was building a new kaolin processing plant at Jeffersonville.

Interstate highway construction contributed markedly to the State's mineral production; 243.9 miles were under construction in 1966, 454.4 miles were open to traffic, and 407.5 miles, or 37 percent of the system, were yet to be built.

Exploratory drilling for phosphate in southeast Georgia was conducted during the year by the Georgia Department of Mines, Mining and Geology.

Reports relating to the State's minerals were published by the Bureau of Mines and the Geological Survey.[3]

REVIEW BY MINERAL COMMODITIES

NONMETALS

Barite.—Primary barite was produced by three companies in Bartow County; Paga Mining Co. was the leading producer. Most of the barite was used in oil well drilling muds, barium chemicals, and paint and rubber fillers.

Cement.—Cement ranked third in value in the State's mineral production. Shipments of portland cement decreased 3 percent in quantity and 5 percent in value, masonry cement shipments were slightly lower and decreased 2 percent in value. Marquette Cement Manufacturing Co. produced masonry and portland cement. Penn-Dixie Cement Corp. and Southern Cement Co. manufactured only portland cement. Eighty-five percent of the portland cement was shipped to Georgia destinations. Out-of-State shipments were principally to Florida, North Carolina, and South Carolina with minor amounts to U.S. possessions and territories and foreign countries. Portland cement shipments went to the following consuming industries: Ready-mix concrete plants (58 percent), highway contractors (13 percent), concrete product manufacturers (10 percent), building material dealers (9 percent), and government agencies and other users (10 percent).

Clays.—Clay comprised 50 percent of the total value of mineral production; kaolin alone accounted for more than 45 percent. Kaolin production increased 18 percent in quantity and 17 percent in value; fuller's earth production increased 14 percent in quantity and 17 percent in value. Miscellaneous clay production was little changed from 1965.

Georgia continued to lead the Nation in kaolin production and ranked second in fuller's earth. Kaolin was mined by 18 companies from 25 mines in eight counties. Seven companies produced fuller's earth from seven mines in four counties, and 13

[3] Browning, J. S., and Ralph B. Adair. Selective Flotation of Mica From Georgia Pegmatites. BuMines Rept. of Inv. 6830, 1966, 9 pp.
White, W. S., and N. M. Denson. Bauxite Deposits of Northwest Georgia With Sections on the Summerville Area by J. C. Dunlap and E. R. Overstreet. U.S. Geol. Survey Bull. 1199-M, 1966, 42 pp.

companies mined miscellaneous clay in nine counties. In all, clay was produced by 36 companies with 48 operations in 18 counties. Leading kaolin producers were Minerals & Chemicals Philipp Corp., J. M. Huber Corp., American Industrial Clay Co., and Freeport Kaolin Co. Principal producers of fuller's earth were Minerals & Chemicals Philipp Corp., Waverly Petroleum Products Co., and Georgia-Tennessee Mining and Chemical Co. Principal producers of miscellaneous clay were Merry Bros. Brick and Tile Co., Chattahoochee Brick Co., Cherokee Brick and Tile Co., Burns Brick Co., and Georgia-Carolina Brick and Tile Co.

Table 4.—Koalin sold or used by producers, by counties

County	1965		1966	
	Short tons	Value	Short tons	Value
Twiggs	1,146,656	$27,259,132	1,170,988	$29,000,518
Washington	1,145,865	25,154,331	1,371,630	29,827,975
Wilkinson	188,337	3,213,509	221,063	4,128,338
Other counties [1]	240,384	1,783,838	442,773	4,199,526
Total	2,721,242	57,410,810	3,206,454	67,156,357

[1] Includes Baldwin, Floyd, Houston (1965), Richmond, Sumter, and Warren (1966) Counties.

Table 5.—Kaolin sold or used by producers, by uses

Use	1965			1966		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Pottery and stoneware:						
Whiteware	119,624	$2,515,100	$21.03	97,711	$1,681,680	$17.21
Floor and wall tile	W	W	W	32,579	323,300	9.92
Refractories: Firebrick and block	221,309	1,567,182	7.08	469,964	3,636,530	7.74
Fillers:						
Paper filling	618,338	11,617,715	18.79	678,136	12,411,412	18.30
Paper coating	1,162,026	31,171,875	26.83	1,251,664	36,176,061	28.90
Rubber	83,128	904,350	10.88	99,631	1,132,400	11.37
Paint	77,758	1,815,900	23.35	96,054	2,280,900	23.75
Fertilizers	9,718	172,000	17.70	29,013	431,900	14.89
Plastics, organic	29,137	535,300	18.37	W	W	W
Portland and other hydraulic cements	46,803	78,666	1.68	W	W	W
Chemicals	16,942	366,600	21.64	28,247	611,200	21.64
Exports	142,168	3,401,200	23.92	211,963	5,433,000	25.63
Other uses [1]	194,273	3,264,922	16.81	211,492	3,037,974	14.36
Total	2,721,242	57,410,810	21.10	3,206,454	67,156,357	20.94

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."
[1] Includes stoneware; art pottery, flower pots, and glaze slip (1966); enameling; mortar; glass refractories; foundries, steelwork (bulk); kiln furniture; other refractories; linoleum and oil cloth; insecticides and fungicides; other fillers; catalysts; other uses; and uses indicated by smybol W.

Table 6.—Miscellaneous clay sold or used by producers, by counties

County	1965		1966	
	Short tons	Value	Short tons	Value
Fulton	344,946	$207,000	323,108	$201,000
Gordon	28,851	17,300	27,840	16,700
Other counties [1]	1,305,521	819,657	1,334,817	822,353
Total	1,679,318	1,043,957	1,685,765	1,040,053

[1] Includes Bibb, Columbia, Floyd, Houston (1966), Polk, Richmond, and Walker (1966) Counties.

Feldspar.—Flotation concentrate was produced by the Feldspar Corp. at its Monticello mill from feldspathic rock mined in Jasper County. Georgia Marble Co. produced a feldspar-quartz flotation concentrate as a byproduct of fines from granite crushing operations at Lithonia. Production and value of feldspar were again higher than in the previous year. The feldspar concentrate was used for glass and pottery and the feldspar-silica mixture for glass only.

Gypsum.—Imported crude gypsum was calcined by two companies at plants in Savannah, Chatam County, and by a third company at Brunswick, Glynn County, for use in manufacturing wallboard and other building products.

Kyanite.—Aluminum Silicates, Inc. increased production of kyanite more than 50 percent at Graves Mountain near Lincolnton. Its principal use was in refractories.

Lime.—Six firms, principally pulp and paper companies, in Camden, Chatham, Glynn, Lowndes, Richmond, and Wayne Counties regenerated lime. A total of 367,000 tons, valued at $7.1 million, was recovered by burning calcium carbonate sludge in rotary kilns. The material was used in the manufacturing process.

Mica.—Scrap mica was produced in Cherokee, Hart, and Jasper Counties. Grinding plants were operated by the Ruberoid Co. at Hartwell, Hart County, and Thompson-Weinman Co. at Cartersville, Bartow County. The dry-ground mica was used principally in the paint, roofing, and rubber industries. Ground mica production increased 7 percent in tonnage and 5 percent in value. No sheet mica was produced in Georgia in 1966.

Perlite.—Crude perlite shipped into the State was expanded by Zonolite Division of W. R. Grace & Co. at its plant in Atlanta and used principally for building plaster, concrete aggregate, and horticultural uses.

Sand and Gravel.—Sand and gravel production, ranking fourth in the State's minerals production increased 7 percent in tonnage and 17 percent in value. Construction sands were higher by 6 percent in tonnage and 14 percent in value; industrial sands increased more than 20 percent in both tonnage and value. Production of gravel was somewhat lower than in 1965.

Twenty-one companies produced sand from 24 pits in 18 counties, and 5 companies mined both sand and gravel in 4 counties. Of the 29 sand and gravel plants, 1 produced more than 600,000 tons, 6 between 200,000 and 400,000 tons, 8 between 100,000 and 200,000 and 14 less than 100,000. The principal producing counties were Bibb, Crawford, Muscogee, Talbot, and Taylor. Atlanta Sand & Supply Co. in Crawford County, Brown Bros. and Taylor Sand Co., both in Talbot County, and Butler Sand Co. and Howard Sand Co., both in Taylor County, were the principal sand producers. J. J. Brown Sand and Gravel Co. was the chief sand and gravel producer.

Stone.—Stone ranked second in value in the State's mineral production. Total crushed stone production increased 6 percent in tonnage and 4 percent in value. Crushed limestone, marble, and sandstone (quartzite) increased in both tonnage and value. Crushed granite output was 2 percent higher, but its value showed little change. Crushed slate tonnage also increased, but with a decrease in value. All dimension stone (granite, limestone, marble, and sandstone) was lower in both tonnage and value; total dimension stone decreased 22 percent in quantity and 15 percent in value.

Stone was produced at 81 quarries in 36 counties by 49 companies and 1 government agency. Dimension granite was produced in 5 counties from 34 quarries by 23 companies. Crushed granite was produced in 19 counties from 24 quarries by 10 companies. Crushed limestone was produced from 12 quarries in 8 counties by 10 companies and 1 government agency. Crushed marble and dimension marble were produced in Pickens County, and crushed marble only was produced in Chattooga and Gilmer Counties. Crushed slate was mined in Bartow and Polk Counties, quartzite in Richmond County, byproduct quartz in Jasper County, crushed sandstone in Polk County, and dimension sandstone in Pickens County.

Leading producers of crushed granite were Vulcan Materials Co. (six quarries), Dixie Lime and Stone Co. (five quarries), Weston & Brooker Co. (two quarries), Stone Mountain Grit Co., Inc., and Hitchcock Corp. (two quarries). Leading producer of dimension granite for building stone and curbing and flagging was Davidson Granite Co., Inc.; for monumental stone, Bennie & Harvey, Coggins Granite Industries, Inc.,

Table 7.—Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1965		1966	
	Quantity	Value	Quantity	Value
Chatham	W	W	15	W
Cherokee	1	$1	----	----
Cook	137	106	143	W
Crawford	W	W	677	W
Dougherty	142	133	87	W
Effingham	W	W	174	W
Evans	W	W	19	$28
Glynn	W	W	9	W
Greene	W	W	130	162
Long	W	W	46	W
Montgomery	38	56	34	25
Muscogee	W	W	375	W
Richmond	W	W	114	W
Telfair	8	9	8	9
Thomas	W	W	197	W
Ware	W	W	29	23
White	----	----	3	4
Undistributed [1]	3,349	3,283	1,855	3,934
Total	3,675	3,588	3,915	4,185

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes Bibb, DeKalb, Fulton, Talbot, Taylor, and Upson (1966) Counties, and counties indicated by symbol W.

Table 8.—Sand and gravel sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1965			1966		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	2,854	$2,231	$0.78	2,951	$2,565	$0.87
Paving	304	263	.87	474	340	.72
Fill	32	14	.44	W	W	W
Other sands	W	W	W	[1] 264	[1] 909	[1] 3.44
Total	W	W	W	3,689	3,814	1.03
Gravel	W	W	W	[2] 226	[2] 371	[2] 1.64
Total sand and gravel	[3] 3,675	[3] 3,588	[3] .98	3,915	4,185	1.07

W Withheld to avoid disclosing individual company confidential data; included with "Total sand and gravel" (1965) and with "Other sands" (1966).
[1] Includes glass, molding, blast, fil, and foundry sands.
[2] Includes gravel used for structural and paving purposes.
[3] Includes glass, molding, blast, and foundry sands; structural and paving gravel.

Comolli Granite Co., and Georgia Marble Co. were the leading producers. Crushed marble was produced by Georgia Marble Co. and Marble Products Co. of Georgia. Dimension marble was quarried by Georgia Marble Co. Excluding the cement companies, the principal producers of crushed limestone were Dalton Rock Products Co., Georgia Rock Products Co., Lambert & Lambert Stone Co., Inc., and Ready Mix Concrete Co., Inc. Superior Stone Co. was the only producer of quartzite. Ruberoid Co. and Georgia Lightweight Aggregate Co. quarried and crushed slate.

Talc.—Georgia Talc Co., Murray County, the only producer, mined, crushed, and ground talc principally for asphalt filler, insecticides, and roofing. Production and value of both crude and ground talc were lower than in 1965.

Table 9.—Dimension granite sold or used by producers, by counties

County	1965			1966		
	Cubic feet	Short tons (equivalent)	Value	Cubic feet	Short tons (equivalent)	Value
DeKalb	845,637	69,284	$1,178,685	667,744	73,009	$941,440
Elbert	766,409	63,612	1,860,080	543,942	43,516	1,485,497
Hancock	17,924	1,488	26,886	W	W	W
Other counties [1]	659,537	54,741	1,040,988	656,280	52,617	1,430,531
Total	2,289,507	189,125	4,106,639	1,867,966	169,142	3,857,468

W Withheld to avoid disclosing individual company confidential data; included with "Other counties."
[1] Includes Madison and Oglethorpe Counties, and counties indicated by symbol W.

Table 10.—Crushed granite sold or used by producers, by uses

Use	1965			1966		
		Value			Value	
	Short tons	Total	Average per ton	Short tons	Total	Average per ton
Concrete and roadstone	15,132,245	$21,151,919	$1.40	15,682,753	$20,891,308	$1.33
Railroad ballast	1,167,099	1,449,195	1.24	1,017,506	1,267,729	1.25
Riprap	249,502	405,702	1.63	162,728	257,607	1.58
Other uses [1]	636,438	669,916	1.05	733,464	1,270,851	1.73
Total	17,185,284	23,676,732	1.38	17,596,451	23,687,495	1.35

[1] Includes stone sand, poultry grit, filter stone, fertilizer filler (1965), and other uses.

Table 11.—Dimension granite sold or used by producers, by uses

Use	1965			1966		
		Value			Value	
	Cubic feet	Total	Average per cubic foot	Cubic feet	Total	Average per cubic foot
Rough monumental	1,368,896	$2,583,586	$1.89	1,147,162	$2,757,028	$2.40
Rubble	546,337	120,496	.22	361,704	145,966	.40
Curbing and flagging	280,000	576,076	2.06	W	W	W
Other uses [1]	94,274	826,481	8.77	359,100	954,474	2.66
Total	2,289,507	4,106,639	1.79	1,867,966	3,857,468	2.06

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."
[1] Includes rough construction (1966), dressed monumental, and architectural stone, and uses indicated by symbol W.

Table 12.—Crushed limestone sold or used by producers, by uses

Use	1965			1966		
		Value			Value	
	Short tons	Total	Average per ton	Short tons	Total	Average per ton
Concrete and roadstone	2,139,537	$2,929,238	$1.37	2,809,477	$4,097,420	$1.46
Agricultural stone	189,155	331,457	1.75	158,632	250,434	1.58
Other uses [1]	1,014,960	1,517,261	1.49	1,144,782	1,617,204	1.41
Total	3,343,652	4,777,956	1.43	4,112,891	5,965,058	1.45

[1] Includes cement, riprap, fluxing stone, railroad ballast (1965), and other uses.

Vermiculite.—W. R. Grace & Co., Zonolite Division, at its Atlanta plant, exfoliated crude vermiculite shipped into the State. Production and value were substantially higher than in 1965.

METALS

Bauxite.—American Cyanamid Co., the only bauxite producer, continued to mine and ship crude ore from its mines in Bartow, Floyd, and Sumter Counties to its drying plant at Adairsville (Halls Station), Bartow County, and to consumers.

Iron Ore.—Brown iron ore shipments, although 4 percent higher in tonnage, increased less than 1 percent in value. Eighty-five percent of the output was mined in the southern part of the State below the fall line, in Marion, Quitman, and Stewart Counties. Fourteen operations as in 1965, were active in this area. Three companies, including one producing crude iron oxide pigments, operated in Bartow County, and one in Polk County; both counties are in the northwestern part of the State. Leading producers were Davis Bros., Dunbar and Layton, and Lumpkin Mining Co., all in Stewart County. Iron ore was shipped to Birmingham and Gadsen steel plants. Both crude iron oxide pigments and finished pigments increased substantially in tonnage and value.

Titanium and Byproduct Minerals.—Humphreys Mining Co. continued to produce titanium concentrates from its new operation northeast of Folkston in Charlton County. Recovered as byproducts were monazite sand and zircon concentrates.

MINERAL FUELS

Peat.—Humus and reed-sedge peat were produced in Lowndes County. Output increased 7 percent over that of 1965.

REVIEW BY COUNTIES

Mineral production was reported from 72 counties; 24 counties had production that was valued above $1 million and constituted 88 percent of the State's total. Ten counties with production of more than $4 million were as follows, in descending order: Washington, Twiggs, Pickens, Fulton, Richmond, Houston, Polk, De Kalb, Bartow, and Wilkenson.

Baldwin.—General Refractories Co. mined kaolin at the Wood mine for the manufacture of fire brick and block.

Bartow.—Mineral production increased 7 percent. Barite, bauxite, and iron ore contributed to this increase. Limestone and slate production were somewhat lower than in 1965. Leading crude barite producers were Paga Mining Co. and New Riverside Ochre Co.; the latter company was also the only producer of crude and finished iron oxide pigments in the State. Thompson-Weinman & Co. operated a grinding plant at Cartersville to produce fillers and extenders from barite, kaolin, marble, mica, and other minerals. Southeastern Highway Contracting Co. quarried and crushed limestone for concrete and roadstone near Adairsville, and Marquette Cement Manufacturing Co. produced limestone for use in its cement plant at Rockmart, Polk County. Ruberoid Co. mined and crushed slate at its Fairmount underground mine for roofing granules and slate flour. American Cyanamid Co. mined bauxite at the Neel and Sutton mines and operated its bauxite drying plant near Adairsville throughout the year. Joe Mosteller and Cain Mining Co., Inc., mined brown iron ore.

Bibb.—Burns Brick Co. and Cherokee Brick & Tile Co. mined miscellaneous clay at Macon for brick and other clay products. Sand Suppliers, Inc., mined sand, and Cornell-Young Co. mined sand and gravel for building and paving.

Charlton.—Humphreys Mining Co. increased its production of ilmenite, monazite, and zircon concentrates in its second year of production at a new mine and plant near Folkston.

Chatham. — Sayler-Marine Construction, Inc., produced building and fill sand. Flintkote Co. and National Gypsum Co. calcined crude gypsum for wallboard and building products at Savannah.

Chattooga.—Marble Products Co. of Georgia quarried and crushed marble for terrazzo chips.

Cherokee.—Glenn-Ray Corp. and Thompson-Weinman & Co. mined scrap mica.

Clarke.—Gainesville Stone Co. quarried and crushed granite for concrete and roadstone at Athens.

Table 13.—Value of mineral production in Georgia, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Baldwin	W	W	Kaolin.
Bartow	$4,270,766	$4,578,206	Barite, limestone, slate, iron ore, bauxite, iron oxide pigments.
Bibb	W	W	Sand and gravel, miscellaneous clay.
Charlton	W	W	Ilmenite, zircon, monazite.
Chatham	W	W	Sand and gravel.
Chattooga	W	W	Marble.
Cherokee	W	W	Mica.
Clarke	W	W	Granite.
Clayton	W	W	Do.
Cobb	W	W	Do.
Columbia	W	W	Miscellaneous clay.
Cook	106,000	W	Sand and gravel.
Crawford	W	W	Do.
Dade	W	W	Limestone.
Decatur	W	W	Fuller's earth.
De Kalb	W	W	Granite, feldspar, sand and gravel.
Dooly	W	------	
Dougherty	133,000	W	Sand and gravel.
Douglas	W	W	Granite.
Early	W	W	Limestone.
Effingham	W	W	Sand and gravel.
Elbert	W	W	Granite.
Evans	W	28,000	Sand and gravel.
Fayette	W	W	Granite.
Floyd	W	W	Limestone, miscellaneous clay, bauxite, kaolin.
Fulton	7,060,700	6,448,475	Cement, granite, miscellaneous clay, sand and gravel.
Gilmer	W	W	Marble.
Glynn	W	W	Sand and gravel.
Gordon	17,300	16,700	Miscellaneous clay.
Greene	W	162,000	Sand and gravel.
Gwinnett	W	W	Granite.
Hall	W	W	Do.
Hancock	26,886	W	Do.
Hart	W	W	Mica.
Henry	W	W	Granite.
Houston	W	W	Cement, limestone, miscellaneous clay.
Jasper	621,352	W	Feldspar, mica, sandstone.
Jefferson	W	990,000	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.
Madison	W	W	Granite.
Marion	W	W	Iron ore.
Mitchell	W	W	Limestone.
Monroe	W	W	Granite.
Montgomery	56,000	25,000	Sand and gravel.
Murray	313,200	255,100	Talc.
Muscogee	W	W	Granite, sand and gravel.
Oglethorpe	588,088	W	Granite.
Pickens	W	W	Marble, sandstone.
Polk	W	W	Cement, slate, miscellaneous clay, iron ore, sandstone.
Quitman	W	W	Iron ore.
Rabun	W	W	Granite.
Richmond	W	5,632,071	Kaolin, sandstone, miscellaneous clay, sand and gravel.
Spalding	------	W	Granite.
Stephens	W	W	Do.
Stewart	1,602,800	1,536,300	Iron ore.
Sumter	W	W	Bauxite, kaolin.
Talbot	W	W	Sand and gravel.
Taylor	W	W	Do.
Telfair	9,000	9,000	Do.
Thomas	W	W	Fuller's earth, sand and gravel.
Twiggs	W	W	Kaolin, fuller's earth.
Upson	------	W	Sand and gravel.
Walker	W	W	Limestone, miscellaneous clay.
Ware	W	23,000	Sand and gravel.
Warren	W	W	Granite, kaolin.
Washington	25,154,331	29,827,975	Kaolin.
White	------	4,000	Sand and gravel.
Whitfield	W	W	Limestone.
Wilkinson	3,213,509	4,128,338	Kaolin.
Undistributed	r92,047,068	94,932,835	
Total	r135,220,000	148,597,000	

r Revised.

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

[1] Counties not listed in the table reported no production of mineral commodities.

Clayton.—Dixie Lime & Stone Co. quarried and crushed granite at Forest Park for concrete and roadstone.

Cobb.—Vulcan Materials Co. produced crushed granite for concrete and roadstone at the Kennesaw quarry.

Columbia.—Georgia Vitrified Brick & Clay Co. mined miscellaneous clay for heavy clay products at its Compania mine at Harlem.

Cook.—Scruggs Concrete, Inc., produced building, paving, and fill sand at the Burneyhill mine.

Crawford.—Atlanta Sand & Supply Co. produced building, paving, blast, and railroad sands at the Rolla mine.

Dade.—Lambert & Lambert Stone Co., Inc., formerly Dave L. Brown Co., increased its production of crushed limestone for concrete, roadstone, and riprap at the Morganville quarry.

Decatur.—Minerals & Chemicals Philipp Corp. and Milwhite Co. mined and processed fuller's earth near Attapulgus for fillers in insecticides and fungicides, absorbent uses, filters for oils and greases, drilling mud, and other uses.

De Kalb.—Total value of mineral production increased 21 percent. Higher output and value of crushed granite and feldspar-silica mixture more than offset lower values of dimension granite. Principal producers of crushed granite were Georgia Marble Co. and Stone Mountain Grit Co., both of Lithonia. Dimension granite producers were Davidson Granite Co., Inc., J. T. Reagan Granite Co., both of Lithonia, and Stone Mountain Granite Corp. and Coffey Granite Co. at Stone Mountain. Georgia Marble Co. also produced a feldspar-silica mixture as a by-product from granite fines for use in glassmaking. Sand and Gravel Pit Co., Decatur, mined building sand for local use.

Dougherty.—Albany Lime and Cement Co. and Dawes Silica Mining Co. were the only sand producers in the county in 1966.

Douglas.—Georgia Marble Co., Douglasville, and Vulcan Materials Co., Lithia Springs, quarried and crushed granite, principally for concrete and roadstone.

Early.—Georgia Rock Products Co. quarried and crushed limestone for concrete and roadstone.

Effingham.—Dawes Silica Mining Co., Inc. produced building, blast, molding, filter, and fertilizer filler sands at the Eden mine.

Elbert.—Production of dimension granite from Elbert County quarries principally for monumental stone decreased 29 percent in quantity and 20 percent in value. Fourteen companies operated 16 quarries for dimension granite. Comolli Granite Co., Georgia Marble Co., Service Granite Co., Elberton Granite Industries, Inc., and Harpers Quarry, Inc., were the leading producers in terms of tonnage. McLanahan Crushed Stone Co. at Elberton was the only crushed granite producer.

Evans.—Evans Concrete Products Co. mined building sand at the Daisy mine near Claxton.

Fayette.—Dixie Lime & Stone Co. quarried and crushed granite at Tyrone for concrete and roadstone, riprap, and railroad ballast.

Floyd.—American Cyanamid Co. mined bauxite from the Hight mine and kaolin from the Watters mine. Chattahoochee Brick Co. and Oconee Clay Products Co. mined shale for use in their brick and clay products plants at Atlanta and Milledgeville, respectively. Ready-Mix Concrete Co., Inc., and Floyd County Highway Department quarried and crushed limestone at Rome, principally for concrete and road material.

Fulton.—The county continued to rank fourth in the State in value of mineral production despite a 9-percent decrease in value. Southern Cement Co. manufactured portland cement and mined miscellaneous clay from a pit adjacent to its plant at Atlanta. Atlanta Brick and Tile Co. and Chattahoochee Brick Co. mined miscellaneous clay and shale for manufacturing brick and other heavy clay products. Hitchcock Corp. and Vulcan Materials Co. crushed granite for concrete and roadstone. W. J. Griffins mined sand and gravel, and C. J. Ross, and Thompson Bros. Sand Co. mined sand only, all for local use. Zonolite Division of W. R. Grace & Co. operated plants at Atlanta for exfoliation of crude vermiculite and expansion of perlite, both shipped in from other States.

Gilmer.—Georgia Marble Co. mined and crushed marble at the Gobel and Whitestone mines for terrazzo and roadstone.

Glynn.—Gray Towing Co. mined building sand at Brunswick. Bestwall Gypsum Co. calcined imported crude gypsum for wallboard and other building materials.

Gordon.—Plainville Brick Co. mined shale near its brick plant at Plainville.

Greene.—L. C. Curtis & Sons, Inc. mined sand for building purposes at Watkinsville.

Gwinnett.—Vulcan Materials Co. produced crushed granite at the Norcross quarry for concrete and roadstone.

Hall.—Gainesville Stone Co. quarried and crushed granite for concrete and roadstone.

Hancock.—Middle Georgia Quarrying Co. produced dimension granite for monumental use at the Spartan quarry.

Hart.—Funkhouser Mills Division of Ruberoid Co. mined and ground mica for roofing, joint cement, and other uses.

Henry.—Vulcan Materials Co. quarried and crushed granite at Stockbridge for concrete, roadstone, and railroad ballast.

Houston.—Penn-Dixie Cement Corp. mined clay and limestone and manufactured portland cement at Clinchfield. Dixie Lime & Stone Co. crushed limestone near Perry for agricultural use.

Jasper.—The Feldspar Corp. mined feldspathic rock and produced flotation-grade feldspar and byproduct mica and quartz at its Monticello mill.

Jefferson.—Georgia-Tennessee Mining & Chemical Co. mined and processed fuller's earth near Wrens for absorbent uses.

Jones.—Hitchcock Corp. (Gray quarry) and Weston & Brooker Co. (Ruby quarry) crushed granite for concrete, roadstone, and railroad ballast.

Lamar.—Dixie Lime & Stone Co. quarried granite at Yatesville for concrete and roadstone.

Lincoln.—Aluminum Silicates Co. continued to expand production at its kyanite mine and processing plant at Licolnton for use in refractories.

Long.—Dawes Silica Mining Co., Inc. mined building sand at Ludowici.

Lowndes.—Georgia Peat Moss Co. produced reed-sedge peat and Lake Park Peat Moss Co. produced moss and humus peat for horticultural and agricultural use.

Madison.—Coggins Granite Industries, Inc. and Georgia Marble Co. quarried dimension granite for monumental use.

Marion.—Pope Mining Co. mined and concentrated brown iron ore near Buena Vista.

Mitchell.—Bridgeboro Lime & Stone Co. crushed limestone for concrete, road material, and agricultural stone (agstone).

Monroe.—Dixie Lime & Stone Co. quarried and crushed granite at its No. 6 quarry, northwest of Macon.

Montgomery.—R. W. Geiger mined paving sand at Mt. Vernon.

Murray.—Georgia Talc Co., the only producer in the State, mined crude talc near Chatsworth and marketed ground talc for asphalt filler, insecticides, paint, roofing, rubber, and other uses.

Muscogee.—Vulcan Materials Co. crushed granite at the Barin quarry north of Columbus for concrete, roadstone, railroad ballast, and riprap. Brown Sand & Gravel Co., Inc., and Calhoun Sand & Gravel Co. mined sand and gravel at Columbus for building use.

Oglethorpe.—Dimension granite principally for rough monumental stone was quarried by 10 companies. Leading producers were American Granite Quarries, Inc., Bennie & Harvey, Hiram B. Brown Granite Co., Dixie Granite Co., and Liberty-Premier Granite Co., Inc.

Pickens.—The county ranked third in value of mineral production in the State. Georgia Marble Co. quarried and manufactured dimension marble at Tate and Nelson for building and monumental uses, and mined and crushed marble at Tate and Whitestone. Marble Products Co. of Georgia also mined and crushed marble. The crushed marble was used for terrazzo, whiting, neutralizers, and roadstone. Hardy Johnson quarried sandstone for rough architectural stone and flagstone.

Polk.—Marquette Cement Manufacturing Co. produced portland and masonry cements at Rockmart. The company mined clay and sandstone in Polk County and limestone in Bartow County to supply the cement plant. Georgia Lightweight Aggregate Co. produced lightweight aggregate from slate mined near the plant at Rockmart, and Chattahoochee Brick Co. mined miscellaneous clay for use in its plant at Atlanta. Phillips Holmes Mining Co. was a new producer of brown iron ore.

Quitman.—Camellia Mining Co. and Gordon Gary Mining Co. continued to produce brown iron ore.

Rabun.—Rabun Quarries, Inc. quarried and crushed granite near Dillard for concrete and roadstone.

Richmond.—Babcock & Wilcox Co. mined and processed kaolin for refractories, fire brick and block, whiteware, paint, chemicals, plastics, and other uses. Georgia-Carolina Brick and Tile Co., Georgia Vitrified Brick & Clay Co., and Merry Bros. Brick and Tile Co. mined miscellaneous clay for building brick and other clay products. Superior Stone Co. crushed quartzite at the Dan quarry north of Augusta. Speer Sand & Gravel Co. mined sand and gravel for building use.

Spalding.—Dixie Lime & Stone Co. quarried and crushed granite for concrete and roadstone near Griffin.

Stephens.—McLanahan Crushed Stone Co., Inc., quarried and crushed granite near Toccoa for concrete, roadstone, and riprap.

Stewart.—Eleven companies, three of them new producers, mined brown iron ore. Principal operators were Davis Bros., Lumpken Mining Co., Dunbar & Layton, Brown-Nuggett Mining Co., and Howell & Chandler.

Sumter.—American Cyanamid Co. mined bauxite and kaolin from the Easterlin mine and kaolin only from the Holloway mine. General Portland Cement Co. mined kaolin for use in its Florida plants.

Talbot.—Brown Bros. Sand Co. and Taylor County Sand Co. mined and processed building sand.

Taylor.—Butler Sand Co. and Howard Sand Co. mined and processed building and paving sand.

Telfair.—Flanders Bros. mined building sand near Scotland.

Thomas.—Cairo Production Co., Inc., Waverly Petroleum Products Co., and Thor Mining Co., a new producer, mined and processed fuller's earth for absorbent uses. Dawes Silica Mining Co., Inc., mined and processed a variety of construction and industrial sands.

Twiggs.—The county ranked second in the State in the value of its mineral production. A. P. Green Refractories Co. and Sam Hall & Sons were new kaolin producers in 1966. Other producers were Cyprus Mines Corp., Freeport Kaolin Co., Georgia Kaolin Co., and J. M. Huber Corp. General Reduction Corp. mined and processed fuller's earth.

Upson.—Jesse Rogers Sand & Gravel Co. was a new producer in 1966.

Walker.—Lambert & Lambert Stone Co. quarried and crushed limestone for concrete and roadstone. Patton Rock Products Corp. produced crushed limestone for concrete and roads, agstone, and flux. General Shale Products Corp. mined shale for use in its Chattanooga, Tenn. brick plant.

Ware.—E. W. Pafford dredged building sand from the Satilla River near Waycross.

Warren.—J. M. Huber Corp. has opened a new kaolin mine and processing plant at Wrens. Weston & Brooker Quarry Co. produced crushed granite at Camak for concrete, roadstone, and railroad ballast.

Washington.—The county ranked first in value in the State's mineral production. Kaolin, the only mineral produced, was mined and processed by American Industrial Clay Co., Anglo-American Clays Corp., Champion Paper & Fiber Co., Cyprus Mines Corp., Minerals & Chemicals Philipp Corp., and Thiele Kaolin Co. The kaolin was sold principally for paper coating and filling; other uses were whiteware, tile, refractories, plastics, paint, rubber, fertilzer, and catalysts.

Wayne.—Rayonier, Inc., calcined sludge and recirculated the resulting quicklime in its cellulose plant at Jesup.

White.—Cleveland Ready-Mix Co. mined a small quantity of bulding sand at Helen.

Whitfield.—Dalton Rock Products Co. quarried and crushed limestone for concrete, road material, and agstone.

Wilkinson.—Kaolin was mined by Minerals & Chemicals Phillip Corp. and Evans Clay Co. principally for paper coating and filling, rubber, paint, and other uses. D. C. Hardy Clay Co. and Oconee Clay Products Co. mined kaolin for fire brick and block, and other refractories.

The Mineral Industry of Hawaii

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 Hawaii Department of Land and Natural Resources.

By Roy Y. Ashizawa [1]

Increased shipments of portland cement for export and local consumption boosted the total value of Hawaii's mineral output to a record $21.3 million in 1966.

Although demand for sand and crushed stone for use as concrete aggregate was at an alltime high, a sharp decrease in demand for fill and base materials caused the production of sand and gravel and stone to decline to 5.6 million tons. Less volcanic cinder was produced for maintenance of tertiary roads, particularly on the island of Hawaii.

Lime shipments to sugar mills increased. Commercial solar-evaporated salt output was unchanged from that of 1965. A greater quantity of black coral was collected off Maui Island, and a deposit of pink coral was discovered off Oahu Island. Clay mining resumed on Oahu when a new company reactivated a shutdown brick plant.

[1] Mineral specialist, Bureau of Mines, San Francisco, Calif.

Table 1.—Mineral production in Hawaii [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement—thousand 376-pound barrels	1,564	$8,297	1,749	$9,046
Lime—thousand short tons	9	305	10	320
Pumice, pumicite, and volcanic cinder—do	380	624	374	716
Sand and gravel—do	751	2,237	511	1,591
Stone—do	5,172	9,353	5,079	9,482
Value of items that cannot be disclosed: Clays, gem stones, and salt	XX	19	XX	98
Total	XX	20,835	XX	21,253

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957-59 dollars

(Thousands)

Year	Value [1]
1957	r $6,018
1958	r 6,350
1959	r 7,524
1960	r 9,086
1961	r 14,668
1962	r 14,497
1963	r 15,079
1964	r 19,256
1965	r 20,710
1966	p 20,895

r Revised. p Preliminary.
[1] The years 1960-66 include the value of portland cement shipments (in thousand dollars), as follows: 1960, $554; 1961, $5,454; 1962, $5,913; 1963, $7,020; 1964, $8,720; 1965, $8,245; 1966, $8,895.

Table 3.—Employment 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
1965:								
Nonmetal	117	78	9	70	1	---	14.33	85,957
Sand and gravel	152	119	18	145	---	1	6.90	207
Stone	520	249	129	1,067	---	35	32.81	608
Total	789	198	156	1,282	1	36	28.86	5,210
1966: p								
Nonmetal	90	92	8	64	---	---	---	---
Sand and gravel	50	186	10	77	---	1	12.99	273
Stone	585	260	152	1,240	---	56	45.16	5,820
Total	725	234	170	1,381	---	57	41.27	5,241

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—A record 1,749,000 barrels of portland cement was shipped by the two producers on Oahu Island of which more than 205,000 barrels was exported. Shipments were distributed as follows: 65 percent to ready-mixed concrete companies, 12 percent to government agencies, 8 percent to building material dealers, 8 percent to concrete product manufacturers, and 7 percent to contractors and miscellaneous customers. Over 1,325,000 barrels was distributed in bulk and 424,000 barrels in paper bags. Consumption of cement in Hawaii. including white and other special types received from the U.S. mainland, reached an alltime high of 1,550,000 barrels. Of this total, 4,000 barrels came from foreign countries.

Local raw materials used in cement production were 402,000 tons of coral limestone and 68,000 tons of basalt and trachyte. Silica sand, gypsum, and grinding aids were imported. The two plants used 45.8 million kilowatt-hours of electrical energy.

Clays.—Pacific Clay Corp. acquired the brick plant of Hawaii Clay Products, Inc., at Barbers Point on Oahu early in 1966. The new company obtained clay near Waimanalo and resumed production of brick and hollow block. Production methods in the plant were modified to improve the quality of the finished products. Larger inventories of brick were maintained to meet customer demand.

Gem Stone.—Beds of coral ranging in color from off-white to deep pink were discovered in the channel between Oahu and Molokai Islands at depths of 1,200 to 1,800 feet. The pink coral was recovered by dragging tangle nets along the ocean floor from surface vessels. As much as $150 per pound was paid for a selected "blush-pink" shade of coral named "Hawaiian Angelskin" by a Honolulu jewelry manufacturer. The material was polished for use in rings, brooches, and earrings.

Large quantities of black coral continued to be recovered by scuba divers off Maui Island at depths up to 200 feet. For reasons of health and safety, each diver limited his deep dives to one per day and to about 18 minutes per dive.

Lime.—The output of lime at plants on Oahu and Maui increased to meet demand by Hawaii's sugar industry, the principal consumer. The lime was used to clarify cane juice. Other lime markets were for masonry mortar, soil stabilization, sewage treatment, water purification, and as a flux in the melting of scrap iron.

Olivine.—Disseminated crystals and grains of olivine are commonly found in the Hawaiian basalts, but few are large enough and high enough in quality for the gem jewelry market. Readily accessible deposits of medium-grained olivine occur predominantly on Hawaii Island. Grains of olivine concentrated by wave action from lava and soils near South Point are deposited along several of the beaches in the area in the form of greenish colored sand. A littoral cone at Mahana Bay contains an abun-

dance of fine-grained olivine crystals. Granular masses of olivine are found in the dunite xenoliths which are exposed, like beach cobbles, in a deep channel of the Kaupulehu lava flow. The latter deposit contains thousands of tons of subrounded xenoliths ranging in size from about 1 inch to 1 foot in diameter.

Pumice and Volcanic Cinders.—Production of pumice and volcanic cinders amounted to 374,000 tons, of which 80 percent was used for road maintenance and for surfacing resort and subdivision lands, and 20 percent for concrete aggregate, roofing granules, and decorative purposes. Much of the output came from Hawaii Island, where nearly 200,000 tons was mined primarily for maintenance of sugarcane haulage roads. Interisland barge shipments of lightweight concrete aggregate to Oahu consisted of pumice from Hawaii Island and volcanic cinders from Molokai Island. The combined tonnage of these shipments was appreciably greater than in 1965.

Salt.—Commercial production of solar-evaporated salt at Keehi Lagoon on Oahu was temporarily discontinued by Tamotsu Tanaka in October, pending the outcome of negotiations for continued rental of the site. The producer established a new facility at Barbers Point, where the recovery of brine from seawater was accelerated with the use of a surplus U.S. Army distillation unit. The brine was evaporated in kettles fired with logs of keawe trees which grow in abundance in the area. A series of concentrating and crystallizing ponds also was under construction at the new facility for production of salt by solar evaporation.

Sand and Gravel.—Output of beach and dune sands and streambed sand and gravel totaled 511,000 tons. Much of the tonnage was sand produced primarily for use in concrete and mortar. Less sand was produced for use as landscape material for resorts than in 1965. A large part of Oahu's requirements of sand was barged from Molokai Island.

Stone.—Total stone production was nearly 5.1 million tons, of which over 4.5 million tons was used as concrete aggregate and base material. The remainder consisted mainly of decorative lava slabs and moss rock, riprap, and coral limestone used for making cement and lime.

Stone quarries throughout the islands yielded 3,536,000 tons of basalt, 841,000 tons of coral limestone, and 702,000 tons of miscellaneous stone. Nearly 79 percent of the total was produced on Oahu Island, 16 percent on Hawaii Island, and 5 percent on Kauai, Lanai, Maui, and Molokai Islands.

Vermiculite.—Crude vermiculite from Montana was thermally expanded on Oahu for lightweight aggregate, insulation, and agricultural uses.

MINERAL FUELS

Various petroleum products, principally, asphalt, fuel oil, gasoline, jet fuel, and liquefied gas, were produced on Oahu at the Barbers Point refinery of Standard Oil Co. of California. The refinery was operated at close to its rated capacity of 35,000 barrels per day, utilizing crude oil imported from foreign oilfields.

Demand increased in Hawaii for all products except aviation gasoline and distillate fuel oil. The largest increase was for kerosine-type jet fuel used in commercial aircraft.

REVIEW BY ISLANDS

Hawaii (Hawaii County).—James W. Glover, Ltd. processed basalt at its Hilo quarry and aa rock near the Hilo airport for concrete aggregate and base material, and hauled volcanic cinder from Kapoho for manufacture of concrete building products. Volcanite, Ltd. produced lightweight concrete aggregate at the Puuwaawaa pumice quarry for local use and for shipment to Oahu via Kawaihae harbor. Miscellaneous volcanic rock and cinders were quarried on plantation lands extending from Naalehu to Keaau, from Pepeekeo to Honokaa, and at Hawi, primarily for construction and maintenance of sugarcane haulage roads. Government crews worked the Keaumoku and Kohala Mountain pits as well as other cinder and rock deposits for material used in repairing roadbeds and road embankments.

James Kuwana was the principal producer of decorative lava slabs and volcanic cinders in the Pahoa and Kapoho areas. Yamada & Sons, Inc., quarried a large ton-

Table 4.—Value of mineral production in Hawaii, by counties

County	1965	1966	Minerals produced in 1966 in order of value
Hawaii	$1,860,000	$1,886,000	Stone, pumice and volcanic cinder, sand and gravel.
Honolulu	16,983,000	17,342,000	Cement, stone, sand and gravel, lime, gem stones, salt, clays.
Kauai	831,000	582,000	Stone, volcanic cinder, sand and gravel.
Maui	1,161,000	1,443,000	Sand and gravel, stone, volcanic cinder, lime, gem stones.
Total	20,835,000	21,253,000	

nage of aa near Keauhou and Honokahau for use as base material for several resort and subdivision projects. Basalt was quarried and processed by J. M. Tanaka Contractors, Inc., about 6 miles southeast of Kona. Kuwaye Bros., Inc., produced pit-run and crusher-run aggregates at the 299th aa pit near Hilo. The dredged coral stockpile at Kawaihae harbor was worked mainly by Yamada, Kuwaye, and Mauna Kea Sand & Gravel Co., Inc. The latter company, formerly known as Kawaihae Products, Inc., operated a semiportable crushing and screening plant between Kawaihae and Kamuela, and produced concrete aggregate, golf course trap sand, and fines for mortar and agricultural liming. Coral was hauled to and from the plant by Island Trucking Service.

Kauai (Kauai County).—Much of Kauai's requirements for concrete aggregate was supplied by Grove Farm Co., Ltd. from its basalt quarry and crushing facility near Puhi. The company also reopened its Koloa cinder pit and increased the capacity of the crusher at its Koloa limestone quarry to meet local demand.

Appreciable quantites of volcanic cinders were quarried for road maintenance at the McBryde Sugar Co. Kapeku hill near Eleele and at the Olokele Sugar Co. pit near Kaumakani. Lihue Plantation Co., Ltd. obtained volcanic rock from quarries near Moloaa and in Kapaia Valley. Accessible beaches and the mouths of principal rivers from Haena to Bonham provided sand used in concrete and for patching roads. A newly formed company, Kauai Concrete and Aggregate Products, planned to establish a rock quarry and crushing plant near Kapaa.

Lanai (Maui County).—Construction and maintenance forces of Dole Corp., at Lanai City, hauled beach sand from Polihua, dune sand from near Manele Bay, and stone stockpiled at the Kaumalapau quarry. Crushed stone requirements for concrete aggregate were purchased from a producer on Oahu Island. Large field boulders for repair of harbor breakwaters were obtained primarily from Koala gulch.

Maui (Maui County).—Concrete Industries, Inc., took steps to consolidate the quarry and plant operations acquired from Kahului Railroad Co. and A & B Commercial Co. The hollow block and flume casting facility at the junction of Highways 35 and 40 was moved to Camp 10, and a portable ready-mixed concrete batch plant was set up at the Kaanapali resort development area. The new company quarried and processed a substantial tonnage of basalt rock at Camp 10 during 1966.

Maui Concrete & Aggregates, Inc., operated a large-scale portable crushing and screening plant near Waikapu to process alluvial gravels obtained from the nearby foothills. Hawaiian Commercial & Sugar Co., Ltd. produced lime at lower Paia, using coral sand from the nearby beach as raw material. Hydrated lime was shipped primarily to sugar mills and for masonry use. The Kaa and Kaanapali beaches and the Wailuku dunes were sources of coral sand used in concrete and road maintenance. Scuba divers at Lahaina worked the deep channel waters off Maui Island to gather black coral for the jewelry trade.

Fong Construction Co. was the principal producer of volcanic cinder from the Olowalu pit. The company also mined cinder from the Polipoli cone for use in construction of the Kula Forest access road. The Honokohau ash pit was worked by road maintenance crews of Maui Pineapple Co. Other producers mined small quanitites of cinder at Puuhele, Puu Laina, Puu Pane, Haleakala, and near Ulupalakua.

Molokai (Maui County).—HC&D, Ltd. continued to mine large quantities of coral sand at Papohaku Beach and lightweight volcanic cinder at Waieli. Both were

trucked to Lono harbor for shipment to Oahu Island on barges having capacities of up to 1,400 tons each. Local requirements for concrete aggregate were supplied mainly by Molokai Aggregates, Inc., from the Manawainui basalt quarry, 3.5 miles northwest of Kaunakakai. The Puuluahine and Kapaakea cinder pits, the streambed gravels in the gulches east of Kaunakakai, and the Moomomi sand dunes were worked by several contractors and public works maintenance crews.

Oahu (Honolulu County).—Portland cement was produced at the Hawaiian Cement Corp. plant at Barbers Point and the Kaiser Cement & Gypsum Corp. plant at Waianae. Shipments of cement for local consumption were 2 percent greater than those in 1965.

Stone producers on Oahu quarried nearly 3.2 million tons of basalt, 790,000 tons of coral limestone, and 14,000 tons of miscellaneous stone, a record total of 4.0 million tons. An increase in output of basalt rock for asphalt and portland cement concrete aggregate contributed significantly to the high yield. Demand for fill and road base material dropped sharply on Oahu during 1966.

Basalt rock was produced by HC&D, Ltd. at its new Kapaa quarry 1 mile west of the original quarry site. Hawaiian Bitumuls and Paving Co. operated a basalt quarry at Kaena. Pacific Cement & Aggregates, a division of Lone Star Cement Corp. of New York, quarried basalt at Halawa and coral limestone at Lualualei. Pacific Concrete & Rock Co. produced basalt at Puu Palailai and coral limestone at a new quarry near Waimanalo. Much of the company's old quarry site at Kailua was being developed into a residential subdivision. Coral limestone also was produced at the Kahuku and Ewa sugar plantations, at the Barbers Point and Waianae quarries of the cement plants, and by Laie Concrete & Aggregates, Inc., near Laie. New high-capacity crushing and screening equipment was installed or being installed at all of the basalt quarries on Oahu during 1966. Completely new rock processing plants were under construction at the Halawa and Kapaa quarries. Allied Aggregates Corp., an affiliate of Kuwaye Bros., Inc., Hilo, used portable equipment to assist in crushing basalt rock at the Kaena quarry. The company later moved into the Barbers Point barge harbor area to quarry and process coral limestone.

GasprO, Ltd. produced quicklime and hydrated lime at Waianae. Moss rock was hand-gathered in the Waianae Range by Joe's Moss Rock Co. for use as interior and exterior decorative stone. Clay was mined near Waimanalo and hauled to the clay products plant at Barbers Point. Crude salt for local consumption was produced at Keehi lagoon by solar evaporation. Expanded vermiculite was produced by Vermiculite of Hawaii, Inc., for special lightweight aggregate and agricultural uses. Maui Divers of Hawaii, Ltd. operated a large lapidary and jewelry manufacturing facility in Honolulu. The company was the principal buyer of Hawaii's black coral and pink coral gem material.

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 Fred V. Carrillo,[1] Ronald P. Collins,[2] and Norman S. Petersen [1]

Idaho mineral production in 1966 was valued at $115 million, an increase of 9.4 percent over that of 1965. Increases in the production values for vanadium, silver, lead, zinc, and particularly phosphate rock, more than offset decreases in sand and gravel, copper, lime, and portland cement. Shoshone County supplied 57 percent of the total value primarily due to the dominant position of the country's silver and base metal mines. The record-setting total value of silver output exceeded $25 million. Production was 19.78 million ounces; the prior single year production record was established in 1937 at 19.6 million ounces. The Sunshine mine, continuing as the Nation's largest silver producer, yielded 7.4 million ounces during the year. Lead and zinc exploration and development activity progressed at a rapid pace in response to persistent market demands. As a result, Coeur d'Alene area mines experienced improved production schedules for the first time since 1963 even though the average market price of lead declined 2 cents dur-

[1] Mineral specialist, Bureau of Mines, Albany, Oregon.
[2] Economist, Bureau of Mines, Albany, Oregon.

Table 1.—Mineral production in Idaho [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ore and concentrate, short tons, antimony content	818	W	834	W
Clays [2] thousand short tons	47	$33	23	$22
Cobalt (content of concentrate) thousand pounds	------	------	10	6
Copper (recoverable content of ores, etc.) short tons	5,140	3,639	4,961	3,589
Gem stones	NA	150	NA	180
Gold (recoverable content of ores, etc.) troy ounces	5,078	178	5,056	177
Iron ore (usable) thousand long tons	9	84	11	97
Lead (recoverable content of ores, etc.) short tons	66,606	20,781	72,334	21,867
Mercury 76-pound flasks	1,119	639	1,134	501
Pumice thousand short tons	46	79	55	107
Sand and gravel do	12,151	13,198	7,544	6,672
Silver (recoverable content of ores, etc.) thousand troy ounces	18,457	23,865	19,777	25,571
Stone thousand short tons	1,831	3,440	2,694	5,415
Tungsten ore and concentrate (60 percent WO_3 basis) short tons	------	------	2	1
Zinc (recoverable content of ores, etc.) do	58,034	16,946	60,997	17,689
Value of items that cannot be disclosed: Cement, garnet (abrasive), lime, peat, perlite, phosphate rock (marketable production), titanium, vanadium, and values indicated by symbol W	XX	22,053	XX	33,020
Total	XX	105,085	XX	114,914

NA Not available. W Withheld to avoid disclosing individual company confidential data. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes fire clay, kaolin, and bentonite; included with "Value of items that cannot be disclosed."

ing the year. Zinc output increased chiefly because of tonnages produced at the Bunker Hill mine and Star-Morning Unit area. In recent years extensive investments have been made in the State's phosphate industry; in the 2-year period from 1964, the value of phosphate rock production had grown 130 percent. Major producers were J. R. Simplot Co., El Paso Products Co., and Monsanto Co.

Mining gave support to the economy, but despite the growth of this basic industry, a constraint on business activity as a consequence of high interest rates for loans in the commercial money markets caused most of the annual economic indicators in table 3 to show a decline or register only moderate gains. Output of sand and gravel products and employment in construction were affected adversely because of generally decreased building activity. The unusually large percentage gain (128.4) in the heavy construction sector was due to the $131.2 million contract awarded for the Dworshak Dam by the U.S. Army Corps of Engineers. Growth from 1965 in State per capita income was 1.9 percent as compared with 7.0 percent for the United States; this was largely attributed to the inability of the State's farm income and employment to keep pace with the national economy.

Employment.—Work was started at the Dworshak Dam near Orofino which increased employment for heavy construction workers. Employment in other sectors of the construction industry was slowed by the tight money market. In 1965, average employment in the construction industry was up almost 23 percent over that of 1964, whereas a decline of 6 percent was registered during 1966. The number of total workers employed rose by about 11,500, up 4.3 percent compared with that of 1965. Since 1962, the annual average weekly earnings and hourly pay for production workers in the mining industry had risen about 15 percent and 17 percent, respectively. The work week declined from 39.4 to 38.7 hours.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]
1961	$67,741
1962	79,711
1963	78,766
1964	78,726
1965	93,096
1966	101,078

[1] Data for 1961–65 revised.

Legislation and Government Programs.—The Office of Minerals Exploration (OME) signed exploration contracts with Beardsley Gulch Mining Co.; Continental Quicksilver, Inc.; and the Sidney Mining Co. The contracts totaled $146,248; Government participation amounted to $96,990.

Table 3.—Indicators of Idaho business activity

	1965	1966 [p]	Change, percent
Personal income:			
Total—millions	$1,660.0	$1,694.0	+2.0
Per capita	$2,395.0	$2,441.0	+1.9
Construction activity:			
Building permits—millions	$47.8	$36.9	−22.8
Heavy engineering awards—do	$73.5	$167.9	+128.4
State highway commission:			
Value of contracts awarded—do	$20.1	$18.6	−7.5
Value of contract work performed—do	$35.5	$27.5	−22.5
Cement shipments to and within Idaho, thousand 376-pound barrels	1,447.5	1,356.2	−6.3
Cash receipts from farm marketings—millions	$526.1	$525.0	−0.2
Mineral production—do	$105.1	$114.9	+9.4
Factory payrolls—do	$180.2	$198.5	+10.2
Annual average labor force and employment:			
Total labor force—thousands	267.9	279.5	+4.3
Unemployment—do	10.9	11.1	+1.8
Employment:			
Construction—do	10.9	10.2	−6.4
Lumber/wood products—do	12.4	12.2	−1.6
Food products—do	14.7	13.2	−10.2
All manufacturing—do	36.5	35.7	−2.2
All industries—do	256.6	268.1	+4.5

[p] Preliminary.

Sources: Survey of Current Business, Construction Review, Pacific Builder and Engineer, Idaho State Highway Commission, The Farm Income Situation, Idaho Labor Market, Labor Force and Employment in Idaho, Distribution by Industry of Wages Paid for Covered Employment in Idaho, and Bureau of Mines.

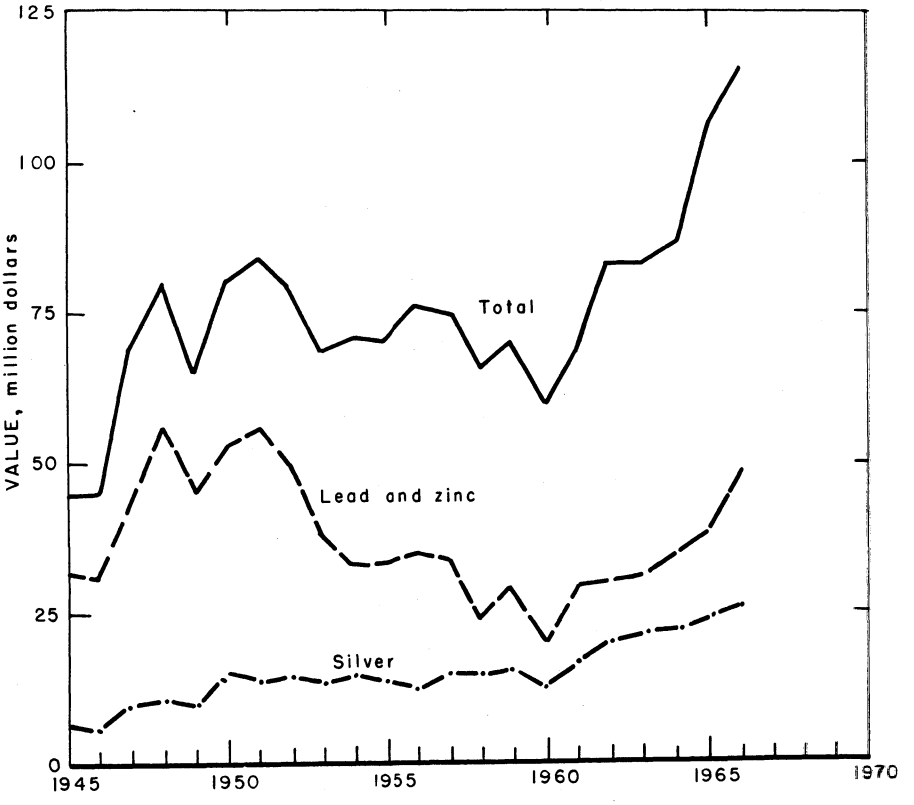

Figure 1.—Value of silver, lead and zinc, and total value of mineral production in Idaho.

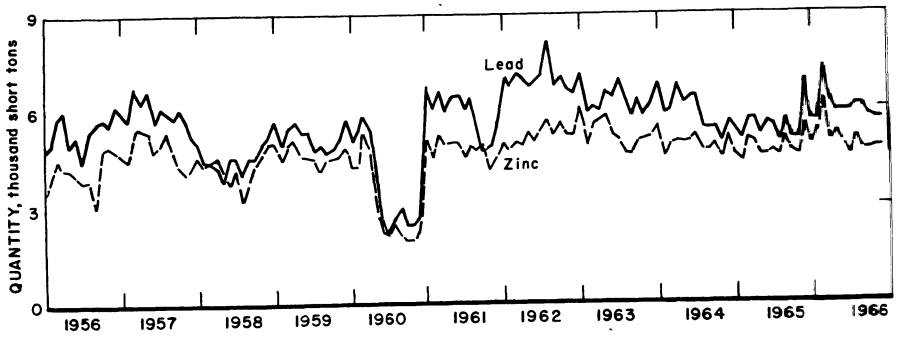

Figure 2.—Mine production of lead and zinc in Idaho, by months in terms of recoverable metals.

Table 4.—Employment 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
1965:								
Metal	2,572	264	678	5,424	9	242	46.27	13,269
Nonmetal and peat	771	224	172	1,390	1	28	20.87	4,854
Sand and gravel	426	192	82	659	---	17	25.80	399
Stone	308	105	32	261	1	4	19.18	23,493
Total	4,077	236	964	7,734	11	291	39.05	11,007
1966: p								
Metal	2,555	258	660	5,291	10	263	51.60	12,933
Nonmetal and peat	545	236	128	1,098	1	37	34.61	6,226
Sand and gravel	385	171	66	517	---	11	21.28	368
Stone	265	112	30	244	---	4	16.39	1,713
Total	3,750	236	884	7,150	11	315	45.59	10,612

p Preliminary.

Table 5.—Annual employment and wages paid in the mineral industries

Year	Mining							
	Metals		Nonmetal		Fuels		Total	
	Annual average employment	Annual payroll (thousands)	Annual average employment	Annual payroll (thousands)	Annual average employment	Annual payroll (thousands)	Annual average employment	Annual payroll (thousands)
1962	2,996	$17,336	270	$1,546	--	--	3,266	$18,882
1963	2,926	17,650	285	1,519	13	$84	3,224	19,253
1964	2,951	18,310	327	1,901	14	82	3,292	20,293
1965	2,935	18,563	540	3,431	3	11	3,478	22,005
1966 p	2,915	19,758	704	5,059	3	9	3,622	24,826

Year	Manufacturing							
	Stone and clay products		Primary metals		Phosphate fertilizers, elemental phosphorus, and sulfuric acid		Total	
	Annual average employment	Annual payroll (thousands)	Annual average employment	Annual payroll (thousands)	Annual average employment	Annual payroll (thousands)	Annual average employment	Annual payroll (thousands)
1962	686	$3,936	970	$5,497	1,254	$8,240	2,910	$17,673
1963	823	4,369	971	5,694	1,217	8,342	3,011	18,405
1964	757	4,138	1,032	6,425	1,106	8,086	2,895	18,649
1965	854	5,210	1,296	8,234	1,245	9,042	3,395	22,486
1966 p	955	5,899	1,316	8,951	1,443	11,563	3,714	26,413

p Preliminary.

Source: Idaho Employment Security Agency; employment covered by unemployment insurance. Industry groups may not correspond with those in the Bureau of Mines canvass.

Table 6.—Hours and earnings of production workers in mining

	1962	1963	1964	1965	1966 p
Annual average:					
Weekly earnings	$107.32	$110.21	$114.91	$116.22	$122.99
Hourly earnings	$2.72	$2.79	$2.88	$3.00	$3.18
Weekly hours	39.4	39.5	39.9	38.8	38.7

p Preliminary.

Source: Idaho Employment Security Agency.

Table 7.—Office of Minerals Exploration contracts active during 1966

County and contractor	Commodity	Contract		
		Date	Total amount	Government participation, percent
Custer:				
Beardsley Gulch Mining Co.	Silver	July 14, 1966	$44,680	75
Owyhee:				
Continental Quicksilver, Inc.	Gold and silver	Feb. 28, 1966	61,360	62.5
Sidney Mining Co.	Gold and silver	Feb. 28, 1966	40,208	62.5

REVIEW BY MINERAL COMMODITIES

METALS

Antimony.—Output of antimony rose 2 percent over the 1965 total, and the value increased 5.5 percent because of a higher average metal price. The antimony, entirely a byproduct of silver ore from the Sunshine mine near Kellogg, was leached from silver concentrates and recovered as cathode metal containing about 96 percent antimony at the Sunshine Mining Co. electrolytic plant.

Cadmium.—Recovery of cadmium at The Bunker Hill Co. electrolytic zinc plant declined 8 percent below the 1965 total because of a lower average cadmium content of zinc concentrate processed.

Cobalt.—Experimental work on cobalt-bearing copper ore mined by Machinery Center, Inc., at the Blackbird mine, Lemhi County, resulted in the shipment of 9,961 pounds of cobalt concentrate containing 1,051 pounds of cobalt.

Copper.—Production of copper declined 3.5 percent below the 1965 total despite a slight increase in value. Output was largely a byproduct of silver production from Coeur d'Alene region mines. Copper ore was mined at the Blackbird mine (Machinery Center, Inc.), Lemhi County, but Shoshone County silver and lead-zinc mines supplied nearly 70 percent of the State total.

A study of the copper, lead, and zinc industries of the Pacific Northwest, prepared by the Bureau of Mines for the Bonneville Power Administration, was published.[3]

Gold.—Increased mining costs and a fixed price resulted in a record low output. Only 1,502 ounces was recovered from ores mined primarily for the gold content. Most of the production was a byproduct of lead, zinc, and silver ores from the Coeur d'Alene region and brought total gold production in the State, both lode and placer, to 5,056 ounces. Placer production was from five small-scale hand operations and one suction dredge. The largest output from any placer operation was 37 ounces, and total production was 67 ounces.

Iron Ore.—Production of iron ore increased approximately 21 percent above the 1965 output. The Iron Mountain deposit near Weiser, operated by Rock Island Gypsum Co., continued to be the largest individual source. C. C. Hill increased output from an open pit near Tensed, and Porter Bros. Corp. shipped magnetite from a stockpile at Lowman.

Lead.—Despite 1-cent-per-pound market price drops in May and in October lead output increased over that of 1965 and reversed a downward production trend begun in 1963. Coeur d'Alene region mines—mainly the Bunker Hill, Lucky Friday, Star-Morning Unit area, and Page—accounted for most of the State total.

Demand remained excellent throughout the year, and mine operators continued extensive exploration and development programs in the Coeur d'Alene region. The Bunker Hill Co. continued exploration from its 1,700-foot-long connection between the Bunker Hill and Crescent mines and discovered a sizable high-grade lead-silver ore zone in the Bunker Hill mine. Production from the Dayrock mine (Day Mines, Inc.), reopened in 1965, reached 200 tons of lead ore per day in October. Explora-

[3] Knostman, Richard W., and Gary A. Kingston. Copper, Lead, and Zinc Industries in the Pacific Northwest. Bonneville Power Administration Pacific Northwest Economic Base Study for Power Markets, v. 2, Pt. 7C, 1966, 139 pp.

Table 8.—Mine production of gold, silver, copper, lead, and zinc in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1957–61 (average)	73	23	1,643	10,106	$354	15,776	$14,346
1962	60	13	1,586	5,845	205	17,772	19,288
1963	57	16	1,535	5,477	192	16,711	21,375
1964	55	7	1,649	5,677	199	16,483	21,313
1965	70	5	1,783	5,078	178	18,457	23,865
1966	52	6	1,995	5,056	177	19,777	25,571
1863–1966 [3]	--	--	149,866	8,328,046	194,621	823,991	664,737

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1957–61 (average)	7,001	$4,118	60,404	$14,429	51,670	$11,855	$45,102
1962	3,861	2,378	84,058	15,467	62,865	14,459	51,792
1963	4,172	2,570	75,759	16,364	63,267	14,551	55,052
1964	4,666	3,042	71,312	18,684	59,298	16,129	59,367
1965	5,140	3,639	66,606	20,781	58,034	16,946	65,409
1966	4,961	3,589	72,334	21,867	60,997	17,689	68,893
1863–1966 [3]	198,014	88,700	7,382,111	1,055,821	2,579,259	546,963	2,550,842

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings retreated, and ore, old slag, and mill cleanings shipped to smelters during the calendar year indicated. Owing to rounding, individual items may not add to totals shown.
[2] Does not include gravel washed.
[3] Partly estimated for years before 1901.

Table 9.—Gold production at placer mines

Year	Mechanical and hydraulic methods [1]			Small-scale hand methods			Total [2]		
	Number of operations	Material treated (thousand cubic yards)	Gold (troy ounces)	Number of operations	Material treated (thousand cubic yards)	Gold (troy ounces)	Number of operations	Material treated (thousand cubic yards)	Gold (troy ounces)
1957–61 (average)	11	112	1,714	12	6	67	23	118	1,781
1962	7	38	318	6	8	58	13	46	376
1963	5	8	90	11	4	54	16	12	144
1964	3	9	80	4	2	24	7	11	104
1965	--	--	--	5	3	31	5	3	31
1966	1	(3)	6	5	2	61	6	3	67

[1] Combined to avoid disclosing individual company confidential data.
[2] Data may not add to totals shown because of rounding.
[3] Less than ½ unit.

Table 10.—Mine production of gold, silver, copper, lead, and zinc in 1966, by counties, in terms of recoverable metals

County	Mines producing		Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
Blaine	5	--	143	$5	402,716	$521
Boise	4	1	175	6	1,155	1
Bonner	3	--	20	1	4,627	6
Boundary	1	--	--	--	308	(1)
Custer	9	1	69	2	259,051	335
Idaho	2	1	15	1	5	(1)
Jerome	--	1	37	1	1	(1)
Owyhee	--	1	1	(1)	--	--
Shoshone	21	--	2,775	97	19,092,200	24,686
Undistributed [2]	7	1	1,821	64	16,722	22
Total [3]	52	6	5,056	177	19,776,785	25,571

	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
Blaine	30	$21	3,142	$950	1,923	$558	$2,055
Boise	(1)	(1)	(1)	(1)	(1)	(1)	8
Bonner	2	1	6	2	2	1	10
Boundary	(1)	(1)	8	3	1	(1)	3
Custer	37	27	874	264	164	48	676
Idaho	--	--	--	--	--	--	1
Jerome	--	--	--	--	--	--	1
Owyhee	--	--	--	--	--	--	(1)
Shoshone	3,454	2,499	67,891	20,523	58,877	17,074	64,880
Undistributed [2]	1,439	1,041	413	125	30	9	1,260
Total [3]	4,961	3,589	72,334	21,867	60,997	17,689	68,893

[1] Less than ½ unit.
[2] Includes values and quantities that cannot be shown separately for Butte, Camas, Gem, Lemhi, and Valley Counties.
[3] Owing to rounding, individual items may not add to totals shown.

tion of the Hunter Ranch property by Day Mines, Inc., and Hecla Mining Co. was continued from the adjacent Lucky Friday property.

The outlook for the Bunker Hill lead smelter operation was brightened by the firm's success in obtaining a 5-year contract to smelt Lucky Friday concentrates; the American Smelting and Refining Company (Asarco) smelter at East Helena, Mont., had processed the material until the expiration of its contract with Hecla in late August. Long-term contracts to smelt foreign concentrates also were negotiated for the Bunker Hill smelter. A new blast-furnace-feed system was activated at the 100,000-ton-capacity lead smelter as part of a modernization program.

Mercury.—Mercury production totaled 1,134 flasks, slightly higher than the 1,119 flasks produced in the previous year, but the value declined 22 percent because the average market price fell to $442 from $571 in 1965. As in the previous year, production was largely from the Idaho-Almaden mine near Weiser, where pozzolan was recovered as a byproduct of processing ore from two of the operation's five open pits.

Silver.—Production of silver increased to an alltime high of 19.78 million ounces, 1.32 million ounces over that of 1965. The price held firm at $1.293 per ounce. Thirteen counties recorded silver production, but approximately 97 percent of the output came from mines in Shoshone County. The largest amount of silver (7,402,951 ounces) was extracted at the Sunshine mine, the Nation's largest silver producer. Other major producing mines included: The Galena (Asarco), Lucky Friday (Hecla Mining Co.), Bunker Hill (The Bunker Hill Co.), Crescent (The Bunker Hill Co.), Page (Asarco), and the Silver Summit (Hecla Mining Co.). Ore from 21 mines contributed to the total silver production for the county.

The increasing demand and the resulting decrease in U.S. Treasury silver stocks heightened interest in production expansion and exploration and development activities throughout the State. In the Coeur d'Alene region, Asarco continued sinking a

Table 11.—Mine production of gold, silver, copper, lead, and zinc in 1966, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Ore:							
Dry gold	7	3,061	448	3,118	900	4,500	9,300
Dry gold-silver	1	1	4	81	---	---	---
Dry silver	8	467,754	987	13,347,352	5,746,600	2,432,600	704,800
Total	16	470,816	1,439	13,350,551	5,747,500	2,437,100	714,100
Copper	2	72,002	1,502	3,238	2,875,900	---	---
Lead	17	297,340	1,361	3,883,072	564,600	55,658,300	7,895,100
Lead-zinc	9	779,961	653	2,142,106	704,500	75,392,500	97,668,700
Zinc	6	37,711	10	27,340	16,000	1,380,400	4,737,800
Total	34	1,187,014	3,526	6,055,756	4,161,000	132,431,200	110,301,600
Other lode material:							
Gold cleanings, gold and silver old tailings [2]	4	250,791	13	332,006	5,300	6,810,800	1,487,400
Lead and lead-zinc mill cleanings and lead-zinc old tailings [2]	5	28,114	11	16,115	8,200	413,900	446,700
Zinc slag	1	58,528	---	22,352	---	2,575,000	9,044,200
Total	10	337,433	24	370,473	13,500	9,799,700	10,978,300
Total lode	52	1,995,263	4,989	19,776,780	9,922,000	144,668,000	121,994,000
Placer	6	(3)	67	5	---	---	---
Total all sources	58	1,995,263	5,056	19,776,785	9,922,000	144,668,000	121,994,000

[1] Detail will not necessarily add to totals because some mines produce more than one class of material.
[2] Combined to avoid disclosing individual company confidential data.
[3] 2,730 cubic yards.

Table 12.—Mine production of gold, silver, copper, lead, and zinc in 1966 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 (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Amalgamation	110	76	---	---	---
Concentration and smelting of concentrates	4,682	19,742,192	9,918,900	141,834,000	112,866,100
Total	4,792	19,742,268	9,918,900	141,834,000	112,866,100
Direct smelting:					
Ore	193	7,856	2,300	146,800	20,700
Mill cleanings	4	4,304	800	112,200	63,000
Old slag	---	22,352	---	2,575,000	9,044,200
Total	197	34,512	3,100	2,834,000	9,127,900
Placer	67	5	---	---	---
Grand total	5,056	19,776,785	9,922,000	144,668,000	121,994,000

three-compartment shaft at a rate of about 230 feet per month as part of the "Coeur Project" begun in 1965 to explore Rainbow Mining and Milling Co., Ltd., and Coeur d'Alene Mines Corp. claims at depth. As part of a $1-million expansion at the Galena mine, Asarco installed a new 1,750-hp hoist, the largest in the Coeur d'Alene region, at the mine's No. 3 shaft. The shaft, originally begun for ventilation in 1960, was being converted to hoist ore from the lower levels of the mine as part of a plan to expand production capacity approximately 50 percent above the existing 500 tons per day. At the Crescent mine, The Bunker Hill Co. intersected and began developing a 3500-level extension of high-grade ore first encountered in 1965 on the 3300 level.

Sunshine Mining Co. obtained operating leases and initiated exploration at several properties adjacent to the Sunshine mine. The firm announced plans to deepen the Sunshine mine to at least 6,300 feet, 3,300 feet below sea level and about 1,700 feet below the current mining level. Seventy Beacon Light Mining Co. claims near Mullan were leased and examined by Cordero Mining Co.

Federal Resources Corp. continued milling operations at its Bellevue mill in Blaine County. A substantial portion of the ore processed originated at the adjacent Silver Star-Queens mine which yielded more ore than in 1965. Clayton Silver Mines announced plans to increase capacity approximately 25 percent above the 180-ton-per-day level achieved through a 1965 expansion at its Clayton operation in Custer County. Sidney Mining Co. received a $40,208 Office of Minerals Exploration contract to continue exploration of its Silver City, Owyhee County, properties.

Titanium.—Porter Bros. Corp. shipped fine-grained ilmenite from its Lowman millsite at about the 1965 rate. The company expanded ore reserves of columbium-tantalum, ilmenite, and other black-sand constituents through churn drilling at its Bear Valley, Valley County, property.

Tungsten.—Tungsten ore was shipped from previously stockpiled material to a California market. The ore, containing 96 units of tungsten trioxide, was mined by Salmon River Scheelite Corp. at the Tungsten Jim mine, in Custer County.

Vanadium.—Output of vanadium was 78 percent above that produced in 1965. Vanadium-bearing ferrophosphorus from the Monsanto Co. elemental phosphorus plant at Soda Springs was processed at the nearby Kerr-McGee facility, and Vitro Chemical Co., Salt Lake City, Utah, utilized similar raw material from the FMC Corp. phosphorus operation in Power County.

Zinc.—Output of zinc followed the trend of its coproduct lead by increasing for the first time since 1963. The increase was largely due to greater production from the Bunker Hill mine, which, along with the Star-Morning Unit area, accounted for over one-half of the State output.

The Bunker Hill Co. continued utilizing a trackless bulk-mining system developed in 1965 to extract low-grade zinc ore bodies at the Bunker Hill mine. Hecla Mining Co. purchased the Morning mine from Asarco early in the year. The mine was formerly leased from Asarco and operated as part of the Star-Morning Unit area.

The $13-million expansion of the Bunker Hill electrolytic zinc plant and related facilities at Kellogg progressed as scheduled. Construction also was begun on a new Bunker Hill research and analytical laboratory to replace the one destroyed by fire in 1965.

NONMETALS

Cement.—Production and shipments of portland cement by the Idaho Portland Cement Co. declined 21 percent compared with the respective totals for the previous year, reflecting generally curtailed construction activity in the State; masonry cement shipments also were lower. Shipments were mainly to destinations within the State; out-of-State markets in the Rocky Mountain area also were served. Limestone requirements for the plant continued to be supplied from the nearby company-operated Inkom quarry. Shale, gypsum, and iron ore requirements were purchased.

Clays.—The quantity of clays sold or used by producers declined 25 percent from the total of the previous year. The decline was caused by a sharp drop in the quantity of miscellaneous clay mined for producing heavy-clay construction products. Fire clay and kaolin production both were greater than in 1965. Bentonitic clay output, used principally for sealing irrigation canals and reservoirs, remained substantially the same. Miscellaneous clay was dug from pits in Ada, Bonneville, Cassia, Elmore, and Minidoka Counties. Fire clay, for refractories manufacturing, was dug at a pit near Helmer, Latah County, by A. P. Green Refractories Co. J. R. Simplot Co. mined and processed kaolin at operations in Latah County for use as a filler clay by the paper industry.

Garnet.—Producers' shipments of garnet increased 18 percent over those of the previous year. Production was from operations of the Emerald Creek Garnet Milling Co. and Idaho Garnet Abrasives Co. (a division of Sunshine Mining Co.), near Fernwood, Benewah County. The processed garnet was marketed mainly as an airblast abrasive. A quantity of abrasive garnet was

shipped by Porter Bros. Corp. from stockpiles at Lowman, Boise County.

Gem Stones.—The value of gem materials collected in the State was estimated at $180,000. The estimate was based largely on a U.S. Forest Service visitor-day count at the Emerald Creek star garnet deposit near Fernwood, Benewah County. Other materials, such as metallic ore specimens and varieties of quartz, also were sought by numerous amateur collectors.

In July, the Bureau of Land Management announced plans for leasing 40 acres of garnet-bearing lands in the St. Joe National Forest in Northeastern Latah County. Under the lease terms there was to be no mining of garnet sands for industrial purposes, but the lease was to allow sales of garnet specimens on a concession basis to mineral collectors.

Gypsum.—Rock Island Gypsum Co. continued to supply agricultural gypsum (land plaster) for local markets. Shipments from stocks at the firm's Rock Creek mine near Weiser were lower than for the previous year.

Kyanite.—There was no production of kyanite for commercial markets during the year, but Sunshine Mining Co. continued drilling and other exploratory work on kyanite deposits near Kooskia in northwestern Idaho County. The Federal Bureau of Mines, at Albany, Oreg., continued beneficiation studies of kyanite-bearing samples from the Woodrat and Goat Mountain deposits.

Lime.—Limestone was calcined to lime at beet-sugar refineries in Bonneville, Canyon, Minidoka, and Twin Falls Counties. Captive production, for interplant use at the respective beet-sugar refineries, declined 6 prcent compared with output for 1965. Secondary lime, regenerated by calcining calcium-carbonate sludge, was produced at a kraft-process paper plant in Nez Perce County.

Peat.—Shipments of peat remained substantially the same as in 1965. Production was from operations of Idaho Peat, Inc., near Downey, Bannock County. Shipments were mainly in bulk form for horticultural and general soil improvement uses.

Perlite.—Production of perlite by Oneida Perlite Corp. at an open-pit operation in Oneida County was reduced sharply compared with that of the previous year. The decline was attributed to curtailed construction activity throughout the firm's marketing area. Shipments of expanded perlite produced at the firm's Malad plant also were less than in the previous year. The expanded perlite was used as loose-fill insulation, concrete and building plaster aggregate, and for soil conditioning.

Phosphate Rock.—Mine production of crude phosphate rock totaled 4.6 million short tons, an 11-percent increase over the 4.2 million tons mined in 1965. Phosphate rock was mined at four operations in two counties. J. R. Simplot Co. continued production from the Gay and Conda mines in Bingham and Caribou Counties, respectively. Monsanto Co. continued production from the Ballard property near Conda, Caribou County, and El Paso Products Co. produced from the Mabie Canyon mine, also in Caribou County. Increased production by all firms contributed to the rise.

The quantity of phosphate rock sold or used by producers was 13 percent greater than the total for the previous year. The major use of phosphate rock produced in the State continued to be for manufacturing elemental phosphorus; demand in 1966 exceeded that of 1965 by 2 percent. Phosphate rock requirements for manufacturing phosphate fertilizers and wet-process phosphoric acid registered sharp gains as the El Paso facilities at Conda were brought into volume production and established operations expanded production.

Phosphate rock was reduced to elemental phosphorus at plants of FMC Corp., Mineral Products Division, at Pocatello, and Monsanto Co., at Soda Springs. The Monsanto firm completed installation of a 70,000-Kilovolt-ampere electric furnace as part of an expansion and modernization program begun in 1965.

FMC Corp. completed the first phase of a multimillion-dollar expansion program at the Pocatello elemental phosphorus works. Included in the program was replacement of two older furnaces by larger and more efficient units. The first unit was completed in December with the second unit scheduled for construction in 1967.

J. R. Simplot Co. continued producing phosphate fertilizers at the firm's Pocatello complex. In February, plans were announced for constructing a third fluosolids reactor and a water-cooling tower at the

works. In October, shipments of phosphoric acid were initiated by the Simplot company for export to the firm's newly constructed fertilizer manufacturing plant at Brandon, Manitoba, Canada. The Pocatello works was to supply the phosphoric acid requirements of the Canadian plant. El Paso Products Co. began volume production of phosphate fertilizers at the company's Agrichemical complex near Conda, Caribou County. Phosphate rock from the Mabie Canyon mine in Dry Valley, some 20 miles distant, was shipped by rail to the plant for processing into ammonium phosphate and concentrated superphosphate fertilizers.

The Bunker Hill Co. continued manufacturing phosphoric acid and phosphate fertilizers at Kellogg, Shoshone County. Calcined phosphate rock from Wyoming sources and sulfuric acid produced at the company Kellogg zinc smelter were used as raw materials for fertilizer manufacturing. In November, construction was completed on a second 350-ton-per-day sulfuric acid plant at the Kellogg site. Production from the plant was to be used in manufacturing fertilizers at the Kellogg complex.

Mountain Fuel Supply Co., Salt Lake City, Utah, began developing phosphate deposits in Caribou County, and in December announced plans for constructing a washing and calcining plant near Soda Springs. Phosphate rock from deposits in the Dry Valley area of Caribou County was to be used as the raw material feed for the plant. Production from the mine and the plant was scheduled to begin in 1967.

The phosphate resources of Idaho were reviewed in a report.[4]

Pozzolan.—El Paso Natural Gas Company begin shipping pozzolan from a plant adjacent to the firm's mercury operation near Weiser, Washington County. Calcined opalite, a waste product from furnacing mercury ore, was used as a raw material feed for the pozzolan plant. Thirty-two thousand tons was shipped for use as a concrete additive at dam construction projects in the Pacific Northwest.

Pumice.—The quantity of pumice and volcanic cinder sold or used by producers registered a 20-percent gain over that of the previous year. Pumice for lightweight aggregate use was produced from operations in Bonneville and Oneida Counties; the largest tonnage came from Bonneville County pits. A quantity of volcanic cinder for use in making concrete products was produced from one operation in Canyon County.

Sand and Gravel.—Sand and gravel production for all uses declined 38 percent from the 12.2-million-ton total in 1965. The sharp decline was largely due to cur-

[4] Service, A. L. An Evaluation of the Western Phosphate Industry and Its Resources. Part 3. Idaho. BuMines Rept. of Inv. 6801, 1966, 201 pp.

Table 13.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	629	$1,100	603	$932
Road material	1,920	2,063	1,484	1,253
Fill	161	192	154	146
Other [1]	101	165	149	243
Total	2,811	3,520	2,390	2,574
Government-and-contractor operations:				
Building	---	---	102	75
Road material	8,470	9,137	4,489	3,690
Fill	865	539	550	320
Other [1]	5	2	13	13
Total	9,340	9,678	5,154	4,098
All operations:				
Building	629	1,100	705	1,007
Road material	10,390	11,200	5,973	4,943
Fill	1,026	731	704	466
Other [1]	106	167	162	256
Grand total	12,151	13,198	7,544	6,672

[1] Includes special sands, railroad ballast, and sand and gravel used for miscellaneous purposes.

tailed requirements for sand and gravel at State highway department projects (2.7 million tons versus 5.9 million tons in 1965).

Curtailments in the light construction industry were reflected in the commercial markets for these commodities. Output by commercial producers totaled 2.4 million tons, a decline of 15 percent from the 2.8-million-ton total of the previous year. Commercial production was reported from 43 operations in 17 counties.

Clark County was the largest producing area with output of 1.7 million tons. Production exceeded 500,000 tons each in Ada, Canyon, and Twin Falls Counties. Sand and gravel production was reported from operations in 41 of the 44 counties in the State; however significant tonnages also were produced which could not be assigned to a specific county of origin.

Universal Lumber & Supply Co. (Del Monte Properties Co.) continued production of quality sand for plaster, glass, abrasive, and other specialty uses from an operation near Emmett, Gem County. J. R. Simplot Co. marketed a quantity of sand for airblast abrasive and construction uses, produced as a byproduct from the firm's Miclasil operation near Bovill, Latah County.

Stone.—Production of stone for all purposes increased 47 percent (863,000 tons) over that produced in 1965. Greater demand for crushed stone at State highway department, U.S. Forest Service, and the U.S. Army Corps of Engineers projects all contributed to the gain.

Production for commercial markets was 946,000 tons, a 14-percent decline from the 1.1-million-ton total of the previous year. Government-and-contractor tonnage (largely contractor production for Federal, State, county, and municipal agencies) was 1.7 million tons, compared with 733,000 tons produced in 1965.

Basalt continued to be the principal stone quarried. Output, which increased 15 percent, was used mainly as a road base and surfacing material, and as riprap. Limestone production declined owing to reduced demand by the cement industry. Sandstone and quartzite output was more than double that of the previous year owing to increased demand for the material as a flux at elemental phosphorus plants and to greater use at U.S. Forest Service projects. Stone production was reported from 18 counties; in addition, significant tonnages were produced which could not be assigned to a specific county of origin.

REVIEW BY COUNTIES

Mineral production was recorded from all of the 44 counties. Shoshone County accounted for 57 percent of the total mineral-output value. Sand and gravel and stone were the principal or only products from 30 counties. Selected counties with significant metal and nonmetal developments are discussed in the following review.

Bannock.—The value of mineral production from operations in the county dropped sharply compared with the 1965 total owing to reduced output of cement from the Inkom plant of Idaho Portland Cement Co. and to the sharply reduced production of sand and gravel. Reduced limestone requirements for cement manufacture also contributed to the decline. Shipments of reed-sedge peat from an operation near Downey remained substantially unchanged from those of the previous year.

Benewah.—Garnet was produced and shipped from two operations near Fernwood. The production total was significantly greater than for the previous year. The Emerald Creek garnet area near Fernwood continued to be a prime gemstone source for collectors and hobbyists. The larger garnet specimens, which had been rejected for processing into industrial abrasive garnet, were sought by numerous collectors. Sand and gravel for road construction and surfacing also was produced.

Bingham.—Mining of phosphate rock and phosphatic shale continued as the principal mineral industry activity. J. R. Simplot Co. increased output of phosphate rock and phosphatic shale from the Gay mine near Fort Hall. The higher grade rock continued to be utilized at the firm's fertilizer complex near Pocatello, and the lower grade phosphatic shale was shipped to the FMC Corp. elemental phosphorus plant west of Pocatello. Sand and gravel totals

Table 14.—Value of mineral production in Idaho, by counties

(Thousand dollars)

County	1965	1966	Minerals produced in 1966 in order of value
Ada	$882	$538	Sand and gravel, stone, clays.
Adams	---	24	Sand and gravel.
Bannock	W	2,734	Cement, stone, sand and gravel, peat.
Bear Lake	280	153	Sand and gravel.
Benewah	W	W	Abrasive garnet, sand and gravel, iron ore.
Bingham	W	W	Phosphate rock, vanadium, sand and gravel.
Blaine	W	2,086	Lead, zinc, silver, sand and gravel, copper, gold.
Boise	2	130	Sand and gravel, stone, gold, silver, lead, copper, zinc.
Bonner	117	39	Sand and gravel, silver, lead, copper, gold, zinc.
Bonneville	1,020	727	Sand and gravel, lime, pumice, stone, clays.
Boundary	283	66	Stone, sand and gravel, lead, silver, zinc, copper.
Butte	14	W	Lead, sand and gravel, silver, zinc, copper.
Camas	21	W	Lead, silver, sand and gravel, zinc, gold, copper.
Canyon	1,247	638	Sand and gravel, lime, pumice.
Caribou	W	W	Phosphate rock, vanadium, stone, sand and gravel.
Cassia	W	122	Sand and gravel, clays.
Clark	758	897	Sand and gravel.
Clearwater	328	1,347	Stone, sand and gravel.
Custer	783	830	Silver, lead, sand and gravel, zinc, copper, gold, stone, tungsten.
Elmore	116	209	Stone, sand and gravel, clays.
Franklin	528	76	Sand and gravel.
Fremont	---	7	Do.
Gem	238	249	Sand and gravel, gold, silver, zinc, lead, copper.
Gooding	185	27	Sand and gravel.
Idaho	155	815	Stone, sand and gravel, gold, silver.
Jefferson	125	126	Sand and gravel.
Jerome	173	15	Sand and gravel, gold, silver.
Kootenai	121	394	Sand and gravel, stone.
Latah	W	W	Clays, stone, sand and gravel.
Lemhi	W	W	Copper, sand and gravel, gold, cobalt, silver, lead, zinc.
Lewis	W	28	Stone.
Lincoln	W	35	Sand and gravel.
Madison	21	47	Sand and gravel, stone.
Minidoka	481	253	Lime, sand and gravel, clays.
Nez Perce	616	328	Sand and gravel.
Oneida	100	W	Pumice, perlite.
Owyhee	200	238	Stone, clays, gold.
Payette	55	155	Sand and gravel.
Power	13	24	Do.
Shoshone	62,910	65,759	Silver, lead, zinc, copper, antimony, stone, sand and gravel, gold.
Teton	202	80	Sand and gravel.
Twin Falls	1,260	W	Sand and gravel, lime.
Valley	134	68	Stone, sand and gravel, iron ore, titanium, abrasive garnet, mercury, gold, silver.
Washington	1,226	1,062	Mercury, stone, iron ore.
Undistributed [1]	30,491	34,588	
Total	105,085	114,914	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes value of mineral production that cannot be assigned to specific counties and values indicated by symbol W.

were lower owing to reduced requirements at State and county road projects.

Blaine.—Federal Resources Corp. continued to be the major producer at its Silver Star-Queens mine at Bellevue. Richer ore than that mined in 1965 supplied more silver and lead from less tonnage than that mined the previous year. Production of 34,732 tons of ore yielded 351,244 ounces of silver, 2,721 tons of lead, 1,356 tons of zinc, and 29 tons of copper; the ore was processed at a 250-ton-per-day concentrator adjacent to the mine, along with ore from several smaller mines in the area.

A silver-lead ore strike was reported near Hailey at the Liberty Gem mine.

Boise.—Minor amounts of gold and silver were produced from one small placer and four small lode mines.

Porter Bros. Corp. shipped a quantity of garnet concentrate from stockpiles at Lowman. The material had been produced several years previously as a byproduct from

milling black-sand concentrates dredged at operations in Valley County.

Bonner.—Duval Corp. initiated a surface exploration program at the Conjecture mine in the Lakeview district. The Conjecture mine had been idle since early in 1964 when Federal Resources Corp. abandoned exploration at the property after spending about $2.75 million.

Bonneville.—Mineral production value from the county declined 29 percent compared with the total for the previous year owing largely to reduced requirements of sand and gravel at State and county highway projects. The county continued as the principal pumice producing area in the State. Output was from the Indian Siding pit of Idaho Falls Pumice Co., Idaho Falls, and from the Albino pit of Idaho Concrete Products, Inc., near Ammon. Utah-Idaho Sugar Co. calcined limestone to quicklime at Idaho Falls for use in refining sugar. Clay mined near Idaho Falls was used in producing heavy-clay construction products by Idaho Falls Brick and Tile Co.

Camas.—Russco Silver, Inc., continued to be the only metal producer in the county, shipping lead ore from its Buttercup mine near Willow Creek to the Federal Resources Corp. mill at Bellevue.

Caribou.—Production values for phosphate rock, vanadium, sand and gravel, and stone ranked the county second in the State in terms of mineral production value. Increased requirements for phosphate rock by the elemental phosphorus and fertilizer manufacturing industries and greater production values for vanadium accounted for most of the 75-percent increase in value over the 1965 total. The quantity of phosphate rock sold or used by producers jumped sharply compared with the total for the previous year. Phosphate rock was mined at the Ballard (Monsanto Co.), Conda (J. R. Simplot Co.), and the Mabie Canyon (El Paso Products Co.) mines; output from all operations increased. Phosphate rock from the Ballard property was reduced to elemental phosphorus at the Soda Springs electric-furnace plant of Monsanto Co., and production from the Conda mine was shipped by rail to the Pocatello fertilizer works of J. R. Simplot Co. The Mabie Canyon production was hauled by rail to the El Paso Products Co. fertilizer manufacturing complex near Conda for producing phosphate fertilizers. Quartzite used as furnace flux at elemental phosphorus plants was quarried near Soda Springs. Sand and gravel and stone were produced for commercial and Government-and-contractor markets.

Custer.—A record production of silver ore (57,442 tons) from the Clayton Silver Mines Clayton mine yielded 246,591 ounces of silver, compared with 26,658 tons of ore which yielded 130,877 ounces of silver in 1965, and the previous record year of 1944 which yielded 214,418 ounces of silver. Approximately 757 tons of lead, 34 tons of copper, 82 tons of zinc, and 54 ounces of gold were recovered from the Clayton ore. Mill capacity was increased to 220 tons per day, and near the end of the year, the zinc separation facilities in the mill were rehabilitated to produce a separate zinc concentrate. The Clayton Silver Mines annual report estimated yearend reserves of 283,858 tons compared with 306,300 tons at the beginning of the year. Mining costs reportedly totaled $159,000, and milling costs were $125,000.

Gem.—Gem State Consolidated Mines, Inc., increased production at its Dewey Group over the previous year to 2,960 tons of ore yielding 261 ounces of gold and 1,834 ounces of silver.

Universal Lumber and Supply Co., a subsidiary of Del Monte Properties Co., announced plans for constructing a $400,000 sand benefication plant near Emmett. The new facility, which was to replace an older plant, was to upgrade sand from nearby deposits to a product suitable for glass, ceramics, building, and abrasive applications.

Latah.—Mineral production value for the county advanced 31 percent compared with the 1965 total. Greater production of roadstone for the State highway department and increased output of kaolin from the Miclasil plant of J. R. Simplot Co. near Bovill accounted for the major portion of the increase. Kaolin for the Simplot Miclasil operation was mined from the Stanford pit northwest of Deary. Fire clay, mined near Helmer, was used at the A. P. Green Refractories Co. plant at Troy.

Lemhi.—The Machinery Center, Inc., Blackbird mine near Cobalt yielded 72,000 tons of ore from which was recovered 1,500 ounces of gold, 3,224 ounces of silver, and 1,438 tons of copper. Producing metal mines in the county totaled 3, compared with 11 small producers active in 1965.

Sundance Mining & Development Co. began sinking a 5- by 7-foot exploration shaft on the Broken Hip silver-lead prospect at Gilmore.

Owyhee.—Sidney Mining Co. completed 2,700 feet of trenching in the Silver City area and began work on the diamond-drilling phase of a $40,000 contract with the Office of Minerals Exploration.

Power.—Phosphate rock from mines in Bingham and Caribou Counties continued to supply requirements of the phosphate processing industry centered at Pocatello. J. R. Simplot Co. utilized phosphate rock from company mines in Bingham and Caribou Counties to manufacture wet-process phosphoric acid and various grades of ammonium phosphate and concentrated superphosphate fertilizer products. FMC Corp. continued to expand productive capacity at its Pocatello elemental phosphorus plant through replacement of smaller capacity furnaces with larger, more efficient units. The first of two such scheduled installations was completed in December. Phosphatic shale mined in Bingham County supplied the plant.

Sulfur from recovery plants in the Western States and Canada was converted to sulfuric acid and used by the J. R. Simplot Co. in manufacturing phosphate and ammonium phosphate fertilizers at Pocatello.

Shoshone.—Twenty-one mines supplied 94 percent of the State's base and precious metal production.

Beaver District.—Zinc-lead ore was produced by lessees and contractors at the Mountain Goat and Monitor mines at the rate of 100 tons per day, according to the Day Mines, Inc., annual report to shareholders. The combined operations yielded 34,883 tons of ore, averaging 0.85 ounce of silver per ton, 1.9 percent lead, and 4.6 percent zinc. Development work consisted of 295 feet of drifting.

Evolution District.—Production from the Sunshine mine, which continued to be the leading silver mine in the Nation, increased 965,731 ounces over that of 1965 with a production of 7.4 million ounces of silver from ore assaying 39.6 ounces per ton. Approximately 200 ounces of gold, 1,260 tons of copper, 250 tons of lead, and 150 tons of zinc also were recovered from 190,782 tons of ore. According to the Hecla Mining Co. annual report, the No. 10 shaft was deepened below the 5000 level, and the station and pockets were excavated on the 4800 level. Development was started on the 4800 level, and by yearend, three diamond-drill holes had intersected ore in the Chester vein.

Sunshine Mining Co. began work on an exploration crosscut to the Bismarck property from the 2700 level in the Sun Con area.

Hecla Mining Co. extracted 39,583 tons of ore averaging 17.3 ounces of silver per ton and 0.5 percent copper from the Silver Summit mine. Only a small tonnage of new ore was developed during the year, including two short ore shoots on the 3600 level and one very short ore shoot on the 4000 level. Yearend ore reserves were 31,000 tons compard with 35,000 tons on January 1.

Hunter District.—According to The Bunker Hill Co. annual report, 246,311 tons of

Table 15.—Mine production of gold, silver, copper, lead, and zinc, in the Coeur d'Alene region, Shoshone County, in terms of recoverable metals

Year	Mines producing		Material sold or treated [1] (thousand short tons)	Gold, lode and placer (troy ounces)	Silver, lode and placer (thousand troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)	Total value (thousands)
	Lode	Placer							
1957–61 (average)	22	1	1,377	2,567	15,460	3,463	58,622	50,927	$41,857
1962	17	1	1,537	3,962	17,578	3,435	83,339	62,713	51,085
1963	16	---	1,463	3,427	16,523	3,332	74,794	63,118	53,980
1964	18	---	1,482	2,952	16,122	3,336	69,586	58,054	57,146
1965	21	---	1,592	2,713	17,918	3,540	63,474	56,443	62,054
1966	21	---	1,786	2,775	19,092	3,454	67,891	58,877	64,880
1884–1966	---	---	[2] 114,374	477,098	722,432	119,470	6,901,396	2,444,186	2,154,510

[1] Does not include gravel washed.
[2] Complete data not available: 1904–66.

ore from the Star Unit area yielded 652,356 ounces of silver, 11,469 tons of lead, and 18,911 tons of zinc. Work on a single deep-hoisting facility proceeded on schedule with completion to the 7300 level anticipated in 1969. Yearend reserves were increased to 1,146,043 tons.

Production from the Lucky Friday mine was 179,716 tons of ore yielding 3.19 million ounces of silver, 1,278 ounces of gold, 20,683 tons of lead, and 1,658 tons of zinc, again making it the Nation's third largest silver producer. Development work on the 3450 level exposed 900 feet of ore comparing favorably in width and grade to the same vein sections on the 3250 level. The Lucky Friday shaft was deepened to the 3850 level. At yearend, ore reserves were 658,000 tons compared with 607,000 tons on January 1.

Hecla Mining Co. and Day Mines, Inc., under an agreement to explore the Day Mines Hunter Ranch property, adjoining Lucky Friday ground to the west, completed 4,000 feet of diamond drilling and drove a lateral 1,500 feet westerly into Hunter Ranch ground. No important mineralization was exposed.

Hecla Mining Co. purchased the Morning mine from Asarco and announced that work was begun that ultimately would take the Star No. 4 shaft to the 9100 level.

Placer Center District.—Asarco reported to its shareholders that the Galena mine was the second largest source of silver in the United States with output of 155,411 tons of ore yielding 4,206,000 ounces of silver and 1,532 tons of copper. The No. 3 shaft was completed to the 3700 level, and a new hoist capable of reaching to the 6000 level was installed. Milling capacity was to be increased from 500 tons to a projected 800 tons per day by 1968.

The Asarco "Coeur Project" was continued on Rainbow Mining and Milling Company, Ltd., property. The surface plant was completed, and a new three-compartment shaft was sunk to a depth of 2,444 feet.

Day Mines, Inc., continued development on the Hornet vein at the Dayrock mine 1250 level. Preparations were underway for deepening the Dayrock shaft 200 feet for a new 1450 level. Ore milled aggregated 35,801 tons containing 7.0 ounces of silver per ton and 7.2 percent lead, according to the Day Mines, Inc., annual report. Development work consisted of 1,273 feet of drifting and crosscutting and 882 feet of raising.

Yreka District.—Increased ore production of 383,630 tons at the Bunker Hill mine yielded 1,525,229 ounces of silver, 25,974 tons of lead, and 21,968 tons of zinc. According to The Bunker Hill Co. annual report, ore reserves showed a very substantial improvement in the category of material amenable to bulk mining methods and having chief values in zinc, and at yearend, comprised 3,768,664 tons of the total 4,604,158 tons of mine ore reserves.

The Bunker Hill concentrator processed a record 750,000 tons of ore, exceeding the 627,000 tons processed the previous year. Included in the tonnage treated were custom ore and old jig tailings.

At the smelter a new record was set for tons of lead smelted, surpassing the previous high established in 1961.

At the Crescent mine, exploration on the 3500 level was finished by midyear, and production was begun toward the end of the year. Ore from the deep levels contributed to the 21,099 tons of ore produced from which 816,771 ounces of silver was recovered. The yearend reserves of 150,879 tons were maintained at approximately the 1965 tonnage by development of the 3500 level.

Valley.—Electronic Metals, Inc. (formerly Antimony Gold Ores Co.), produced 1 flask of mercury at the Hermes mine in the Yellow Pine district and shipped 30 flasks from stocks to W. R. Grace & Co.

Porter Bros. Corp. shipped small amounts of magnetite and garnet from stockpiles at Lowman.

Washington.—Silver Bullion Mining Co. began drilling 34 copper claims on Cuddy Mountain, northeast of Cambridge.

Most of the iron ore mined in the State came from the Rock Island Gypsum Co. Iron Mountain open-pit mine near Weiser. Production was magnetite for use in manufacturing cement.

El Paso Natural Gas Company Idaho-Almaden mine, near Weiser, continued to supply nearly all of the mercury produced in the State; 58,550 tons of ore was extracted yielding 1,133 flasks of mercury.

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 Richard E. Dawes [1] and Robert G. Bottge [2]

Illinois mineral production in 1966 was valued at $618.3 million, over 4 percent higher than in 1965. Increases in total value of coal, fluorspar, liquefied petroleum (LP) gases, natural gasoline and cycle products, peat, and sand and gravel more than offset decreases in portland and masonry cements, clays, lead, lime, natural gas, petroleum, stone, tripoli, and zinc. Mineral fuels comprised 73 percent of the State total value, nonmetals over 26 percent, and metals less than 1 percent.

In 1966, the State led in fluorspar production, ranked fourth in bituminous coal output, and was among the leading States in the production of construction materials —cement, clays, lime, sand and gravel, and stone. Illinois also ranked high in the processing of mineral raw materials.

[1] Mining engineer, Bureau of Mines, Minneapolis, Minn.
[2] Industry economist, Bureau of Mines, Minneapolis, Minn.

Table 1.—Mineral production in Illinois [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	9,358	$30,622	9,203	$28,617
Masonry—thousand 280-pound barrels	615	1,907	614	1,868
Clays [2]—thousand short tons	2,169	4,601	1,894	3,996
Coal (bituminous)—do	58,483	218,972	63,571	244,837
Fluorspar—short tons	159,140	7,861	176,175	8,002
Lead (recoverable content of ores, etc.)—do	3,005	938	2,285	691
Natural gas—million cubic feet	7,396	865	7,230	860
Peat—short tons	36,774	453	44,374	565
Petroleum (crude)—thousand 42-gallon barrels	63,708	186,664	[3] 61,982	[3] 185,947
Sand and gravel—thousand short tons	36,228	40,480	38,237	43,201
Stone—do	47,066	61,294	46,157	60,961
Zinc (recoverable content of ores, etc.)—short tons	18,314	5,348	15,192	4,406
Value of items that cannot be disclosed: Fuller's earth, gem stones, lime, natural gas liquids, and tripoli	XX	33,020	XX	34,362
Total	XX	593,025	XX	618,313

XX Not applicable.

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

[2] Excludes fuller's earth, included with "Value of items that cannot be disclosed."

[3] Final figure; supersedes figure given in commodity section.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Millions)

Year	Value [1]	Year	Value [1]
1955	$575	1961	$577
1956	560	1962	604
1957	570	1963	604
1958	582	1964	608
1959	582	1965	612
1960	596	1966	[p] 630

[p] Preliminary.
[1] Data for 1955–57, 1959–64 revised.

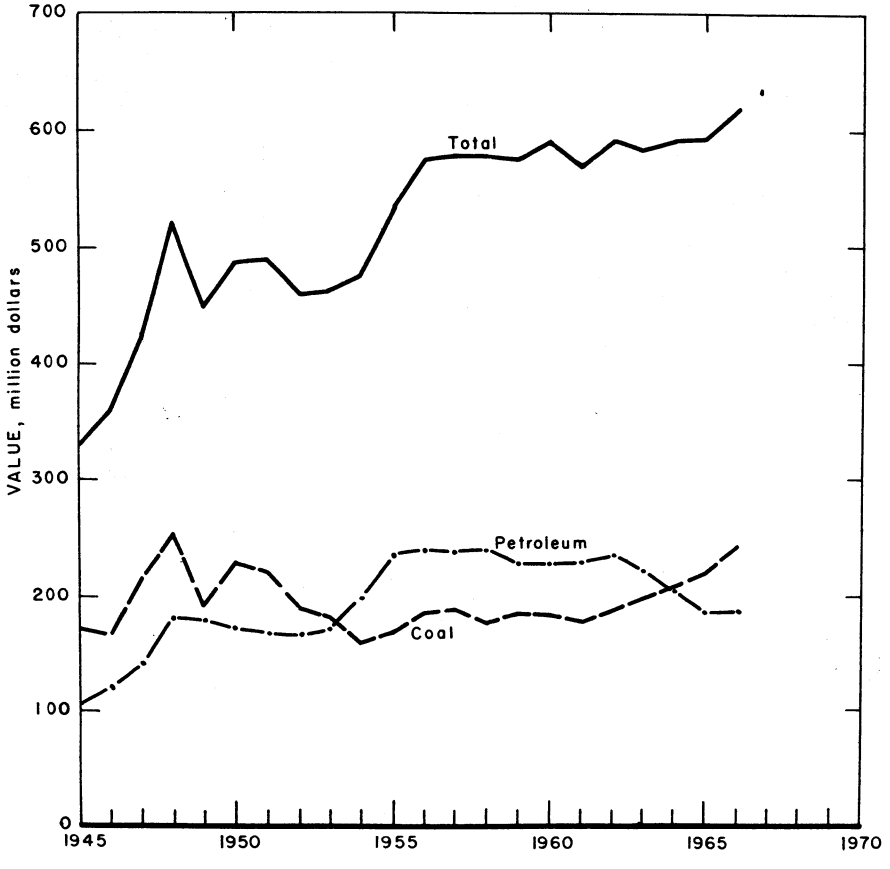

Figure 1.—Value of coal, petroleum, and total value of mineral production in Illinois.

Table 3.—Employment 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
1965:								
Coal	8,312	252	2,096	16,351	14	687	42.87	7,356
Metal	67	249	17	133	---	5	37.47	1,169
Nonmetal	1,399	249	349	2,818	1	83	29.81	4,673
Sand and gravel	1,567	223	349	2,901	---	61	21.03	2,799
Stone	3,597	262	942	7,891	1	139	17.74	1,560
Peat	24	93	2	18	---	---	-----	-----
Total	14,966	251	3,755	30,112	16	975	32.91	5,115
1966: p								
Coal	8,600	246	2,114	16,680	8	710	43.05	5,134
Metal	75	249	18	146	---	10	68.49	1,068
Nonmetal	1,290	267	344	2,791	1	95	34.40	3,621
Sand and gravel	1,645	225	370	3,158	---	40	12.67	826
Stone	3,500	271	948	7,967	3	135	17.32	2,876
Peat	19	117	2	19	---	1	52.65	53
Total	15,129	251	3,796	30,761	12	991	32.61	3,947

p Preliminary.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Illinois ranked fourth in the Nation in the production of bituminous coal with an output of 63.6 million tons valued at $244.8 million. The totals represent a 9-percent increase in tonnage and a 12-percent increase in value over 1965 levels. Value of bituminous coal production accounted for nearly 40 percent of the State's total mineral production value.

Nearly 59 percent of the State's coal production was utilized in Illinois. Approximately 39 percent was shipped to consumers in Indiana, Iowa, Kentucky, Minnesota, Missouri, and Wisconsin. The remainder was consumed at the mines. Electric utilities consumed over two-thirds of the total production, general manufacturing and processing industries 26 percent, retail dealers 4 percent, and coke and gas plants 3 percent. The increase in coal consumption by electric utilities was nearly 5 million tons. Shipments to general manufacturing and processing industries and coke and gas plants increased. Shipments to retail dealers and to railroads for fuel continued to decline. About 88 percent of the coal was shipped by rail, 9 percent by truck, and 2 percent by water.

Total Illinois coal consumption was 46.4 million tons, of which 37.6 million tons came from within the State. This represents an increase of nearly 5 percent of the total amount consumed. Electric utilities, the largest consumer, obtained about 90 percent of their requirements from Illinois producers.

Production was reported from 83 mines in 26 counties, exluding mines with less than 1,000 tons of annual production. About 93 percent of the total output came from 12 counties, each of which had production in excess of 1 million tons. Those counties, in order of rank, were Perry, Franklin, Fulton, St. Clair, Williamson, Christian, Saline, Montgomery, Randolph, Jefferson, Knox, and Peoria.

Nine companies and their subsidiaries each produced over 1 million tons in 1966. Together, they accounted for nearly 95 percent of the State's production; they were Ayrshire Collieries Corp., Bell & Zoller Coal Co., Freeman Coal Mining Corp., Old Ben Coal Corp., Peabody Coal Co., Sahara Coal Co., Inc., Southwestern Illinois Coal Corp., Truax-Traer Coal Division (Consolidation Coal Co., Inc.), and The United Electric Coal Cos. The Peabody Coal Co. No. 10 underground mine in Christian County was the largest bituminous coal mine in the Nation. The Southwestern Illinois Coal Corp. Captain Mine in Perry County ranked second in the Nation in total bituminous coal production and was the largest strip mine.

Table 4.—Coal (bituminous) production in 1966, by counties

(Excludes mines producing less than 1,000 short tons)

County	Number of mines operated		Production (short tons)			Value
	Underground	Strip	Underground	Strip	Total	
Adams	-----	1	-----	21,827	21,827	$153,601
Christian	1	-----	5,604,931	-----	5,604,931	W
Douglas	1	-----	653,624	-----	653,624	W
Franklin	4	-----	7,598,406	-----	7,598,406	W
Fulton	-----	7	-----	7,370,303	7,370,303	30,375,727
Gallatin	1	2	80,621	59,724	140,345	567,837
Greene	-----	1	-----	2,313	2,313	13,557
Grundy	-----	1	-----	370,041	370,041	W
Jackson	-----	3	-----	586,620	586,620	2,011,924
Jefferson	1	-----	2,767,835	-----	2,767,835	W
Knox	-----	2	-----	2,368,324	2,368,324	W
Logan	1	-----	19,477	-----	19,477	97,385
Macoupin	1	-----	447,719	-----	447,719	1,714,099
Mercer	1	-----	12,694	-----	12,694	72,356
Montgomery	2	-----	3,301,384	-----	3,301,384	W
Peoria	1	3	7,937	1,415,063	1,423,000	6,867,314
Perry	-----	4	-----	9,414,563	9,414,563	30,752,779
Randolph	1	3	826,485	2,378,302	3,204,787	11,502,369
St. Clair	2	2	421,339	5,761,165	6,182,504	W
Saline	4	7	1,845,032	1,996,533	3,841,565	15,890,435
Schuyler	-----	1	-----	211,005	211,005	W
Stark	-----	1	-----	589,093	589,093	W
Vermilion	2	3	44,222	784,136	828,358	3,930,901
Washington	1	-----	32,557	-----	32,557	W
Will	-----	1	-----	556,525	556,525	W
Williamson	10	7	3,794,183	2,227,205	6,021,388	23,389,536
Total	34	49	27,458,446	36,112,742	63,571,188	244,836,613

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

The Peabody Coal Co. River King strip mine ranked as the fifth largest mine in the Nation and the third largest strip mine.

Strip mines supplied nearly 57 percent of the total production, and underground mines, the remainder. Production increases over 1965 were about 11 percent for strip mines and 6 percent for underground mines. The average value per ton was $3.85, up from $3.74 in 1965.

All but a minor fraction of the coal produced underground was loaded by machines; these included 79 mobile loaders and 65 continuous miners. Equipment used at strip mines included 145 power shovels, draglines, and wheel excavators. Cleaning equipment operated at 49 plants processed nearly 81 percent of the total production.

Inland Steel Co. started sinking a shaft for a $20 million, 2.5-million-ton-per-year mine in Jefferson County, to be in production in 1968. Old Ben Coal Corp. began sinking a shaft for a 3-million-ton-per-year mine (Old Ben No. 26) in Franklin County, to be in production in 1969. Truax-Traer Division (Consolidation Coal Co., Inc.) began using its rapid coal-loading barge facilities on the Mississippi River near Kellogg, Randolph County. One-hundred-ton railroad hopper cars can be unloaded at a rate of one every 34 seconds.

Coke.—Almost 2.6 million tons of coke, valued at nearly $51.7 million, was produced at six plants. This represented an increase of nearly 3 percent in quantity and 5 percent in value compared with 1965 levels. Consumption of coke by producing companies increased about 8 percent to over 2.5 million tons. During 1966, 568 ovens were operated, the same as in 1965.

Producing plants recovered over 214,000 tons of coke breeze valued at more than $1.6 million, representing a 7-percent increase in quantity and nearly a 21-percent increase in value from that of 1965. More than 126,000 tons of coke breeze was used by producers in agglomerating iron ore, compared with 122,000 tons in 1965. Other products of coke-oven plants included coke-oven gas, tar, ammonia, crude light oil, and light-oil derivatives.

Peat.—Peat was produced by six companies in Cook, Kane, Lake, and Whiteside Counties. Sales increased nearly 21 percent in quantity and 25 percent in value. Moss and reedsedge types were sold in bulk and in packaged form; humus was sold in bulk form. All were used for general soil conditioners.

Petroleum, Natural Gas, and Natural Gas Liquids.—Crude petroleum production decreased almost 3 percent in quantity, but only slightly in value, and comprised 30 percent of the State total value of mineral production. Most of the production came from oilfields in the southeastern part of the State. Waterflood oil production accounted for about two-thirds of the total output.

As reported by the Illinois State Geological Survey, Fayette County accounted for approximately 8.9 million barrels, or over 14 percent of the State total crude petroleum production. Other counties producing over 5 million barrels in order of rank were Lawrence, White, Wayne, and Marion. Output from these four counties represented nearly 40 percent of the State crude oil production.

The Illinois State Geological Survey reported the completion of 1,262 wells in 1966, of which 675 were producing oil wells, 4 were gas wells, 328 were dry holes in pools, and 255 were unsuccessful wildcats. Total footage drilled was 2,837,879, of which 56 percent was in producing wells. Data do not include service wells, structure tests, natural gas storage wells, and old wells worked over.

Table 5.—Crude petroleum production, by counties

(Thousand 42-gallon barrels and thousand dollars)

County	1965		1966	
	Quantity	Value [1]	Quantity	Value [1]
Adams	8	$23	4	$11
Bond	135	396	134	403
Brown	2	6	3	10
Champaign	-----	-----	3	8
Christian	887	2,599	712	2,135
Clark [2]	776	2,274	724	2,173
Clay	2,703	7,920	2,842	8,524
Clinton	1,105	3,238	951	2,854
Coles	802	2,350	708	2,125
Crawford	3,473	10,176	3,469	10,406
Cumberland	(2)	(2)	(2)	(2)
De Witt	269	788	283	848
Douglas	104	305	95	286
Edgar	57	167	63	190
Edwards	969	2,839	980	2,941
Effingham	441	1,292	426	1,278
Fayette	10,903	31,946	8,917	26,751
Franklin	1,360	3,985	1,449	4,346
Gallatin	1,057	3,097	887	2,662
Hamilton	2,978	8,726	4,321	12,963
Hancock [2]	44	129	35	106
Jasper	741	2,171	1,694	5,081
Jefferson	1,411	4,134	1,337	4,012
Lawrence	6,908	20,240	7,024	21,072
McDonough	(2)	(2)	(2)	(2)
Macon	25	73	18	54
Macoupin	7	21	4	11
Madison	283	829	249	748
Marion	7,827	22,933	5,477	16,432
Montgomery	2	6	1	3
Moultrie	5	15	6	18
Perry	43	126	24	72
Randolph	122	357	103	309
Richland	1,961	5,746	2,128	6,384
Saline	700	2,051	1,001	3,004
Sangamon	219	642	167	501
Shelby	77	226	65	196
Wabash	2,528	7,407	2,779	8,336
Washington	570	1,670	567	1,701
Wayne	5,643	16,534	6,032	18,096
White	6,515	19,089	6,188	18,564
Williamson	48	141	30	89
Undistributed	-----	-----	80	241
Total [3]	63,708	186,664	[4] 61,982	[4] 185,947

[1] County values calculated by using State average value per barrel; $2.93 for 1965 and $3.00 for 1966.
[2] Production of Cumberland County included with Clark County, and that of McDonough County with Hancock County because actual source of production cannot be identified.
[3] Data may not add to totals shown because of rounding.
[4] Final figure; supersedes figure given in commodity section.

Source: Illinois Geological Survey.

According to the American Petroleum Institute [3], proved crude oil reserves on December 31 totaled over 362 million barrels, a 9-million-barrel decrease from the reserves of the previous year.

Proved reserves of natural gas on December 31 totaled approximately 236,000 million cubic feet, according to the American Gas Association.[4] This represents an increase of nearly 27,000 million cubic feet over 1965 estimates.

Proved-recoverable reserves of natural gas liquids totaled less than 2.9 million barrels on December 31, according to the American Gas Association.[5]

NONMETALS

Cement.—Portland and masonry cements were produced by four companies with plants in La Salle, Lee, and Massac Counties. Total shipments decreased about 2 percent in quantity, and declined over 6 percent in value. Nearly 96 percent of the portland cement shipments consisted of types I and II (general use and moderate heat). The remainder was high-early-strength and special-use types.

Over 93 percent of the portland cement was shipped in bulk, the remainder in bags. About 65 percent of the shipments were by truck and 34 percent by rail. The remainder was shipped by water or was consumed by the plants.

Consumers in Illinois received about 62 percent of the portland cement shipped. Nearly 17 percent was shipped to Wisconsin and 17 percent was shipped to Indiana, Iowa, Kentucky, and Tennessee, combined. Of the masonry cement shipped, about 34 percent was to consumers in Wisconsin, 30 percent to Illinois, and 26 percent to Tennessee.

Cement production consumed nearly 2.6 million tons of limestone and 350,000 tons of other raw materials including shale, clay, sand, slag, and gypsum. About 270 million kilowatt-hours of electricity was used in the manufacturing process; 63 percent was purchased and the rest home-generated.

Clays.—Total production and value of fire clay, miscellaneous clay, and shale declined about 13 percent. Tonnage of miscellaneous clay and shale used in manufacturing heavy clay products, lightweight aggregate, and cement declined 7, 17, and 23 percent, respectively. Use of fire clay for heavy clay products, refractories, and pottery decreased 9, 11, and 28 percent, respectively. Production of fuller's earth for absorbent uses increased 2 percent.

Production of clay and shale was reported from 20 counties. Fire clay was produced by 10 companies operating in Greene, Grundy, La Salle, McDonough, Marshall, and Scott Counties.

Fluorspar.—Illinois supplied about 70 percent of the total domestic fluorspar output, ranking first among the six fluorspar-producing States. Total shipments increased nearly 11 percent while value increased almost 2 percent. Sales of acid and ceramic grades increased about 17 percent and 5 percent, respectively, in quantity and 1 percent and 5 percent in value. Sales of metallurgical grade decreased 54 percent in quantity and 53 percent in value. Acid grade accounted for 59 percent of the total; ceramic grade, 40 percent; and metallurgical grade, less than 1 percent.

About 605,000 tons of crude ore was milled to obtain about 182,000 tons of finished fluorspar as well as byproduct lead and zinc concentrates. All of the finished fluorspar was produced in Hardin County. Crude ore came from Hardin and Pope

[3] Oil and Gas Journal. Reserves Inch Up, but Reserves/Production Ratios Plunge. V. 65, Apr. 3, 1967, p. 128.
[4] Work cited in footnote 3.
[5] Work cited in footnote 3.

Table 6.—Finished portland cement produced and shipped

(Thousand barrels and thousand dollars)

Year	Active plants	Production	Shipped from mills	
			Quantity	Value
1957–61 (average)	4	9,163	8,831	$28,329
1962	4	9,081	9,145	30,205
1963	5	9,465	9,281	30,577
1964	4	9,978	9,790	32,191
1965	4	9,235	9,358	30,622
1966	4	9,108	9,203	28,617

Counties in Illinois and from Kentucky. A small amount of Illinois crude ore was milled in Kentucky.

Producers included Hastie Mining Co., Minerva Oil Co., Ozark-Mahoning Co., J. W. Patton & Sons, and Ridge Mining Co. Aluminum Company of America, Hoeb Mining Co., and various small producers removed crude ore from stockpile in 1966.

Lime.—Total production and value of quicklime and hydrated lime decreased nearly 5 percent and 6 percent, respectively. About 53 percent was used for chemical and industrial uses, 42 percent for refractory purposes, and 5 percent for construction purposes. One-third of the production was used within the State, while nearly 50 percent was shipped to Indiana. Shipments were made to 18 other States and Canada.

Perlite.—Crude perlite mined outside the State was expanded by eight companies with plants in Champaign, Cook, DeKalb, Kankakee, Lake, and Will Counties. Production increased over 1 percent while value declined slightly. The primary uses were in roof insulation, 69 percent; concrete aggregate, 10 percent; loose fill insulation, 9 percent; and as a filter aid, 6 percent.

Sand and Gravel.—Illinois ranked seventh in the Nation in quantity and fourth in value of sand and gravel produced. Production was reported from 71 counties in which there were 261 commercial and 83 Government- and contractor operations. Commercial operations accounted for over 97 percent of the total production. About 86 percent of the commercial sand and gravel output was shipped by truck, 13 percent by rail, and 1 percent by water.

Total production of sand and gravel increased about 6 percent in quantity and 7 percent in value. The 10 leading producers of sand and gravel were Chicago Gravel Co.; Concrete Materials Division (Martin Marietta Corp.); Crystal Lake Trucking & Excavating Co.; Elmhurst-Chicago Stone Co.; Material Service Division (General Dynamics Corp.); Vulcan Materials Co. (Midwest Division); Moline Consumers Co.; Ottawa Silica Co.; Road Materials Corp.; and Wedron Silica Co. These companies represented about 47 percent of the total State production. Ten counties, each with an output exceeding 1 million tons, provided two-thirds of the total sand and gravel. These counties were Cook, Grundy, Kane, Lake, La Salle, McHenry, Peoria, Tazewell, Will, and Winnebago.

Stone.—Illinois ranked second in the Nation in stone production and fourth in value. Nearly all of the production was limestone with a small amount of sandstone (ganister) mined in Alexander County. No slate was produced in 1966. Total production of crushed and broken stone declined 2 per cent while value decreased less than 1 percent. The largest use for crushed and broken stone was in concrete aggregate and roadstone, followed by agricultural purposes and cement. About 92 percent of the crushed and broken limestone was shipped by truck, 7 percent by rail, and 1 percent by water.

Crushed and broken limestone was produced in 59 counties, nine of which accounted for nearly 62 percent of the tonnage and 58 percent of the value. Those counties with over 1 million tons of production were Cook, Kankakee, La Salle, Lee, Livingston, Randolph, Rock Island, St. Clair, and Will. Cook County was the leading producer with nearly one-third of the State's total production. The 10 leading companies, representing about 54 percent of the total output, were Columbia Quarry Co.; Dolese & Shepard Co.; Elmhurst-Chicago Stone Co.; Industrial Chemicals Division (Allied Chemical Corp.); Lehigh Stone Co.; Marquette Cement Manufacturing Co.; Material Service Division (General Dynamics Corp.); Vulcan Materials Co. (Midwest Division); Moline Consumers Co.; and Pontiac Stone Co. Dimension stone was produced in three counties.

Sulfur.—Shipments of elemental sulfur increased about 6 percent in quantity and 9 percent in value. The Anlin Company of Illinois recovered sulfur by the Amine-Gas-Purification and Modified-Claus processes at its Hartford plant in Madison County. The Pure Oil Co. (Division of Union Oil Co. of California) recovered sulfur by the Modified-Claus process at its Lemont plant in Will County.

Tripoli (Amorphous Silica).—Production of crude material decreased about 1 percent in quantity and 2 percent in value. Output of prepared material decreased less than 1 percent in quantity and value. Prepared material was used for abrasives, filler, and other purposes.

Crude material was recovered from underground mines in Alexander County by Illinois Minerals Co. and Tamms Indus-

Table 7.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	6,149	$5,532	6,823	$6,181
Paving	5,184	4,583	5,615	4,920
Railroad ballast	W	W	25	25
Glass (unground sand only)	1,861	4,041	1,745	3,655
Molding (unground sand only)	1,029	3,075	1,203	3,916
Other [1]	2,843	6,141	2,824	6,613
Total	17,066	23,372	18,235	25,310
Gravel:				
Building	7,185	6,360	7,513	6,715
Paving	9,667	9,302	10,058	9,723
Railroad ballast	52	39	235	163
Fill	1,257	773	1,211	682
Other	33	34	10	13
Total	18,194	16,508	19,027	17,296
Total sand and gravel	35,260	39,880	37,262	42,606
Government-and-contractor operations:				
Sand: Paving	293	165	207	114
Gravel:				
Paving	675	435	751	475
Fill	-----	-----	17	6
Total	675	435	768	481
Total sand and gravel	968	600	975	595
All operations:				
Sand	17,359	23,537	18,442	25,424
Gravel	18,869	16,943	19,795	17,777
Total	36,228	40,480	38,237	43,201

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

[1] Includes blast, engine, fill, filtration, grinding and polishing, oil (hydrafrac), railroad ballast (1965), fire or furnace (1966), and other construction and industrial sands.

Table 8.—Limestone sold or used by producers, by uses

Use	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rubble—thousand short tons	2	$17	2	$14
House stone veneer—thousand cubic feet	24	102	23	106
Flagging—do	5	5	12	9
Total—approximate thousand short tons [1]	4	[2] 123	5	129
Crushed and broken:				
Riprap—thousand short tons	724	1,071	645	941
Concrete aggregate and roadstone—do	35,399	45,984	34,521	45,381
Railroad ballast—do	558	528	552	581
Agriculture—do	4,755	7,053	4,923	7,319
Cement—do	2,716	2,009	2,550	2,093
Other [3]—do	2,908	4,517	2,961	4,510
Total—do	47,060	61,162	46,152	[2] 60,824
Grand total—do	[2] 47,065	61,285	46,157	60,953

[1] Average weight of 170 pounds per cubic foot used to convert cubic feet to short tons.

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

[3] Includes limestone for asphalt filler, chemical uses, dust for coal mines, fertilizer, lime, metallurgical uses, mineral food, poultry grit, stone sand, whiting or whiting substitute, and other uses.

tries Co. Both companies operated plants and sold finished material. Tamms Industries Co. installed new equipment at its operation during the year.

Vermiculite.—Production increased about 6 percent, shipments increased about 2 percent, and value of shipments increased 3 percent. The material was used primarily for insulation, concrete and plaster aggregate, masonry fill, and agricultural purposes. Three companies operated plants in Cook, DeKalb, and Macoupin Counties utilizing crude material mined outside the State.

METALS

Lead and zinc production, in terms of recoverable metal, decreased 24 percent and 17 percent, respectively. Total value of lead production decreased 26 percent and zinc production value decreased 18 percent. Principal producers were Eagle-Picher Industries, Inc., in northern Illinois, and Aluminum Company of America, Minerva Oil Co., and Ozark-Mahoning Co. in southern Illinois. Southern Illinois producers recovered lead and zinc as byproducts of their fluorspar operations. Reduced crude ore production from northern Illinois operations was the principal reason for decreased lead and zinc production.

Average weighted yearly prices used to calculate total lead and zinc values were 15.115 cents per pound for lead and 14.5 cents per pound for zinc. Prices were down from the 1965 average of 15.6 cents per pound for lead and 14.6 cents per pound for zinc.

Eagle-Picher Industries, Inc., formerly the The Eagle-Picher Co., conducted exploration work in northern Illinois and operated the Blackjack, Graham group, and the newly opened, Rehm-Bauer mines. The Graham was closed in January.

Pig Iron and Steel.—About 6.5 million tons of pig iron, valued at $364.8 million, was shipped from Illinois blast furnaces or consumed by the producing companies. The quantity increased over 1 percent from the 1965 level. Five companies operated blast furnaces in Chicago and Granite City. Of the 22 blast furnaces in the State, seven were inactive during the year, eight were out of blast part of the year, and seven operated throughout the year. Youngstown Sheet & Tube Co. began dismantling its three blast furnaces, which had been inactive since 1960.

About 4.8 million short tons of domestic iron and manganiferous ores, 2.5 million short tons of sinter, and 2.4 million short tons of pellets were consumed in Illinois blast furnaces. Pellet consumption was up nearly 7 percent.

The iron and steel industry consumed over 2.5 million short tons of limestone and dolomite; about 59 percent in blast furnaces, 22 percent in steel furnaces, and the remainder in agglomerating plants. In addition, more than 4.5 million short tons of coke was consumed by blast furnaces. Illinois agglomerating plants consumed over 3.2 million short tons of iron ore. Over 21 percent of the iron ore consumed by agglomerating plants and 62 percent of the 641,000 tons of ore consumed in steel furnaces was foreign.

According to the American Iron & Steel Institute, steel production decreased 2 percent to 10,960,000 tons in 1966.

Other Metals.—American Zinc Co. recovered cadmium and germanium as byproducts at its Monsanto zinc smelter and Fairmont City roasting plant. American Potash

Table 9.—Mine production of lead and zinc

Year	Mines producing	Crude ore sold or treated (short tons)			Lead (recoverable metal)		Zinc (recoverable metal)		Total value
		Fluorspar-lead-zinc	Lead and/or zinc	Total	Short tons	Value	Short tons	Value	
1957–61 (average)	21	363,080	590,534	953,614	2,716	$645,168	26,057	$6,037,776	$6,682,944
1962	17	399,742	571,158	970,900	3,610	664,240	27,413	6,304,990	6,969,230
1963	13	400,283	350,647	750,930	2,901	626,616	20,337	4,677,510	5,304,126
1964	14	359,247	177,894	537,141	2,180	571,160	13,800	3,753,600	4,324,760
1965	8	495,686	185,444	681,130	3,005	937,560	18,314	5,347,688	6,285,248
1966	8	520,891	128,088	648,979	2,285	690,756	15,192	4,405,680	5,096,436

& Chemical Corp. processed concentrates containing thorium, rare-earth elements, and yttrium at its West Chicago plant. New Jersey Zinc Co. recovered cadmium as a byproduct at its Depue zinc refinery. United Refining & Smelting Co. produced bismuth, cadmium, and some low-melting alloys at its Franklin Park plant.

REVIEW BY COUNTIES

Mineral production in 1966, excluding natural gas and natural gas liquids, was reported from 100 of the 102 counties. Of this group, Cook County led in value of mineral output with $33.7 million. Mineral production values of over $30 million were recorded in Franklin, Fulton, La Salle, and Perry counties. Other leading counties with mineral-output values exceeding $20 million were Christian, Fayette, Lawrence, St. Clair, and Williamson. Total value of mineral production increased in 64 counties and decreased in 36 counties.

Sand and gravel production was recorded in 71 of the 102 counties. Details concerning sand and gravel production by, and/or under contract for, the State, county, and municipal highway departments are not included in the individual county sections. References to sand and gravel output are generally limited to commercial operations only.

Adams.—Limestone was produced from the underground mines of Calcium Carbonate Co. (formerly Black White Limestone Co.), Marblehead Lime Co. (Division General Dynamics Corp.), and Menke Stone & Lime Co. Moline Consumers Co. operated six quarries with portable plants and Turner Stone Corp. operated a portable plant at one quarry. Quantity of output increased 25 percent and value 11 percent over that of 1965. Material was used for riprap, flux, roadstone, chemical uses, manufacture of lime, and agricultural (aglime) purposes.

Marblehead Lime Co. produced hydrated lime and quicklime at its Marblehead plant and quicklime at its Quincy plant. Menke Stone & Lime Co. produced both types of lime at its Quincy plant.

Blick's Sand Co. and Quincy Sand Co. mined sand and gravel near Quincy for building, road construction, and fill. Production increased 17 percent.

Triple S Mines, Inc., produced about 22,000 tons of coal from a strip mine near Augusta. Value and quantity declined about 17 and 18 percent, respectively. About 70 percent of the product was cleaned by jigs.

Crude petroleum was produced from fields in the southeast part of the county. Production decreased about 50 percent in quantity.

Alexander.—Tripoli (amorphous silica) was produced by Illinois Minerals Co. and Tamms Industries Co. from underground mines near Elco and Tamms, respectively. The material was used for abrasives, fillers, and other uses.

Sand and gravel for building, road construction, and engine use was produced by the H. H. Halliday Sand Co. from a dredge operated near Cairo.

Sandstone was produced by Virgil Bridges near Elco from an underground mine under lease from the Western Fire Brick Co. (Division A. P. Green Fire Brick Co.). The product was shipped to the Western Fire Brick Co. plant in Granite City for processing into refractory material.

Bond.—Crude petroleum was produced from fields located throughout the county. Output decreased about 1 percent from that of 1965.

About 272,000 tons of sand and gravel was produced for building, road construction, and fill. Munie Gravel Pit and Pruitt Sand Pit operated near Keyesport and Greenville, respectively. The former company operated both portable and stationary plants while the latter operated only a stationary plant. The plant of Greenville Gravel Co., Inc., near Greenville, was idle during the year.

Richards Brick Co. produced about 63,000 tons of clay and shale near New Douglas for use in manufacturing heavy clay products.

Brown.—Hollembeak Gravel Co. operated a portable sand and gravel plant near Mt. Sterling and produced material for paving and fill. Moline Consumers Co. and Pea Ridge Stone Co. operated a portable and a stationary plant, respectively, near Mt. Sterling and produced crushed limestone for roadstone and aglime. Frederic Brick &

Table 10.—Value of mineral production in Illinois, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Adams	$2,176,597	$2,396,648	Stone, lime, coal, sand and gravel, petroleum.
Alexander	247,210	266,203	Tripoli, sand and gravel, stone.
Bond	721,300	736,516	Petroleum, sand and gravel, clays.
Boone	438,276	403,171	Stone, sand and gravel.
Brown	37,860	100,069	Stone, sand and gravel, clays, petroleum.
Bureau	592,000	514,000	Sand and gravel.
Calhoun	21,720	W	Stone.
Carroll	372,634	419,344	Stone, sand and gravel.
Cass	2,000	-------	
Champaign	W	587,965	Sand and gravel, petroleum.
Christian	W	W	Coal, petroleum, stone.
Clark [2]	3,156,625	3,082,242	Petroleum, stone, sand and gravel.
Clay	W	8,757,465	Petroleum, stone.
Clinton	W	W	Petroleum, stone, sand and gravel.
Coles	W	W	Do.
Cook	33,400,798	33,672,505	Stone, lime, sand and gravel, clays, peat.
Crawford	W	W	Petroleum, sand and gravel.
Cumberland [2]	W	193,000	Sand and gravel.
DeKalb	736,450	823,377	Stone, sand and gravel.
De Witt	W	W	Petroleum, sand and gravel.
Douglas	W	W	Coal, petroleum.
Du Page	W	W	Stone, sand and gravel.
Edgar	169,010	189,990	Petroleum.
Edwards	2,839,170	2,941,446	Do.
Effingham	W	1,288,042	Petroleum, sand and gravel.
Fayette	W	27,081,914	Petroleum, stone, sand and gravel, clays.
Ford	222,000	239,000	Sand and gravel.
Franklin	W	W	Coal, petroleum.
Fulton	29,296,031	30,903,727	Coal, sand and gravel.
Gallatin	3,556,348	3,597,762	Petroleum, coal, sand and gravel.
Greene	512,446	487,936	Stone, clays, coal.
Grundy	4,947,057	5,290,795	Sand and gravel, coal, clays.
Hamilton	8,725,540	12,963,390	Petroleum.
Hancock [2]	765,150	609,574	Stone, petroleum.
Hardin	13,630,187	12,986,493	Fluorspar, zinc, stone, lead.
Henderson	715,794	557,638	Stone, sand and gravel.
Henry	355,975	335,600	Do.
Iroquois	W	W	Sand and gravel.
Jackson	W	2,352,174	Coal, stone, sand and gravel.
Jasper	2,171,130	5,118,064	Petroleum, sand and gravel.
Jefferson	W	W	Coal, petroleum, stone.
Jersey	172,972	184,903	Stone.
Jo Daviess	1,945,763	1,592,362	Zinc, stone, lead, sand and gravel.
Johnson	1,229,019	914,883	Stone.
Kane	2,979,703	3,296,179	Sand and gravel, stone, peat.
Kankakee	W	W	Stone, clays, sand and gravel.
Kendall	499,529	492,768	Stone, sand and gravel.
Knox	W	W	Coal, stone, sand and gravel, clays.
Lake	W	778,344	Sand and gravel, peat.
La Salle	30,574,721	30,275,715	Cement, sand and gravel, stone, clays.
Lawrence	20,451,440	21,260,646	Petroleum, sand and gravel.
Lee	W	W	Cement, stone, sand and gravel, clays.
Livingston	2,656,587	2,843,469	Stone, clays, sand and gravel.
Logan	717,710	800,387	Sand and gravel, stone, coal.
McDonough [2]	W	W	Stone, clays.
McHenry	4,069,662	4,210,826	Sand and gravel, stone.
McLean	W	764,000	Sand and gravel.
Macon	W	W	Sand and gravel, petroleum.
Macoupin	1,589,551	1,725,151	Coal, petroleum.
Madison	2,676,161	2,388,909	Stone, petroleum, sand and gravel.
Marion	W	W	Petroleum, stone.
Marshall	452,780	546,354	Sand and gravel, clays.
Mason	32,000	23,000	Sand and gravel.
Massac	W	W	Cement, stone, sand and gravel.
Menard	W	W	Stone.
Mercer	320,706	291,616	Stone, coal, clays, sand and gravel.
Monroe	W	W	Stone.
Montgomery	W	W	Coal, stone, petroleum.
Morgan	-------	2,000	Sand and gravel.
Moultrie	27,650	36,450	Petroleum, sand and gravel.
Ogle	1,740,657	1,985,660	Sand and gravel, stone.
Peoria	8,852,974	9,357,805	Coal, sand and gravel, stone.
Perry	21,305,515	30,825,118	Coal, petroleum.
Pike	758,854	719,551	Stone, sand and gravel.
Pope	2,000	2,000	Sand and gravel.
Pulaski	W	W	Clays, stone, sand and gravel.
Putnam	11,000	57,000	Sand and gravel.
Randolph	11,383,178	13,306,021	Coal, stone, petroleum, sand and gravel.
Richland	5,745,730	6,384,123	Petroleum.
Rock Island	1,847,331	2,133,802	Stone, sand and gravel.

See footnotes at end of table.

Table 10.—Value of mineral production in Illinois, by counties [1]—Continued

County	1965	1966	Minerals produced in 1966 in order of value
St. Clair	$24,525,879	$26,781,897	Coal, stone, sand and gravel, clays.
Saline	19,506,603	18,894,776	Coal, petroleum.
Sangamon	1,649,327	1,354,754	Sand and gravel, petroleum, clays.
Schuyler	W	W	Coal, stone.
Scott	W	W	Stone, clays.
Shelby	411,610	W	Petroleum, stone, sand and gravel.
Stark	W	W	Coal.
Stephenson	615,343	564,866	Stone, sand and gravel.
Tazewell	1,387,500	1,544,000	Sand and gravel, clays.
Union	W	W	Stone, sand and gravel.
Vermilion	5,583,216	5,376,908	Coal, stone, clays, sand and gravel.
Wabash	7,579,040	8,475,364	Petroleum, sand and gravel.
Warren	W	W	Stone.
Washington	2,255,170	2,411,561	Petroleum, stone, coal.
Wayne	16,533,990	18,097,303	Petroleum, sand and gravel.
White	19,271,950	18,753,087	Do.
Whiteside	883,904	949,771	Peat, stone, sand and gravel.
Will	7,966,685	9,111,525	Sand and gravel, coal, stone.
Williamson	22,698,932	23,478,798	Coal, petroleum.
Winnebago	2,209,924	2,119,404	Sand and gravel, stone.
Woodford	W	W	Sand and gravel.
Undistributed [3]	228,093,426	184,303,894	
Total	593,025,000	618,313,000	

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

[1] 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 listed because no production was reported.

[2] Value of petroleum production in Cumberland County included with Clark County, and McDonough County with Hancock County because actual source of production cannot be identified.

[3] Includes value for natural gas, natural gas liquids, some petroleum and sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

Tile Co. produced shale near Mt. Sterling for use in manufacturing draintile.

Crude petroleum production increased about 50 percent from 1965 levels. Production came from the southwestern part of the county.

Bureau.—New Jersey Zinc Co. operated a zinc smelter at Depue and also recovered cadmium as a byproduct. About 733,000 tons of sand and gravel was produced by 10 companies, operating stationary and portable plants near Buda, Bureau, Manlius, Princeton, Seatonville, Spring Valley, Tiskilwa, and Walnut.

Christian.—About 5.6 million tons of coal was mined by Peabody Coal Co. at its No. 10 underground mine near Pawnee, the largest bituminous coal mine in the Nation. The county ranked second in underground production and sixth in total output in the State. About 46 percent of the product was cleaned, and 96 percent of the product was shipped by rail.

Crude petroleum production declined about 20 percent from 1965. Production came from fields in the northern and eastern parts of the county.

Tri-County Stone Co. produced limestone at a stationary plant near Nokomis for roadstone and aglime.

Cook.—Value of the county's mineral production increased to nearly $33.7 million, ranking it first in Illinois. The county led in production of crushed limestone with 14.7 million tons valued at $18.4 million, representing an 8-percent increase over that of 1965. Producers included Dolese & Shepard Co., near Hodgkins; R. P. Donohoe Co., Inc., near Lemont; Material Service Division (General Dynamics Corp.) with quarries near Chicago, McCook, and Thornton; and Vulcan Materials Co. (Midwest Division) with quarries near Hillside, Lemont, and McCook. Processed materials were used for concrete aggregate, roadstone, aglime, dead-burned dolomite, lime manufacturing, flux, and railroad ballast. The Riverside quarry of Material Service was idle.

Marblehead Lime Co. produced hydrated lime and quicklime at its plants near South Chicago and Thornton. Standard Lime & Refractories Co. (Division of Martin Marietta Corp.) produced quicklime near McCook. Total quantity and value of county lime production declined.

The nearly 1.1 million tons of sand and gravel produced, a slight increase over 1965, was used chiefly for building and

road construction. Chicago Gravel Co. operated a stationary plant near Elgin; Doetsch Bros. operated portable plants near Glenview, Schaumburg, and Wheeling; Material Service Division (General Dynamics Corp.) operated stationary plants at Spaulding, Wheeling, and Worth; and Worth Sand & Gravel Co., Inc., operated a stationary plant near Worth.

Clay was processed by American Brick Co. (formerly Chicago Brick Co.) near Riverdale, Brisch Brick Co. near Stickney, and Illinois Brick Co. near Blue Island. Carey Brick Co. discontinued operations. Total output and value were down 12 and 14 percent, respectively.

Humus peat was mined near Barrington by Henry Frenzer, Inc., and sold in bulk for general soil improvement.

Blast and steel furnaces were operated in the Chicago area by Interlake Steel Corp., Republic Steel Corp., United States Steel Corp., and Wisconsin Steel Division (International Harvester Co.).

Crude perlite was shipped into the State and was expanded by Research Sales (ITT Bell & Gossett Hydronics) near Dolton and by Silbrico Corp. near Chicago. The products were used as filter aids, loose fill insulation, concrete aggregate, plaster aggregate, soil conditioning, and several miscellaneous uses.

Crude vermiculite, mined outside the State, was expanded by the Zonolite Division (W. R. Grace & Co.) at its Chicago plant for loose fill insulation, plaster and concrete aggregate, agricultural uses, and other miscellaneous uses.

Mica was ground by U.S. Mica Co., Inc., at its Forest Park plant. The material was sold for use in paint, roofing, insulation, plastics, well drilling, joint cement, and other uses.

United Refining & Smelting Co. produced bismuth, cadmium, and low melting alloys at its Franklin Park plant.

Crawford.—Crude petroleum production decreased less than 1 percent. The Main Consolidated field was the principal producing area. The county was the seventh largest crude petroleum producer in the State.

County sand and gravel production was used for building, paving, and fill. Crawford Sand & Gravel Co. operated a dredge (formerly owned by W. J. Wyke) near Hutsonville. Bowman Gravel Co. operated a stationary plant near Palestine.

Douglas.—Moffat Coal Co. produced nearly 654,000 tons of coal from its underground mine near Murdock. All of the product was cleaned by jigging. Nearly 70 percent was shipped by rail.

Crude petroleum production decreased about 9 percent. Production came primarily from fields in the southwestern part of the county.

Fayette.—The county led the State in production of crude petroleum with output of 8.9 million barrels, representing 14 percent of the total. However, production declined 18 percent from that of 1965. The Louden field, located in the eastern part of the county, was the principal producing field. Crude petroleum production helped to make the value of this county's mineral output sixth in the State (excluding natural gas and natural gas liquids).

Crushed limestone was produced by Winter Stone Quarry at its stationary plant near Ramsey, chiefly for road construction and aglime.

Sand and gravel was produced at stationary plants near Hagarstown and Mulberry Grove by Dugan Sand & Gravel and Lutz Sand Co., respectively. Total county production more than doubled from 1965 and was used for building, paving, fill, and molding purposes.

Diller Shale Products Co. produced 12,500 tons of clay for use in manufacturing heavy clay products at its St. Elmo plant.

Franklin.—The county ranked second in total value of mineral production in the State, second in total coal production, and first in underground coal production. Coal output increased about 23 percent to 7.6 million tons. Production came from the Orient No. 5 mine operated by Freeman Coal Mining Corp. near Benton, and from Old Ben Coal Corp.'s No. 9 mine near West Frankfort, its No. 21 mine near Sesser, and its No. 24 mine near Benton. All of the mines were underground. About 69 percent of the coal was cleaned at three plants, and 98 percent was shipped by rail. Old Ben Coal Corp. began sinking a shaft in August for its No. 26 mine near Sesser. Production was planned for 1969.

Production of crude petroleum increased 7 percent from 1965. Although the Benton

field was the primary source, production was obtained throughout the county.

Fulton.—The county ranked third in total value of mineral production in the State, third in total coal output, and second in strip production. Seven strip mines produced over 1 percent more coal, with a value nearly 6 percent greater than in 1965. Producing companies included Midland Electric Coal Corp., Peabody Coal Co., Thunderbird Collieries Corp., Truax-Traer Coal Division (Consolidation Coal Co., Inc.) (formerly Little Sister Coal Corp.), and The United Electric Coal Cos. Seven cleaning plants were operated. Over 65 percent of the production was shipped by rail, 27 percent by barge, and 8 percent by truck.

Duck Island Sand & Gravel Co., Glasers Gravel, Holle Building Service Co., and Otter Creek Sand & Gravel Co. produced 492,000 tons of sand and gravel for building, paving, and fill purposes. Production declined 6 percent in quantity and 15 percent in value.

Gallatin.—Crude petroleum production declined 16 percent from that of 1965. Production came from the northeastern part of the county.

JoLor Mining Co., Marshall Equipment Co., and Wenzel Coal Co., Inc., produced over 140,000 tons of coal, an increase of 47 percent from that of 1965. The first two companies operated strip mines, and the latter an underground mine. Mines operated by Marshall Equipment Co. and Wenzel Coal Co., Inc., discontinued production. Peabody Coal Co. began developing a new strip mine late in the year.

Delta Materials Co. produced sand and gravel near Shawneetown from two dredges and a stationary plant. Output was for building, road construction, and fill.

Greene.—Crushed limestone was produced at four stationary plants operated by Orton Quarry, Inc., near Hillview; Raid Quarries, Inc., near Eldred; and Martin Valstad near Hillview and Kane. Output was for concrete, roadstone, and aglime.

American Vitrified Products Co. produced clay and shale near White Hall for use in manufacturing vitrified sewer pipe. Ruckels Potteries, Inc., sold modeling clay to schools and colleges from its stockpile.

Birch Creek Coal Co. produced about 2,000 tons of coal from its strip mine near Roodhouse for local consumption.

Grundy.—Sand and gravel was produced near Morris by Material Service Division (General Dynamics Corp.) and Penoyer Gravel Co. Output was used for building and road construction.

Coal was produced by Peabody Coal Co. at its strip mine near South Wilmington. Production increased over 5 percent from the 1965 level. The mine extends into Will County, and the cleaning plant is in Kankakee County. All of the coal produced was cleaned by jigs, and nearly 53 percent was shipped by rail.

Illinois Clay Products Co. (Division A. P. Green Fire Brick Co.) produced clay near Coal City for use in manufacturing refractories.

Hardin.—Shipments of finished fluorspar increased 11 percent in quantity and 2 percent in value. Major producers were Aluminum Company of America, Minerva Oil Co., and Ozark-Mahoning Co. These companies also produced lead and zinc concentrates as byproducts of their fluorspar operations. Aluminum Company of America continued to process stockpiled material. Rosiclare Lead & Fluorspar Mining Co. and several other companies sold stockpiled fluorspar. Some Illinois crude ore was processed in Kentucky.

Crushed limestone was produced by five companies operating five stationary plants. Denny & Simpson Stone Co., Inc., Rigsby & Barnard Quarry, Beecher Williams, and Ozark-Mahoning Co. produced crushed limestone chiefly for road construction and aglime. The latter company's product came from mill tailings of its fluorspar operations. Missouri Portland Cement Co. quarried limestone for use in cement manufacture.

Jackson.—Coal was produced from two new strip mines operated by the Main Line Coal Corp. and from one strip mine operated by Truax-Traer Coal Division (Consolidation Coal Co.). All mines were near Elkville. The Truax-Traer Coal Division Burning Star No. 1 strip mine was abandoned in June. All of the coal production was shipped by rail, and over 67 percent was cleaned. Total county coal production declined to 587,000 tons, a 56-percent drop from the 1965 level.

Lawder Sand Co. produced sand from a dredge near Grand Tower for building, paving, fill, and filtration purposes. Illinois Quarry Co. produced crushed limestone

from a stationary plant near Ava, chiefly for roadstone and aglime.

Jefferson.—Coal was produced by Freeman Coal Mining Corp. at its Orient No. 3 underground mine near Waltonville. The entire output was cleaned, and nearly 96 percent was shipped by rail. Production was up slightly over that of 1965. Inland Steel Co. began sinking a shaft near Sesser for its underground coal mine which will produce about 2.5 million tons per year when it becomes operational in 1968.

Belle Rive Mining Co., Inc., and Randall Stone Co. quarried limestone from two stationary plants near Mt. Vernon, chiefly for road construction and aglime.

Production of crude petroleum came from fields located throughout the county. Production declined 5 percent from that of 1965.

Jo Daviess.—Eagle-Picher Industries, Inc., produced lead and zinc ore from its Blackjack, Graham group, and Rehm-Bauer mines. The Graham group was closed in January and the Rehm-Bauer was opened in February. All ore was concentrated at the Graham mill. The Schoenhard Mining Co. continued to rob pillars at the old Dinsdale mine. This ore was processed in Wisconsin.

About 472,000 tons of crushed limestone was produced by seven companies for concrete, roadstone, railroad ballast, and aglime. Production declined over 11 percent from that of 1965. Some of the material came from lead-zinc jig tailings.

Dubuque Sand & Gravel Co. operated a stationary plant near East Dubuque and produced sand and gravel for building purposes and fill.

Kane.—Eleven companies produced nearly 3.3 million tons of sand and gravel to rank the county third in Illinois in that commodity. Production was up nearly 8 percent over that of 1965. Products were used for building, paving, fill, and railroad ballast.

Three portable plants produced limestone near North Aurora, South Elgin, and Big Rock. These plants were operated by Conco-Western Stone Co., Fox River Stone Co., and Elmer Larson, Inc., respectively. Total production increased about 2 percent from that of 1965. Output was used for concrete aggregate, roadstone, aglime, rubble, and flagging.

Reed-sedge peat was produced by Batavia Soil Builders near Batavia for general soil improvement. Material was sold in bulk.

George B. Smith Chemical Works, Inc., produced iron oxide pigments at its plant near Maple Park.

Kankakee.—Crushed limestone production declined slightly from 1965 to rank the county fourth in the State. Lehigh Stone Co. and Manteno Limestone Co. operated stationary plants near Kankakee and Manteno, respectively. Output was used for concrete, roadstone, railroad ballast, and aglime.

Clay was produced by Eastern Illinois Clay Co. and St. Anne Brick & Tile Co. near St. Anne and by Kankakee Clay Products Co. Division (Eastern Illinois Clay Co.) near Kankakee. Production which increased 9 percent, was used in heavy clay products and lightweight aggregate.

Sand and gravel was produced by Engleman Trucking and John Grosso & Sons near Kankakee. Material was used for building, paving, and fill.

U.S. Perlite Corp. produced expanded perlite from material mined outside the State at its Momence plant for use in acoustical tile.

Peabody Coal Co. operated a cleaning plant for coal produced in Will and Grundy Counties.

Knox.—Midland Electric Coal Corp. operated its Mecco and Middle Grove strip mines near Victoria and Farmington. Coal produced at the Mecco mine was cleaned at the company plant at the mine site; that produced at the Middle Grove mine was cleaned at the company's Fulton County plant. About 98 percent of the county's total coal production was shipped by rail.

Abingdon Rock Co., Inc., produced crushed and broken limestone at its stationary plant near Abingdon for road construction, aglime, and riprap.

Lawrence Downin and R. A. Cullinan & Son, Inc., produced sand and gravel from portable plants near London Mills and Abingdon, respectively, for paving use and fill.

Galesburg Brick Co. near East Galesburg produced about 27,000 tons of shale, which was used in the manufacture of building brick.

Briggs Manufacturing Co. produced ground feldspar at its Abingdon plant for use in pottery making. Crude material was mined outside the State.

Lake.—Sand and gravel production increased 1 percent to nearly 1.2 million tons. Seven companies operated plants near Antioch, Gurnee, Half Day, Libertyville, Prairie View, Wadsworth, and Wauconda. Material produced was used for building, road construction, and fill.

Joseph W. Grenus and Marvin J. Walker produced peat moss near Millburn and Lake Villa, respectively, for general soil improvement. Output was sold in bulk.

National Gypsum Co. produced calcined gypsum and expanded perlite at Waukegan. Filter Materials Corp. expanded perlite at its Lake Zurich plant. Crude material processed at the plants came from outside the State. Expanded perlite was used in building plaster and as a filter aid.

National Brick Co. discontinued its clay operation near Deerfield.

La Salle.—The county ranked fifth in the State in total mineral production value, although mineral production decreased 1 percent to $30.3 million.

Portland and masonry cements were produced by Alpha Portland Cement Co. and Marquette Cement Manufacturing Co. at La Salle and Oglesby, respectively. Both companies also produced limestone and clay or shale for use in cement manufacturing.

Total production of clay and shale declined 29 percent. Hydraulic-Press Brick Co. and Ristokrat Clay Products Co. produced clay for use in brick manufacturing. Illinois Valley Minerals Co. and La Salle Canyon Quarry mined clay for use in the manufacture of refractories. Material Service Division (General Dynamics Corp.) mined shale for use in manufacturing lightweight aggregate.

Four companies quarried limestone for use in cement, road construction, and aglime. Total production declined 14 percent from that of 1965. Producing companies were Alpha Portland Cement Co. near La Salle; H & F Stone Co. near Sheridan; Marquette Cement Manufacturing Co. near Oglesby; and Utica Stone Co. near Utica. Troy Grove Stone Co. did not operate its limestone quarry in 1966.

Nearly 4.4 million tons of sand and gravel was produced by 13 companies. Production increased 2 percent in quantity and 7 percent in value. The county continued to rank second in quantity and first in value in the State in this commodity. Products were used for building, paving, fill, railroad ballast, and industrial purposes. Industrial sand was produced by six companies: The American Silica Sand Co., Inc., near Utica; Arrowhead Silica Corp. and Pure Silica Co. near Troy Grove; Bellrose Silica Co. and Ottawa Silica Co. near Ottawa; and Wedron Silica Co. near Wedron.

Lawrence.—This county supplied 11 percent of the State's crude petroleum, ranking it second in the State in this commodity. Production increased 2 percent. The Lawrence field was the primary producing field in the county.

Production of sand and gravel declined slightly to 250,000 tons. Output was for road construction and fill. Ambraw Gravel Co. and Gregory Gravel Co. operated stationary plants near Lawrenceville. H & B Gravel Co., Inc., operated a dredge, also near Lawrenceville.

Lee.—Portland and masonry cements were produced near Dixon by Medusa Portland Cement Co. The company mined limestone and clay for use in cement manufacturing.

Sand and gravel production and value increased from that of 1965. Output was used for building, road construction, engine use, and fill. C. C. Macklin, Nelson Sand & Gravel Co., and Rock River Ready Mix, Inc., operated plants near Steward, Nelson, and Dixon, respectively.

Crushed and broken limestone was produced by six companies at eight plants near Ashton, Dixon, Lee Center, and Steward. Total production of 1.3 million tons was used for cement, concrete aggregate and roadstone, and aglime.

Livingston.—Limestone production increased 8 percent to nearly 1.8 million tons. Seven companies operated quarries near Chenoa, Fairbury, Pontiac, and Weston, and produced material used for concrete aggregate, roadstone, riprap, aglime, chemical uses, and asphalt.

Sand and gravel was produced by Howard Arnold Construction, Inc., Rowe Construction Co., and Valley View Dirt & Gravel Co. near Fairbury, Strawn, and Manville, respectively. Total output of 79,000 tons was used for building, paving, and fill.

Diller Tile Co., Inc., Hydraulic-Press Brick Co., and Streator Clay Pipe Co. produced clay and shale near Chatsworth and Streator for use in manufacturing building brick, vitrified sewer pipe, and other heavy clay products. The output increased over 6 percent in quantity from that of 1965.

Logan.—The Rocky Ford Limestone Co. produced crushed limestone at its stationary plant near Lincoln for roadstone and aglime.

Total sand and gravel production increased 29 percent to 323,000 tons. Allsopp's Sand & Gravel near Mt. Pulaski; R. A. Cullinan & Son, Inc., near Atlanta; and Hoagland Transfer, Inc.; and The Lincoln Sand & Gravel Co. near Lincoln produced material used for building, road construction, engine sand, and fill.

El-B Coal Co., Inc., produced over 19,000 tons of coal from an underground mine near Lincoln. Output was consumed locally.

McDonough.—Crushed and broken limestone was produced by Colchester Stone Co. and McClure Quarries, Inc., near Colchester and by Olson Bros. near Industry. Production was used for roadstone, aglime, and riprap.

Booz & Co., Colchester Brick & Tile Co., and Martin's Clay Pits produced clay and shale near Colchester for use in pottery and stoneware, refractories, building brick, and other heavy clay products.

Crude petroleum was produced, although actual county production data were unavailable. Petroleum production data for McDonough and Hancock Counties are combined and shown under Hancock County in table 5.

McHenry.—This county ranked first in the State in the quantity of sand and gravel produced; nearly 6.2 million tons, or 16 percent of the State total. Thirteen companies and the county highway department operated plants near Alden, Algonquin, Cary, Crystal, Griswold Lake, Harvard, Huntley, Island Lake, McHenry, Marengo, and Woodstock. Production was used for building, road construction, railroad ballast, and fill. Garden Prairie Stone Co., Inc., produced about 30,000 tons of limestone from a stationary plant near Marengo for roadstone, aglime, and flagging.

Macoupin.—Little Dog Coal Co. produced about 448,000 tons of coal from its underground mine near Gillespie. The entire output was cleaned by jigs and concentrating tables. About 72 percent was shipped by rail.

International Vermiculite Co. exfoliated vermiculite at its Girard plant for insulation purposes.

Crude petroleum production declined 43 percent to about 4,000 barrels. Production came from fields in the east-central part of the county.

Madison.—Limestone was produced at three stationary plants near Godfrey and Alton for use as concrete aggregate, roadstone, aglime, riprap, and in fertilizer. Producing companies were C. M. Lohr, Inc., Reliance Quarry, Inc., and Mississippi Lime Co. The latter company operated an underground mine. Total quantity and value of production declined about 10 percent.

Sand production declined 14 percent from that of 1965. C. E. Barker Trucking Service, Inc., and Mississippi Lime Co. produced sand near Granite City and Alton for building, paving, engine use, and other purposes.

The Anlin Company of Illinois recovered sulfur by Amine-Gas-Purification and Modified-Claus processes at its Hartford refinery.

Granite City Steel Co. operated coke ovens and blast and steel furnaces at Granite City. Work continued on the company's modernization program.

Crude petroleum production declined 12 percent to 249,000 barrels. Producing fields were in the eastern part of the county.

Marion.—The county ranked fifth in the State in crude petroleum production. Output was 5.5 million barrels, representing 9 percent of the State total.

Shoots Stone Quarry produced limestone from a stationary plant near Iuka for roadstone, aglime, and riprap.

Marshall.—Hydraulic-Press Brick Co. mined clay near Sparland for use in building brick manufacture. Vernon Henry and Wilson's Gravel Co. produced sand and gravel from seven pits near Henry, Lacon, La Rose, Magnolia, and Washburn. Total production was 436,000 tons, up 10 percent from that of 1965.

Massac.—Missouri Portland Cement Co. produced portland and masonry cements near Joppa, from limestone quarried in

Hardin County and barged to the cement plant.

Columbia Quarry Co. produced limestone at its Mermet No. 10 quarry near Karnak for roadstone, aglime, and riprap.

About 134,000 tons of sand and gravel was produced for building, paving, and fill. Material was produced by Delta Materials Co. near Joppa, and Federal Materials Co., Inc., and Metropolis Ready Mix Concrete Co. near Metropolis.

Menard.—Crushed limestone was produced by Athens Stone Quarry and D–P Indian Point Limestone Products, Inc., at stationary plants near Athens. Output was used for roadstone, aglime, and riprap.

Petersburg Clay Products Co., Inc., closed its pit and plant operations.

Mercer.—Hazel Dell Coal Corp. produced about 13,000 tons of coal at its underground mine near New Windsor. All of the production was shipped by truck.

Hydraulic-Press Brick Co. produced shale near Aledo for use in manufacturing building brick.

Crushed limestone was produced by Mercer County Stone & Coal Co. and Viola Materials, Inc., from stationary plants near Viola, chiefly for roadstone.

Montgomery.—Freeman Coal Mining Corp. and Truax-Traer Coal Division (Consolidation Coal Co., Inc.) produced coal from their underground mines near Farmersville and Coffeen, respectively. Total production increased about 40 percent to 3.3 million tons. Truax-Traer Coal Division shipped its entire output to a powerplant by conveyor; Freeman Coal Mining Corp. cleaned its entire output by jigging or pneumatic methods and shipped 87 percent of its total production by rail.

Central Illinois Stone Co., Inc., Nokomis Quarry, Inc., and Tri-County Stone Co. produced crushed limestone near Nokomis for concrete and roadstone, aglime, and railroad ballast. Total output decreased 13 percent to 645,000 tons.

Production of crude petroleum decreased to about 1,000 barrels.

Peoria.—Total production of coal increased 9 percent to 1.4 million tons. Strip mines were operated by Peabody Coal Co. near Edwards; Sherwood-Templeton Coal Co., Inc., near Laura; and The United Electric Coal Cos. near Glasford. Zaborac Coal Co. operated an underground mine near Peoria.

Six companies produced over 1.4 million tons of sand and gravel from eight pits and a dredge. Production was about the same as in 1965. Output was for building, paving, and fill.

Production of crushed limestone declined about 16 percent to 805,000 tons. LaMar Stone Co., Long Rock Co., and Princeville Stone Co. operated stationary plants near Princeville and produced material for roadstone and aglime.

Perry.—The county ranked first in total coal output. Over 9.4 million tons, an increase of 45 percent over that of 1965, was produced from four strip mines. Southwestern Illinois Coal Corp. operated its Captain and Streamline mines near Percy; the former was the largest strip mine in the Nation and had the second largest output of all mines. Truax-Traer Coal Division (Consolidation Coal Co., Inc.) operated its Burning Star No. 2 mine near DuQuoin, and The United Electric Coal Cos. operated its Fidelity No. 11 mine also near DuQuoin. All of the companies operated cleaning plants, and over 98 percent of the county coal production was shipped by rail.

A decline of 44 percent occurred in crude petroleum production. Producing fields were in the northern part of the county.

Pope.—Crude fluorspar-lead-zinc ore was produced by Ozark-Mahoning Co. from its Barger, Parkinson, and Barnett properties. The ore was processed at the company's mill in Hardin County. Fluorspar ore mined by James W. Patton & Sons was sold to processors in Hardin County and Kentucky.

Pulaski.—Star Enterprises, Inc., mined fuller's earth near Olmsted and sold it for absorbent uses. Limestone was produced near Ullin by Columbia Quarry Co. and sold for roadstone, railroad ballast, aglime, and riprap. Delta Materials Co. and Mize Gravel Pit produced sand and gravel for paving.

Randolph.—About 3.2 million tons of coal was produced from three strip mines and one underground mine. Total production increased about 12 percent over that of 1965. About 98 percent of the total output was cleaned, and over 95 percent was shipped by rail. Southwestern Illinois Coal

Corp. operated its Streamline strip mine near Percy. The mine extends into Perry County. Truax-Traer Coal Division (Consolidation Coal Co., Inc.) recorded first production from its Burning Star No. 3 strip mine near Sparta. Zeigler Coal & Coke Co. operated its underground Spartan mine near Sparta. R & N Mining Co. acquired the strip mine formerly operated by Eden Mining Corp. near Sparta but suspended operations in July.

Chester Quarry Co. near Chester; Industrial Chemicals Division (Allied Chemical Corp.) (formerly Solvay Process Division) and Stotz Quarry Co. near Prairie du Rocher; and Randolph Quarries, Inc., near Roots produced limestone for concrete, roadstone, aglime, riprap, chemical, and other miscellaneous uses.

Southern Illinois Sand Co. operated a dredge near Chester and produced building, paving, and engine sand.

Crude petroleum was produced from fields in the northeastern part of the county. Production declined 16 percent to 103,000 barrels.

St. Clair.—The county ranked fourth in total coal output and third in strip mine production. Total production was nearly 6.2 million tons, an increase of 8 percent over that of 1965. Production came from two underground mines, operated by Belle Valley Coal Co., Inc., near Belleville and Midland Electric Coal Corp. near Marissa. Peabody Coal Co. operated two strip mines, the Midwest mine near Millstadt and the River King mine near Freeburg. The River King mine was the fifth largest bituminous coal mine in the Nation and the third largest strip mine. Midland Electric Coal Corp. abandoned its mine in March. Nearly all of the county coal output was cleaned and 66 percent was shipped by rail.

Four companies operated five stationary plants for producing crushed limestone. The county ranked second in the State in crushed stone output with nearly 2.3 million tons, a decrease of 15 percent from that of 1965. Columbia Quarry Co. operated plants near Dupo and Columbia; East St. Louis Stone Co. and The Casper Stolle Quarry & Contracting Co. operated near Dupo; and Quality Stone Co., Inc., operated near Hecker. Products were used for concrete aggregate, roadstone, railroad ballast, aglime, stone sand, and riprap.

Missouri-Illinois Material Co. produced sand from a stationary plant near East St. Louis for building, paving, fill, and engine uses.

Clay and shale were mined by Hill Brick Co. and Hydraulic-Press Brick Co. near Fairview and East St. Louis for use in manufacturing building brick and lightweight aggregate.

American Zinc Co. operated a zinc smelter at Monsanto and a roasting plant at Fairmont City. The Minerals, Pigments, & Metals Division (Chas. Pfizer & Co., Inc.) produced ground barite and iron oxide pigments at East St. Louis.

Saline.—Coal was produced from seven strip mines and four underground mines. Production declined 18 percent to 3.8 million tons. Nearly 99 percent of the county's coal was shipped by rail and the remainder by barge and truck. Companies operating strip mines were as follows: Houston Coal Co.; R & F Coal Co.; Sahara Coal Co., Inc.; Shawnee Coal Co.; and Stonefort Coal Mining Co., Inc. The New Gallatin Coal Co.; Sahara Coal Co., Inc.; and Walnut Grove Mining Co., Inc., produced coal from underground mines near Harrisburg. During the year, the R & F Coal Co. abandoned all three of its mines. Shawnee Coal Co., J. W. Coal Co., Inc., New Gallatin Coal Co., and Walnut Grove Mining Co., Inc., also abandoned their mines. Stonefort Coal Mining Co., Inc., sold its Will Scarlet mine near Stonefort to Peabody Coal Co.

Crude petroleum production increased about 43 percent to 1.0 million barrels. Producing fields were in the Northern part of the county.

Sangamon.—Buckhart Sand & Gravel Co., Inc., near Buckhart and Clear Lake Sand & Gravel Co. and Springfield Sand & Gravel Co. near Springfield operated stationary plants and produced sand and gravel for building, paving, and fill. Total production decreased 9 percent to 701,000 tons.

Clay Products Co. and Poston Brick & Concrete Products Co. produced shale near Springfield for building brick and lightweight aggregate. Tamms Industries Co. produced iron oxide pigments at its Lyons plant.

Crude petroleum was produced southeast of Springfield. Production decreased 24 percent to 167,000 barrels.

Schuyler.—Coal was produced by Peabody Coal Co. from its Key strip mine near Rushville, through July when the

mine was closed. All of the output was cleaned, and over 93 percent was shipped by barge.

Elas Quarry produced crushed limestone from a stationary plant near Pleasant View for road construction.

Scott.—Limestone was produced by Krueger Quarry and Thomas Quarry, Inc., near Winchester for concrete aggregate, roadstone, aglime, and riprap. Sterling Shafer mined clay and shale near Alsey for building brick manufacture.

Stark.—Stonefort Coal Mining Co., Inc., operated its Allendale strip mine near Wyoming until June, when the mine was acquired by Peabody Coal Co. Nearly all of the coal was cleaned and shipped by rail.

Tazewell.—Sand and gravel was produced at eight locations by four companies. Total production of 1.4 million tons was about the same as in 1965. R. A. Cullinan & Son, Inc., operated four pits, Concrete Materials Division (Martin Marietta Corp.) operated two dredges, and Peoria Concrete Construction Co. and C. A. Powley Co. operated one pit each.

Peoria Brick & Tile Co. produced shale near East Peoria for use in building brick manufacture.

Union.—Crushed limestone was produced by American Limestone Co. Division (American Zinc Co.) at two stationary plants near Jonesboro and by Midwest Stone Co. at its portable plant near Anna. Production was sold for concrete aggregate and roadstone, railroad ballast, aglime, and flux. The Illinois Marble Co., Inc. (subsidiary of General Stone & Materials Corp.), produced house stone veneer at its mill in Anna from limestone quarried near Mill Creek.

Sand and gravel was produced by Bittle Construction Co. at a portable plant near Anna for road construction and fill.

Vermilion. — Coal production totaled 828,000 tons, down slightly from that of 1965. Deep Valley Coal Co. and V-Day Coal Co. operated underground mines near Danville. Ayrshire Collieries Corp. (formerly Fairview Collieries Corp.), Lee Coal Co., and Two Rivers Coal Co. operated strip mines near Danville and Oakwood. Lee Coal Co. suspended operations in January. Over 98 percent of the coal was cleaned, and 76 percent was shipped by rail.

Sand and gravel production increased to 262,000 tons. Eight companies operated eight pits to produce material used for paving and fill. Material Service Division (General Dynamics Corp.) produced crushed limestone from a stationary plant near Fairmount, chiefly for road construction and aglime. Western Brick Co. Division (Illinois Brick Co.) mined shale near Danville for use in manufacturing building brick and lightweight aggregate.

Wabash.—Crude petroleum production increased 10 percent to 2.8 million barrels. Producing fields partially or wholly within the county were the Allendale, Mt. Carmel, and New Harmony Consolidated.

Allendale Gravel Co., George Aulvin Sand & Gravel Co., DunBar Sand & Gravel Co., and Mt. Carmel Sand & Gravel Co. produced sand and gravel near Allendale, Cowling, Bellmont, and Mt. Carmel, respectively. Output was for building, paving, and fill. Total production decreased 15 percent to 153,000 tons.

Washington.—Venedy Coal Co. produced coal from an underground mine near Venedy. Nearly all of the output was shipped to local consumers via truck.

Limestone was crushed by Covington Stone Co. at its quarries near Okawville and Nashville and by Pitts Quarry, Inc., at its quarry near Radom. Output was for road construction and aglime. Covington Stone Co.'s Nashville plant was bought from the Nashville Stone Co. Division (Five Star Exploration & Development Corp.).

Crude petroleum production declined slightly to 567,000 barrels. Producing fields were located throughout the county.

Wayne.—The county ranked fourth in crude petroleum production with an output of 6.0 million barrels. Production increased 7 percent from that of 1965. A portion of the Clay City Consolidated field is in the county.

White.—Crude petroleum production totaled 6.2 million barrels, ranking this county third in the State with 10 percent of the State production. Production declined 5 percent from that of 1965. Portions of the New Harmony Consolidated and Roland Consolidated fields are in the county.

Sand and gravel production declined slightly to 179,000 tons. Eastwood Sand &

Gravel Works and Mt. Carmel Sand & Gravel Co. produced building and paving material at plants near Grayville and Crossville.

Whiteside.—Limestone was crushed at six quarries, operated by four companies. Total production decreased 12 percent to 214,000 tons, which was used for road construction and aglime. Producing companies were Alldritt Bros. near Fulton; Cordova Quarry Co. near Erie; Johnson Coal Co. near Morrison; and Rein, Schultz & Dahl, Inc., with quarries near Emerson, Erie, and Sterling. The operation of Johnson Coal Co. was sold to Alldritt Bros. in December.

Total sand and gravel production was 110,000 tons, used entirely for road construction. Collinson Bros. operated a fixed plant near Prophetstown and McCue Bros., Inc., a portable plant near Sterling.

Anderson Peat Co. produced moss peat and Markman Peat Co. produced reed-sedge peat at operations near Morrison. Material was sold in bulk and packaged form for general soil improvement.

Will.—Coal was produced from two seams by Peabody Coal Co. at its strip mine near South Wilmington. Production was up 12 percent from that of 1965. The mine extends into Grundy County, and all of the production was cleaned at a plant in Kankakee County. Nearly 53 percent was shipped by rail.

Sand and gravel production totaled 3.2 million tons, ranking the county fourth in the State in that commodity. Production was up 10 percent over that of 1965. Six companies operated nine plants near Joliet, Lemont, Lisle, Lockport, and Plainfield. Output was for building and road construction, railroad ballast, and fill.

Crushed limestone was produced at four stationary plants. Production increased 9 percent to 2.1 million tons, ranking the county third in the State. Lincoln Stone Quarry, Inc., and National Stone Co. Division (Dolese & Shepard Co.) operated quarries near Joliet while Material Service Division (General Dynamics Corp.) and Wm. D. Tierney & Son operated quarries near Lockport. Production was used for concrete aggregate, roadstone, aglime, railroad ballast, and metallurgical purposes.

Johns-Manville Products Corp. produced expanded perlite at its Rockdale plant for roof insulation and at its Joliet plant for filler and filter aid. The Pure Oil Co. (Division of Union Oil Co. of California) recovered sulfur by the Modified-Claus process at its Lemont refinery.

Williamson.—The county ranked fifth in total coal production in the State, third in underground production, and sixth in strip mine production. Total production of 6.0 million tons was about the same as in 1965. Sixty-three percent of the production came from 10 underground mines and the remainder from seven strip mines. Of the total, over 95 percent was cleaned and 91 percent was shipped by rail.

Companies producing coal from underground mines were Barbara Kay Coal, Inc., Black Crystal Coal Co., Freeman Coal Mining Corp.; Harrisburg Coal Co., Inc., Parton Coal Co., Inc., and Peabody Coal Co. all near Marion; Basin Cream Coal Co., Inc., near Herrin; Bell & Zoller Coal Co. near Zeigler and Johnson City; and Blue Bird Coal Co. near Harrisburg. Companies operating strip mines were Forsyth-Energy Co. near Herrin; Liberty Coal Co. near Carterville; Main Line Coal Corp. near Elkville; and Menow Coal Co., Inc., Peabody Coal Co., Stonefort Coal Mining Co., Inc., and Thunderbird Collieries Corp. near Marion. Operations suspended or closed during the year included the strip mine of Menow Coal Co., Inc., Peabody Coal Co.'s Utility strip mine, Bell & Zoller Coal Co.'s Zeigler No. 3 underground mine, and the underground mine of Black Crystal Coal Co.

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 Donald F. Klyce [1] and Mary B. Fox [2]

Indiana mineral production was valued at more than $230 million in 1966, 5 percent greater than that of 1965. Production of 11 mineral commodities was reported, with output value of five commodities (cement, coal, petroleum, sand and gravel, and stone) accounting for 97 percent of the State total.

Value of abrasives, cement, clay, coal, gypsum, sand and gravel, and stone increased, while natural gas, peat, and petroleum declined. Lime was produced at a commercial plant for the first time since 1953. Nonmetals accounted for 56 percent of the value of State mineral production, and the remainder represented the value of mineral fuels, as no metallic ores were mined in the State.

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Table 1.—Mineral production in Indiana [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasives (whetstones)---short tons	5	$15	5	$15
Cement, portland---thousand 376-pound barrels	14,925	48,797	15,305	49,826
Clays---thousand short tons	1,459	2,160	1,491	2,196
Coal (bituminous)---do	15,565	59,927	17,326	67,857
Natural gas---million cubic feet	239	56	215	51
Peat---short tons	53,873	511	38,111	456
Petroleum (crude)---thousand 42-gallon barrels	11,429	32,458	10,617	31,850
Sand and gravel---thousand short tons	24,867	22,220	24,992	23,542
Stone---do	24,574	42,124	24,323	42,474
Value of items that cannot be disclosed: Masonry cement, gypsum, and lime, (1966)	XX	10,299	XX	11,743
Total	XX	218,567	XX	230,010

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957–59 dollars

(Millions)

Year	Value [1]	Year	Value [1]
1957	$199	1962	$206
1958	201	1963	208
1959	210	1964	215
1960	211	1965	224
1961	204	1966	p233

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[1] Data for 1958–64 revised.

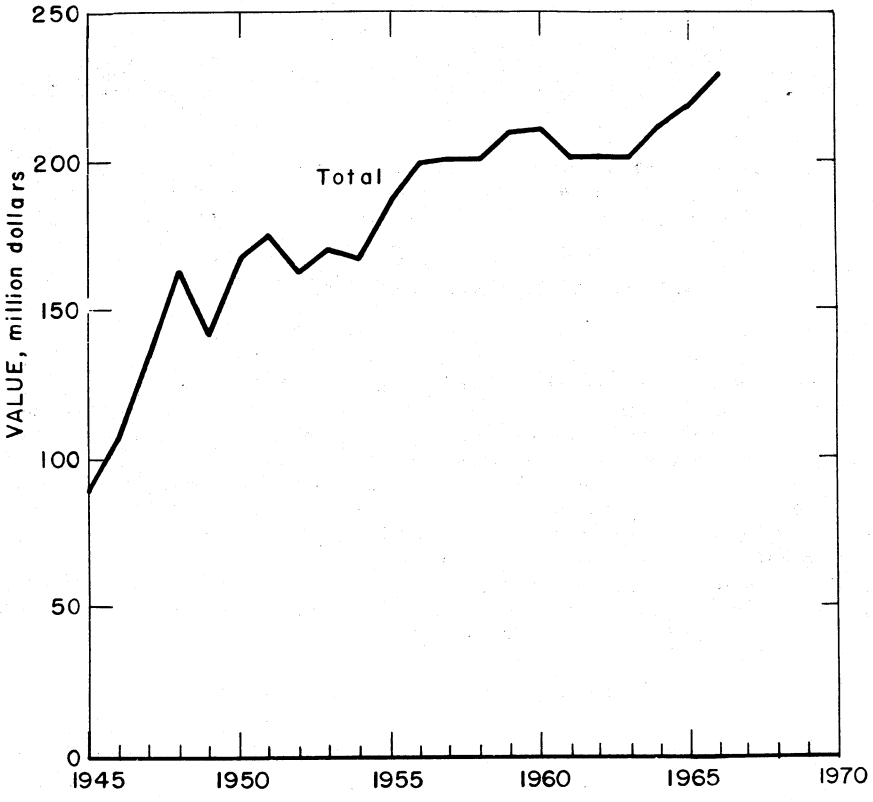

Figure 1.—Total value of mineral production in Indiana.

Table 3.—Employment 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
1965:								
Coal	2,570	208	535	4,101	---	132	32.19	3,393
Nonmetal	827	261	216	1,728	---	32	18.51	964
Sand and gravel	1,129	250	282	2,529	1	32	13.05	4,875
Stone	2,812	276	776	6,389	3	127	20.35	4,349
Peat	41	180	7	62	---	2	32.52	3,740
Total	7,379	246	1,816	14,809	4	325	22.22	3,777
1966: p								
Coal	2,455	216	531	4,104	2	155	38.26	6,890
Nonmetal	800	257	206	1,621	---	26	16.04	2,512
Sand and gravel	1,190	244	291	2,502	3	38	16.39	7,550
Stone	3,075	291	896	7,383	2	153	20.99	3,748
Peat	30	260	8	70	---	4	57.31	1,118
Total	7,550	256	1,932	15,680	7	376	24.43	5,038

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasives.—Whetstones were fabricated at a mill near Orleans in Orange County from sandstone obtained from one of the oldest quarries in the State, said to be in operation for more than 150 years.

Cement.—Cement was produced at five plants: At Buffington in Lake County, by Universal Atlas Cement Division of United States Steel Corp.; at Mitchell in Lawrence County, by Lehigh Portland Cement Co.; at Limedale in Putnam County, by Lone Star Cement Corp.; and at Logansport in Cass County, and Speed in Clark County, by Louisville Cement Co. Portland and masonry cements were produced at all plants.

The average mill value of portland cement was $3.26 per barrel compared with $3.27 in 1965, while masonry cement was $3.09 in 1966 and $3.06 in 1965. An increase in portland cement shipments offset a decrease in sales of masonry cement. Yearend stocks of portland cement were 2.0 million barrels compared with 1.5 million barrels in 1965. About 38 percent of the portland cement shipped was used in Indiana. Out-of-State shipments went chiefly to consumers in Illinois, Kentucky, and Wisconsin, and shipments were also made to 12 other States. About 3.5 million tons of limestone and more than 1.1 million tons of slag, clays and shale, gypsum, sand, air-entraining compounds, and grinding aids were used in manufacturing cement. Approximately 339 million kilowatt-hours of electrical energy was used at the plants. The dry process of manufacture was used at three plants and the wet process at two plants. Annual finished portland cement capacity of Indiana plants was 20.3 million barrels.

Lone Star Cement Corp. announced plans to build a 4-million-barrel wet process plant in Putnam County to replace its present Limedale plant. Lehigh Portland Cement Co. installed new crushers and conveyors at its Mitchell plant.

Louisville Cement Co. announced plans to double the capacity of its Logansport plant. A second 12- by 450-foot process kiln was added as well as additional cement storage.

Clays.—Clay production was about 2 percent greater than that of 1965. Fire clay was mined in 7 counties and miscellaneous clay and shale in 19 counties. Clay was used in the manufacture of cement, lightweight aggregate, heavy clay products (building brick, pipe, draintile), and miscellaneous uses including pottery and stoneware.

The Indiana Geological Survey published a map showing locations of clay and shale operations.[3]

Figures compiled by the Indiana Geological Survey indicated that the value of products manufactured from clay and shale excluding cement, which is reported elsewhere, was $48.2 million.

Gypsum.—Output of crude gypsum was 43 percent greater than that of 1965, reflecting an increased demand for building materials. Crude gypsum was mined from underground deposits near Shoals, in Martin County, by National Gypsum Co. and United States Gypsum Co. Both companies operated plants adjacent to the mine sites for the manufacture of lath, plaster, and wallboard. Uncalcined gypsum was sold for use as portland cement retarder and agricultural use (land plaster). United States Gypsum Co. also operated a board plant at East Chicago in Lake County.

[3] Webb, William M. Locations of Clay and Shale Operations in Indiana. Indiana Geological Survey Miscellaneous Map No. 14, 1966.

Table 4.—Clays 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
1957–61 (average)	352	$610	1,192	$2,150	1,544	$2,760
1962	347	569	1,103	1,686	1,450	2,255
1963	448	724	1,098	1,623	1,546	2,347
1964	376	644	1,169	1,620	1,545	2,264
1965	329	526	1,130	1,634	1,459	2,160
1966	314	511	1,177	1,685	1,491	2,196

The Indiana Geological Survey reported that the purity of low-grade gypsum deposits whose major contaminant is limestone or dolomite can be raised significantly by differential crushing and screening.[4]

Lime.—Lime was produced commercially in Indiana, for the first time since 1953, at the new plant of Marblehead Lime Co., at Buffington. The plant went into operation in July and has two 300-foot rotary kilns and a capacity of 1,000 tons per day. Output was sold for use in steelmaking. Limestone for this plant is brought in by lake freighter from Michigan.

Mineral Wool.—Blast furnace slag from steel mills in Lake County, and small quantities of clays, gravel, and limestone were used to manufacture mineral wool. Plants were located in Huntington, Madison, Wabash, and Wayne Counties.

Perlite.—Crude perlite, mined in Western States, was expanded at plants in Lake, Martin, and Scott Counties. It was used principally in plaster, insulation, and concrete aggregate.

Sand and Gravel.—Sand and gravel production was slightly larger (125,000 tons) than that of 1965 and totaled nearly 25 million tons. Increased demand chiefly for road materials and railroad ballast offset declines in industrial sand, and sand and gravel for building purposes and fill. Production was reported in 68 counties from 215 commercial and 69 Government-and-contractor operations.

The largest output again was from Marion County. Large production also was reported from Allen, Elkhart, Hamilton, Kos-

[4] French, R. R. Dry Beneficiation of Gypsum. Transactions of SME. V. 235, June 1966, pp. 157–161.

Table 5.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	4,933	$4,172	4,654	$4,005
Paving	3,577	2,887	4,127	3,454
Fill	2,193	969	2,099	1,446
Industrial [1]	W	W	672	1,689
Other [2]	844	1,582	81	52
Total	11,547	9,610	11,633	10,646
Gravel:				
Building	3,793	4,409	2,947	3,480
Paving	6,615	6,623	7,091	7,191
Railroad ballast	45	35	W	W
Fill	1,956	1,041	1,910	1,201
Other	203	99	584	548
Total	12,612	12,207	12,532	12,420
Total sand and gravel	24,159	21,817	24,165	23,066
Government-and-contractor operations:				
Sand:				
Paving	14	6	23	10
Other	-----	-----	16	9
Total	14	6	39	19
Gravel:				
Building	3	1	-----	-----
Paving	647	380	785	456
Fill	44	16	3	1
Total	694	397	788	457
Total sand and gravel	708	403	827	476
All operations:				
Sand	11,561	9,616	11,672	10,665
Gravel	13,306	12,604	13,320	12,877
Total	24,867	22,220	24,992	23,542

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes abrasives, blast, engine, fire or furnace, glass, molding, and other industrial sand.
[2] Includes railroad ballast and other construction sand.

ciusko, La Porte, Madison, St. Joseph, Tippecanoe, and Vigo Counties.

The leading commercial producers, in alphabetical order, were American Aggregates Corp.; Hanna Sand & Gravel Co., Inc. (Western Indiana Aggregates, Inc.); Irving Materials, Inc., No. 2; Neal Gravel Co., Inc. (Interstate Sand & Gravel Co., Inc.); Rieth-Riley Construction Co., Inc.; S. & L. Gravel Co., Inc.; Standard Materials Corp. (Martin Marietta Corp.); and Western Indiana Aggregates, Inc.

Slag (Iron-Blast Furnace).—Slag, a by-product of pig iron production in Lake County blast furnaces, was used in manufacturing cement, mineral wool, and roofing granules. Crushed slag was used as an aggregate and expanded for lightweight aggregate.

Stone.—Stone output in Indiana was valued at $42.5 million, a slight increase over that of 1965. More than one-quarter of the amount represents the value of dimension limestone, probably Indiana's best known mineral product. With the exception of small amounts of sandstone and calcareous marl, the remainder was crushed limestone, used principally in concrete aggregate and roadstone, agricultural limestone (aglime), and in cement manufacture.

Production of Salem limestone, which supplied most of the building stone, was centered in Lawrence and Monroe Counties around Bedford and Bloomington. Leading dimension stone producers included Bloomington Limestone Corp., Empire Stone Co., Independent Limestone Co., Indiana Limestone Co., Inc., and Texas Quarries, Inc. The Indiana Geological Survey published a map showing location of mills, quarries, and outcrops of Salem limestone in the Bedford-Bloomington dimension limestone belt.[5]

Crushed stone was produced from dolomites and limestones. Ste. Genevieve limestone was the most important formation and was mined by numerous companies in a belt that extends from Harrison and Crawford Counties, on the Ohio River, northward through Orange, Lawrence, Monroe, Owen, and Putnam Counties. Other Mississippian limestones also were

Table 6.—Limestone sold or used by producers, by uses

Use	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Dimension:				
Rough construction, thousand short tons	W	W	----	----
Rubble, do.	W	W	51	$173
Rough architectural, thousand cubic feet	2,651	$3,095	2,648	3,266
Sawed, do.	1,167	2,889	1,234	3,230
House stone veneer, do.	886	1,614	844	1,491
Cut, do.	481	3,091	523	3,547
Flagging, do.	W	W	123	30
Total (approximate thousand short tons) [1]	456	10,993	440	11,737
Crushed and broken:				
Riprap, thousand short tons	143	230	159	205
Concrete aggregate and roadstone, do.	18,170	23,718	17,784	23,055
Railroad ballast, do.	436	544	382	484
Agriculture, do.	2,453	3,489	2,567	3,697
Cement, do.	2,616	2,071	2,646	2,187
Other [2], do.	207	606	260	699
Total, do.	24,025	30,658	[3] 23,799	30,327
Grand total, do.	[3] 24,480	41,651	24,239	42,064

W Withheld to avoid disclosing individual company confidential data; included in total.
[1] Average weight of 145 pounds per cubic foot used to convert cubic feet to short tons.
[2] Includes limestone for asphalt filler, dust for coal mines, fertilizer, filter beds, mineral food, metallurgical uses, and stone sand.
[3] Data do not add to total shown because of rounding.

Table 7.—Calcareous marl production

Year	Number of producers	Short tons	Value
1957–61 (average)	8	62,870	$40,431
1962	16	50,952	34,657
1963	17	59,265	36,635
1964	29	86,493	52,335
1965	21	64,493	40,260
1966	21	61,532	38,778

[5] Carr, D. D. and L. F. Rooney. Map of Bedford-Bloomington Dimension Limestone Belt Showing Mills, Quarries, and Outcrop of Salem Limestone. Indiana Geological Survey Miscellaneous Map No. 13, 1966.

quarried within and to the east and west of this belt. Crushed stone production was extensive in southeastern Indiana, where Silurian and Devonian limestone and dolomite were quarried in Clark, Scott, Jennings, Ripley, Bartholomew, Decatur, Shelby, and Rush Counties. Most of the crushed stone production of northern Indiana came from Silurian dolomite.

The leading counties in crushed stone production, in order of output, were Clark, Putnam, Lawrence, Allen, Crawford, and Huntington Counties. The leading crushed stone producers, in alphabetical order, were Bloomington Crushed Stone Co., Inc.; Erie Stone, Inc. (Irving Bros. Gravel Co., Inc.); Louisville Cement Co.; May Stone & Sand, Inc.; Mulzer Bros.; Newton County Stone Co., Inc.; Standard Materials Corp. (Martin Marietta Corp.); Utica Limestone Quarry (Louisville Sand & Gravel Co.); and Western Indiana Aggregates, Inc.

Calcareous marl, used for soil enrichment, was produced principally in Lagrange, La Porte, Marshall, and Noble Counties. Five other counties reported minor production.

Sandstone was quarried in Crawford, Lawrence, Martin, Monroe, Morgan, and Spencer Counties. About two-thirds of the output was milled for use as building stone, while the remainder was sold as crushed or broken stone. A quartz conglomerate, quarried in Martin County, was crushed for use in manufacturing refractories.

Sulfur.—Byproduct sulfur was recovered from crude petroleum at the Whiting Refinery of American Oil Co. using the Mathieson-Fluor process.

MINERAL FUELS

Coal (Bituminous).—In 1966 coal continued to be Indiana's principal mineral commodity, with a value of nearly $68 million, compared with $60 million in 1965. Output was more than 11 percent larger than that of 1965. Fifty-one mines were operated, 10 less than in 1965. Of these, 38 were strip mines which accounted for 89 percent of the output, and 13 were underground mines. Nearly 13.9 million tons of coal was mechanically cleaned at 11 plants. About 61 percent of the coal was moved by rail, 13 percent by truck, 10 percent by water, and the remainder principally by conveyor or tram. Nearly 63 percent of the coal mined in Indiana was used for power generation by electrical utilities.

Coal was mined in 15 counties, but more than 97 percent came from 6 counties, with mines in Warrick County having the largest output.

The Kings Station Mine, which the Princeton Mining Co. closed on March 31, was acquired by Old Ben Coal Corp. and operation resumed in September.

Coke.—Coke was produced at five plants with 2,218 ovens. Output was 8.4 million tons, compared with 8.3 million tons in 1965. About 12.1 million tons of coal was carbonized at Indiana coke plants, most of which came from Kentucky and West Virginia. None was mined in Indiana. Most of the coke produced in Indiana was used in northern Indiana blast furnaces.

Table 8.—Coal (bituminous) production in 1966, by counties

(Excludes mines producing less than 1,000 short tons)

County	Number of mines operated		Production (short tons)			Value
	Underground	Strip	Underground	Strip	Total	
Clay	-----	5	----------	1,185,823	1,185,823	$4,805,637
Daviess	-----	1	----------	30,284	30,284	149,000
Fountain	-----	1	----------	W	W	W
Gibson	2	-----	262,365	----------	262,365	W
Greene	1	4	1,100	2,385,300	2,386,400	9,300,993
Knox	1	-----	70,060	----------	70,060	W
Owen	-----	1	----------	W	W	W
Parke	-----	1	----------	11,751	11,751	71,013
Perry	-----	1	----------	W	W	W
Pike	2	5	56,739	2,241,190	2,297,929	8,989,205
Spencer	-----	6	----------	93,494	93,494	423,572
Sullivan	2	2	1,350,218	1,585,940	2,936,158	11,823,694
Vermillion	1	-----	6,516	----------	6,516	28,019
Vigo	1	1	77,054	472,915	549,969	W
Warrick	3	10	36,865	7,436,788	7,473,653	28,182,469
Total	13	38	1,860,917	15,465,433	17,326,350	67,857,125

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

Peat.—Reed-sedge, moss, and humus peat were dug from bogs in Grant, La Porte, Marion, Marshall, Warren, and Wells Counties. Marketed output reported was 29 percent less than that of 1965. The peat was used principally for soil conditioning and horticultural use.

Petroleum and Natural Gas.—Both the amount of oil produced and the number of wells completed were less in 1966 than in the previous year. Production amounted to 10,616,748 barrels, or 812,054 barrels less than that of 1965.

A total of 794 well completions was reported for 1966 as compared with 862 for 1965. Of the 794 wells, 529 were drilled for exploratory and developmental purposes, 107 in connection with gas storage projects, and 158 for secondary recovery purposes.

The 331 exploratory tests produced 35 oil wells, 6 gas wells, and 290 dry holes, and the 198 development wells drilled produced 101 oil wells, 7 gas wells, and 90 dry holes. Successful exploratory drilling resulted in 1 new field, 23 new pools, and 4 extensions in Mississippian formations; 1 new field and 3 new pools in Pennsylvanian formations; 3 new fields, 2 new pools, and 1 extension in Devonian formations; and 1 new field, 1 new pool, and 1 extension in Ordovician formations.

Although exploration in and production from the Ordovician has been negligible in recent years, the most significant exploration success was discovery of a new field in the Trenton (Ordovician) in Wabash County. By the end of the year, 17 wells had been completed in this field. This discovery has stimulated intensified exploration efforts in the eastern part of the State.

La Porte County, in northwestern Indiana, led the State in exploration activity with 48 wells drilled, but no significant reserves were discovered.

The principal production of natural gas was reported from the Trenton field in east central Indiana, the Huntingburg and Zoar fields in Dubois County, and the Moore field in De Kalb County.

The proved oil reserve at the end of 1966 was 47.9 million barrels, and the total liquid hydrocarbon reserve was 63 million barrels.[6]

METALS

Aluminum.—Aluminum Company of America operated a smelter in Warrick County. In April, a fourth potline was put into operation increasing annual rated capacity to 175,000 tons of primary aluminum. Capacity of the Warrick plant was

[6] American Gas Association, American Petroleum Institute, and Canadian Petroleum Association. Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas. V. 21, 1966.

Table 9.—Crude petroleum production in 1966, by major fields

Name of field	Year discovered	Area, acres	Location, county	Number of wells		Production (barrels)
				Producing	Completed	
Caborn Consolidated	1940	1,820	Posey	103	6	170,828
Coe South	1961	430	Pike	17	---	175,871
College Consolidated	1941	750	Posey	NA	3	179,195
Evansville	1947	400	Vanderburgh	NA	1	193,862
Griffin Consolidated	1938	7,250	Gibson and Posey	NA	7	2,534,131
Heusler Consolidated	1938	2,120	Posey and Vanderburgh	NA	2	432,529
Mount Carmel Consolidated	1941	1,890	Gibson and Knox	NA	11	116,806
Mount Vernon Consolidated	1941	2,280	Posey	140	9	464,778
Newtonville Consolidated	1943	510	Spencer	NA	---	254,261
Owensville Consolidated	1940	1,830	Gibson	NA	1	170,618
Owensville North Consolidated	1943	1,960	---do	NA	2	197,762
Plainville	1950	350	Daviess	NA	---	104,550
Princeton North Consolidated	1943	960	Gibson	NA	2	171,119
Spencer Consolidated	1948	520	Posey	NA	---	107,235
Springfield Consolidated	1946	2,500	---do	NA	5	918,862
Union-Bowman (New) Consolidated.	1941	15,000	Gibson, Knox, and Pike	NA	14	578,080
Welborn Consolidated	1941	1,730	Posey	NA	4	212,729
Welborn North Consolidated	1953	370	---do	NA	---	119,932
Wheatonville Consolidated	1949	1,520	Gibson	NA	1	159,277
Undistributed	XX	XX		NA	84	3,354,323
Total	XX	XX		NA	152	10,616,748

NA Not available. XX Not applicable.

Source: Petroleum Section, Indiana Geological Survey.

also increased with the installation of new furnaces. The second of two continuous cold rolling mills and two continuous coil preparation lines went into regular operation early in the year.

Pig Iron and Steel.—Pig iron and steel were produced in Lake County, at East Chicago, by Inland Steel Co. and Youngstown Sheet & Tube Co., and at Gary by United States Steel Corp. In September Bethlehem Steel Corp. began producing coils from its hot strip mill at Burns Harbor, in Porter County. The Burns Harbor plant presently has steel finishing facilities, but a 5-year program will provide the plant with steelmaking facilities, including a blast furnace, coke ovens, basic oxygen furnaces, raw materials handling and other auxiliary facilities.

State output of pig iron was nearly 12 million tons, compared with 11.1 million in 1965.

The American Iron & Steel Institute reported that steel production in Indiana totaled 18.0 million tons, compared with 17.1 million in 1965.

REVIEW BY COUNTIES

Mineral production was reported from 88 of the 92 counties; Benton, Brown, Ohio, and Tipton Counties were the exceptions. In each of 25 counties the value of mineral production was $1 million or more.

Some oilfields extend over county lines and exact production for each county cannot be determined; thus value of petroleum production cannot be accurately distributed to the county level. Nearly two-thirds of the State value of mineral production, exclusive of petroleum and natural gas, came from 10 counties: Cass, Clark, Greene, Lake, Lawrence, Monroe, Pike, Putnam, Sullivan, and Warrick. In addition, Gibson and Posey Counties accounted for more than half of the State petroleum production.

Only those counties with significant production or activity are discussed below. See table 11 for additional detail.

Adams.—A limestone quarry near New Corydon was operated by John W. Karch Stone Co. Material for concrete aggregate, roadstone, aglime and a small quantity of flagging was produced. Meshberger Bros. Stone Corp. operated quarries at Linn Grove and Pleasant Mills, producing limestone for concrete aggregate, roadstone, and agricultural use.

The Krick-Tyndall Co. mined clay near Decatur for manufacturing vitrified sewer pipe. Sand and gravel was produced for building, road construction, and fill at fixed plants near Decatur and Geneva.

Allen.—Limestone was quarried near Edgerton by Midwest Aggregates Corp. (Old Fort Industries, Inc.); riprap, roadstone, and aglime were produced. May Stone & Sand, Inc., operated sand and gravel plants and limestone quarries and crushing plants in the county. In addition to building and paving materials and fill, limestone for agricultural use, flux, and asphalt filler were produced.

Sand and gravel was also produced at plants near Fort Wayne by Paul C. Brudi Stone & Gravel Co., Inc., and Aboite by W. W. Gravel Co., Inc. It was used chiefly for building, road construction, and fill.

Bartholomew.—Meshberger Stone, Inc., operated a limestone quarry and crushing plant in the Columbus area and produced material for riprap, flux, roadstone, aglime, filter beds, and stone sand.

Blackford.—Clay was mined near Hartford City by the Inman Tile Co. for their own use in manufacturing draintile. J & K Stone Corp. (Old Fort Industries, Inc.) operated the Montpelier quarry and produced material for concrete aggregate, roadstone, and aglime. Road gravel was produced by S & L Gravel Co., Inc.

Brown.—The Brown County Stone Co., Inc., discontinued its sandstone quarry operation during the year.

Carroll.—Delphi Limestone Co. operated a quarry near Delphi and produced riprap, aglime, and roadstone. Gravel for fill was mined near Delphi. The county highway department produced sand and gravel for road use. The Brim Gravel Co. (Brim Gravel Transit Mix Co., Inc.) discontinued its sand and gravel operation near Flora.

Cass.—Louisville Cement Co. operated a plant at Logansport and produced portland and masonry cements. A second 450-foot kiln was added during the year. The company mined clay and quarried lime-

Table 10.—Value of mineral production in Indiana, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Adams	$733,612	$718,825	Stone, sand and gravel, clays.
Allen	2,441,385	2,613,726	Stone, sand and gravel.
Bartholomew	W	W	Stone.
Blackford	W	W	Stone, sand and gravel, clays.
Boone	174,000	138,000	Sand and gravel.
Brown	3,245	----------	
Carroll	W	W	Stone, sand and gravel.
Cass	W	W	Cement, stone, sand and gravel, clays.
Clark	W	W	Do.
Clay	3,483,715	5,097,391	Coal, clays.
Clinton	39,000	46,000	Sand and gravel.
Crawford	W	W	Stone.
Daviess	198,873	210,000	Coal, sand and gravel.
Dearborn	W	W	Sand and gravel.
Decatur	W	W	Stone.
De Kalb	425,000	385,000	Sand and gravel.
Delaware	1,408,188	1,400,409	Stone, sand and gravel.
Dubois	16,673	1,515	Clays.
Elkhart	431,782	618,803	Sand and gravel, stone.
Fayette	W	W	Sand and gravel.
Floyd	W	W	Stone.
Fountain	574,410	652,546	Sand and gravel, coal, clays.
Franklin	W	33,280	Sand and gravel, clays.
Fulton	185,100	230,600	Sand and gravel, stone.
Gibson	W	W	Coal, sand and gravel.
Grant	W	W	Stone, sand and gravel, peat.
Greene	4,930,486	9,604,993	Coal, clays, sand and gravel.
Hamilton	1,443,890	1,626,912	Sand and gravel, stone.
Hancock	83,000	W	Sand and gravel.
Harrison	609,900	813,550	Sand and gravel, stone.
Hendricks	W	W	Sand and gravel.
Henry	W	W	Do.
Howard	W	W	Stone, sand and gravel.
Huntington	W	W	Stone, sand and gravel, clays.
Jackson	321,854	315,620	Sand and gravel, clays.
Jasper	W	676,306	Stone, sand and gravel.
Jay	W	W	Do.
Jefferson	W	W	Stone.
Jennings	320,671	322,503	Do.
Johnson	W	W	Sand and gravel.
Knox	644,577	719,258	Sand and gravel, coal.
Kosciusko	554,949	577,378	Sand and gravel, stone.
Lagrange	338,150	W	Do.
Lake	W	W	Cement, sand and gravel, clays.
La Porte	W	W	Sand and gravel, stone, peat.
Lawrence	14,161,373	14,199,452	Cement, stone.
Madison	1,631,264	1,726,200	Stone, sand and gravel.
Marion	W	W	Sand and gravel, peat.
Marshall	246,201	320,384	Sand and gravel, stone, peat.
Martin	W	W	Gypsum, clays, stone.
Miami	W	W	Sand and gravel.
Monroe	7,727,485	8,262,478	Stone.
Montgomery	68,454	73,428	Clays, sand and gravel.
Morgan	789,988	950,068	Clays, sand and gravel, stone.
Newton	W	W	Stone, sand and gravel.
Noble	216,275	224,612	Sand and gravel, stone.
Orange	763,061	749,974	Stone, abrasives.
Owen	826,401	898,604	Stone, clays, sand and gravel, coal.
Parke	408,486	405,587	Sand and gravel, clays, coal.
Perry	W	W	Stone, coal.
Pike	6,891,988	8,991,875	Coal, stone.
Porter	W	W	Sand and gravel, clays.
Posey	73,000	W	Sand and gravel.
Pulaski	W	W	Stone, clays.
Putnam	10,117,110	11,078,845	Cement, stone, sand and gravel, clays.
Randolph	W	W	Stone, sand and gravel.
Ripley	307,951	484,373	Stone.
Rush	309,583	331,956	Stone, sand and gravel.
St. Joseph	589,996	629,220	Sand and gravel, stone.
Scott	218,118	258,432	Stone.
Shelby	1,368,874	1,222,310	Stone, sand and gravel.
Spencer	352,059	498,176	Coal, stone, sand and gravel.
Starke	40,000	W	Sand and gravel.
Steuben	W	W	Sand and gravel, stone.
Sullivan	14,097,199	11,985,644	Coal, sand and gravel, stone.
Switzerland	131,481	W	Stone, sand and gravel.
Tippecanoe	W	W	Sand and gravel.
Union	9,000	13,000	Do.
Vanderburgh	26,264	21,042	Clays.
Vermillion	587,703	575,727	Sand and gravel, clays, coal.

See footnotes at end of table.

Table 10.—Value of mineral production in Indiana, by counties [1]—Continued

County	1965	1966	Minerals produced in 1966 in order of value
Vigo	$3,210,603	$3,362,275	Coal, sand and gravel, clays.
Wabash	W	441,250	Stone, sand and gravel.
Warren	W	W	Sand and gravel, peat.
Warrick	24,186,580	28,299,401	Coal, stone.
Washington	W	W	Stone, sand and gravel.
Wayne	645,927	712,236	Sand and gravel, stone.
Wells	W	W	Stone, sand and gravel, peat.
White	331,730	348,895	Stone.
Whitley	162,000	W	Sand and gravel.
Undistributed [2]	108,708,386	106,141,941	
Total	218,567,000	230,010,000	

W Withheld to avoid disclosing individual company confidential data.

[1] Data for petroleum and natural gas are not available on a county basis; however, values for these commodities are included with "Undistributed." Benton, Ohio, and Tipton Counties are not listed because no production was reported.

[2] Includes value for petroleum, natural gas, some sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

stone in the area for its own use. The Cass County Stone Corp. and The France Stone Co. operated limestone quarries and crushing plants in the Logansport area and produced roadstone, railroad ballast, agricultural limestone, fluxstone, and riprap. Sand and gravel was produced from fixed and portable plants for building and road use.

Clark.—Louisville Cement Co. operated a plant at Speed and manufactured portland and masonry cements. The company also produced clay and limestone as raw material for its cement plant. Limestone was quarried and crushed at Jeffersonville by T. J. Atkins & Co., at Sellersburg by the Sellersburg Stone Co., Inc., and at Utica by Utica Limestone Quarry (Louisville Sand & Gravel Co.). Over 2.4 million tons of limestone was produced in the county. Principal uses were for cement manufacture, concrete aggregate, roadstone, aglime, and riprap. Sand and gravel was produced near Jeffersonville and Utica and sold for building, road use, and fill.

Clay.—Nearly 1.2 million tons of coal was produced from five strip mines. The largest production came from the Ayrshire Collieries Corp. Chinook mine. Fire and miscellaneous clays were produced in several coal mines from underclays of the Pennsylvanian System. The clays were used in the manufacture of brick, tile, stoneware, cements, and for other purposes.

Crawford.—Mulzer Bros. operated the Cape Sandy quarry near Leavenworth and the Eckerty quarry. Part of the latter operation was underground. Hy-Rock Products Co. operated an underground quarry at Marengo. The limestone was crushed for use as roadstone, concrete aggregate, railroad ballast, and aglime. Sandstone was quarried and milled for building use near Taswell by French Lick Sandstone Co., Inc., from the Hill quarry; and by Springs Valley Sandstone Co. from the Westall quarry.

Daviess.—The J. & H. Coal Co. produced coal from a strip mine southeast of Cannelburg. The Mize Gravel Co. dredged sand and gravel near Elnora for building, road use, and fill.

Decatur.—Harris City Stone Co., Inc., operated the Harris City quarry near Greensburg, and the New Point Stone Co. operated the New Point quarry near New Point. With the exception of a small amount of riprap, the limestone was crushed and used for concrete aggregate, roadstone, and aglime.

Delaware.—Limestone quarries and sand and gravel pits were operated in the vicinity of Muncie. The production was used for building and road materials, fill, aglime, and flux. Output was about the same as that of 1965. The principal operators were Irving Bros. Stone & Gravel (Irving Bros. Gravel Co., Inc.), J & K Stone Corp. (Old Fort Industries, Inc.), Muncie Stone & Lime Co., and Park Sand & Gravel, Inc.

Dubois.—The Frick Bros. Coal Co. underground mine, near Jasper, was abandoned in 1965. Hugo H. Bartelt mined clay for use in manufacturing stoneware from an underground mine near Huntingburg. The Huntingburg clay pit, which had been operated by Sylvester Stenftenagel, was abandoned.

Elkhart.—About 745,000 tons of sand and gravel was produced compared with half a million tons in 1965. Most of the production came from pits in the vicinity of Elkhart and Goshen, and was used principally in road construction, although some was used for building construction and fill. Marl was dipped from pits near Elkhart and Middlebury and sold for soil enrichment.

Floyd.—The New Albany quarry near Greenville was operated by Standard Materials Corp. (Martin Marietta Corp.). Most of the limestone was crushed and sold for roadstone and agricultural use; some was used for riprap.

Fountain.—Coal was produced from the Maple Grove No. 2 strip mine. Shale mined near Veedersburg was used in making building brick by Hydraulic-Press Brick Co., and that mined near West Point in the manufacture of inorganic plastic by Rostone Corp. Neal Gravel Co., Inc. (Interstate Sand & Gravel Co., Inc.) operated a large plant at Attica and produced material for building, road use, and fill. The county highway department produced and contracted for road gravel.

Franklin.—Miscellaneous clay was mined near Batesville by Batesville Brick & Tile Corp. for its own use. The county highway department produced road gravel. Standard Materials Corp. (Martin Marietta Corp.) did not operate its sand and gravel plants at Metamora and New Trenton in 1966.

Fulton.—Sand and gravel was produced with both fixed and portable plants in the Kewanna and Rochester areas, and was used for building, road construction, and fill. A small quantity of marl was dipped from several pits in the county for agricultural use.

Gibson.—Coal was produced from the Somerville No. 1 and Kings Station underground mines. The latter was closed by the Princeton Mining Co. in March and reopened in September by Old Ben Coal Corp. No coal was produced from the Gibson County portion of the latter company's Enos strip mine in 1966. Sand and gravel for road use, fill, and building purposes was mined near Owensville and Patoka. Much of the petroleum produced in Indiana came from fields in Gibson and adjoining Posey Counties.

Grant.—Flagstone and crushed limestone for road and agricultural use were produced from the Pipe Creek quarry near Sweetser by Pipe Creek Stone Co. (Irving Bros. Gravel Co., Inc.). The same company operated a large sand and gravel plant at Marion and produced building and road materials. Moss peat was dug from a bog near Jonesboro and sold for soil improvement.

Greene.—Nearly 2.4 million tons of coal was produced, mostly from strip mines. The Richardson mine, the only remaining underground mine in the county, closed in April. The largest coal production was reported from the Airline-Hawthorn and Old Glory strip mines of Peabody Coal Co. Fire clay was mined from the Comet clay pit near Switz City by Micheals, Inc. It was used in the manufacture of building brick, as was miscellaneous shale mined near Bloomfield. Sand and gravel was produced near Bloomfield for building, road use, and fill.

Hamilton.—A limestone quarry was operated near Noblesville by Stony Creek Stone Co., Inc. The output was crushed for agricultural use and road material. Sand and gravel plants were operated near Carmel by American Aggregates Corp., Noblesville by F. Beaver & Sons, Inc., and Fortville by Irving Materials, Inc., No. 2. The material was used for building, road use, and fill.

Harrison.—Limestone was quarried and crushed near Corydon and Depauw for concrete aggregate, roadstone, and agricultural use. Industrial sand (glass, blast, and for other uses) was mined near Elizabeth by Indiana Glass Sand Corp. The drying facilities added last year almost doubled the capacity of the original plant. Sand and gravel for building, road use, and fill was obtained from a pit near Mauckport.

Howard.—Limestone output from the Yeoman Stone Co. quarry near Kokomo was crushed and sold for roadstone, concrete aggregate, and agricultural use. Gravel for road use and fill was mined near Alto and Kokomo.

Huntington.—Limestone was quarried near Huntington by Erie Stone, Inc. (Irving Bros. Gravel Co., Inc.) and sold for riprap and crushed for use as flux, roadstone, railroad ballast, and agricultural use. At Markle, Heller Stone Co., Inc., quarried and crushed limestone for road and agri-

cultural use. Majenica Tile Co., Inc., mined miscellaneous clays at Majenica for its own use. Sand and gravel was produced at several sites for building, road use, and fill.

Jackson.—Lehigh Portland Cement Co. mined shale from the Brownstown pit for use at its Mitchell cement plant. Miscellaneous shales were mined at Brownstown and Medora, and used in manufacturing building brick and other heavy clay products. Sand and gravel pits near Brownstown and Seymour yielded building and road materials and fill.

Jasper.—Limestone was quarried near Pleasant Ridge and Rensselaer and crushed for road and agricultural use. Sand and gravel was dredged near Rensselaer for building and road use.

Jay.—Rockledge Products, Inc., operated a limestone quarry near Portland, and produced riprap and crushed material for concrete aggregate, roadstone, and aglime. The company installed a new crusher, elevators, and loaders which increased capacity to 500 tons an hour. S & L Gravel Co., Inc., produced road gravel with a portable plant.

Jefferson.—Standard Materials Corp. (Martin Marietta Corp.) operated the Hanover limestone quarry and produced roadstone, material for concrete, and agricultural limestone.

Jennings.—Berry Materials Corp. operated a quarry near North Vernon and produced limestone for road material and aglime.

Knox.—The White Ash Coal Corp. produced coal from an underground mine near Wheatland. About 577,000 tons of sand and gravel was produced near Patoka and Vincennes and used principally for building, road materials, and fill.

Kosciusko.—Marl was dipped from several pits in the county and sold for agricultural use. About 677,000 tons of sand and gravel was produced from pits near Etna Green, Leesburg, Syracuse, and Warsaw for building, road use, and fill. The county highway department produced gravel for its own use.

Lagrange.—Marl was dipped from pits near Howe, Lagrange, and Middlebury, and sold for agricultural use. Sand and gravel, mostly for road use, was mined in the Lagrange area. Output was slightly above that of 1965.

Lake.—Portland and masonry cements were manufactured at Buffington by Universal Atlas Cement Division of United States Steel Corp. Slag from Lake County blast furnaces and limestone from Michigan quarries, shipped by water, were the principal raw materials used. Adjacent to the cement plant is the new lime plant of Marblehead Lime Co., which began operation in July. Limestone used at the plant was shipped by water from Michigan quarries. Plant output of pebble lime was sold for use in steelmaking. Clay, mined near Munster, was used in making building brick by American Brick Co. (formerly National Brick Co.). Sand and gravel was produced from pits near Lowell and was used for building, paving, and fill. United States Gypsum Co. operated a calcining and board plant at East Chicago and manufactured building materials. Crude perlite, mined in Western States, was expanded at the plant for use in plaster and insulation. Perlite was also expanded by Federal Cement Products, Inc., at Hammond for use in concrete aggregate. Roofing granules were manufactured by H. B. Reed & Co., Inc., from blast furnace slag at Hammond. Byproduct sulfur was recovered from crude petroleum at Whiting by American Oil Co. using the Mathieson-Fluor process. Pig iron and steel were manufactured at East Chicago by Inland Steel Co. and Youngstown Sheet & Tube Co., and at Gary by United States Steel Corp.

La Porte.—Humus peat was dug from a bog near La Porte and sold in packaged form as an ingredient for potting soils. Marl, for agricultural use, was dipped from pits near La Porte and Walkerton. More than 1 million tons of sand and gravel was produced from sand dunes and pits in the county. In addition to materials for building, paving, and fill, dune sands were processed at a plant in Michigan City for use as glass sand, molding, and engine sand.

Lawrence.—Dimension limestone was produced in and around Bedford by companies that operated both quarries and stone mills. Building stone was also fabricated by independent mills from stone purchased from local quarries. Crushed and broken limestone used as riprap, roadstone, concrete aggregate, aglime, railroad ballast, and cement was produced by Bloomington Crushed Stone Co., Inc., Mitchell Crushed

Stone Co., Inc. (Ralph Rogers & Co., Inc.), Oolitic Ground Limestone Co., and Lehigh Portland Cement Co. who also manufactured portland and masonry cements at Mitchell.

Sandstone was quarried and milled by Cummings Stone Co., Indiana Sandstone Co., Inc., and Springs Valley Sandstone Co. The sawed stone was used in building construction.

Madison.—The Lapel limestone quarry was operated by Standard Materials Corp. (Martin Marietta Corp.). Riprap and crushed stone for concrete aggregate, roadstone, railroad ballast, and agricultural use was produced. About 924,000 tons of sand and gravel was obtained from deposits near Anderson and Frankton and used for road material, fill, and building purposes.

Marion.—The county continued to rank first in the production of sand and gravel. Plants were operated in and around Indianapolis by American Aggregates Corp., Fisher Oil & Gravel Co., Inc., Shannon Gravel Co., and Standard Materials Corp. (Martin Marietta Corp.). Reed-sedge peat was produced in the Indianapolis area and sold in bulk for general soil improvement.

Marshall.—Marl and peat, both sold for soil improvement, were produced in the Argos and Bremen areas. Sand and gravel was produced near Argos and Culver and used in building, paving, and for fill.

Martin.—Clay was mined near Loogootee by Loogootee Clay Products Corp. for use in manufacturing building brick. General Refractories Co. quarried a quartz conglomerate near Shoals for use in manufacturing silica brick. Springs Valley Sandstone Co. operated the Sellers quarry and produced building stone. Crude gypsum was produced from underground mines near Shoals by National Gypsum Co. and United States Gypsum Co. and manufactured into building materials (wallboard, lath, plaster, etc.) at plants adjacent to the mine sites. At both plants crude perlite, mined in Western States, was expanded for use in plaster and insulation.

Monroe.—Dimension limestone was produced in the Bloomington area by companies operating both quarries and stone mills, as well as by independent mills that fabricated purchased stone. Leading producers included Bloomington Limestone Corp., Empire Stone Co., B. G. Hoadley Quarries, Inc., Independent Limestone Co., Indiana Limestone Co., Inc., Midwest Quarries Co., Inc., Texas Quarries, Inc., Victor Oolitic Stone Co., and Woolery Stone Co., Inc. Bloomington Crushed Stone Co., Inc., operated a quarry and crushing plant near Bloomington and produced roadstone, concrete aggregate, and aglime. Indiana Calcium Corp. operated a fine-grinding plant at Bloomington using spalls purchased from stone mills and produced filler material for use in pottery manufacture and other uses. Hinkle Sandstone Co. operated the Hinkle quarry and milled sandstone for building use.

Montgomery.—Clay and shale were mined near Crawfordsville by American Vitrified Products Co. and Hydraulic-Press Brick Co. for their own use. Sand and gravel for building, paving, and fill was also mined near Crawfordsville.

Morgan.—Clay and shale were mined near Brooklyn and Martinsville for use in making building brick and heavy clay products, and was bloated for lightweight aggregate. Sandstone was quarried from the High Bluff quarry near Mooresville and used principally for retaining walls. Limestone was quarried and crushed at Gosport and sold for use in concrete aggregate, roadstone, and for agricultural use. About 432,000 tons of sand and gravel was mined near Martinsville and Waverly and used for building, paving, and fill.

Newton.—At Kentland, limestone was quarried and crushed by Newton County Stone Co., Inc., for use as railroad ballast, roadstone, concrete aggregate, and for agricultural use. Building and paving sand and gravel was produced near Morocco.

Noble.—Marl was dipped from a pit near Topeka and sold for agricultural use. About 297,000 tons of sand and gravel was mined at several sites in the county with fixed and portable plants. The material was used for building purposes, road construction, maintenance, and fill.

Orange.—Whetstones were fabricated from sandstone quarried near Orange by Hindostan Whetstone Co. Limestone was quarried near French Lick, Orleans, and Paoli. Most of the material was crushed and used for roadstone, concrete aggregate, and agricultural purposes. A small amount was sold for riprap.

Owen.—Coal was produced from the Burcham strip mine. Fire clay was mined from the Old Glory strip mine by Peabody Coal Co. and sold for use in making floor and wall tile, and refractories. Limestone was quarried near Spencer and crushed for use as road material and for agricultural purposes. The Romona (dimension limestone) quarry, which had been operated by Ingalls Stone Co., Inc., was idle in 1966. Sand and gravel was mined near Gosport and Spencer for building and road use.

Parke.—S. L. Turner Coal & Clay Co., Inc., produced coal from the Turner strip mine and also mined fire clay from the underclays of the Brazil Block coal bed. The clay was sold to a brick manufacturer. American Vitrified Products Co. abandoned its plant and clay pit and did not operate in 1966. Cayuga Brick & Tile Co. also did not operate in 1966 because of fire damage to its plant in 1965. Sand and gravel was mined near Montezuma and Rockville and used for building, road construction, and fill.

Perry.—Coal was produced from the Foster strip mine. Mulzer Bros. operated the Derby limestone quarry and crushed the output for use as roadstone, concrete aggregate, and aglime.

Pike.—About 2.3 million tons of coal was produced from four strip and two underground mines. The Enos Coal Corp. (Old Ben Coal Corp.) had the largest production from the Enos and Blackfoot No. 5 strip mines. The county highway department quarried sandstone (riprap) for its own use.

Porter.—Fire clay was mined from pits near Portage and used in the manufacture of refractories and flowerpots. Crisman Sand Co., Inc., mined industrial (furnace) sand near Portage. Bethlehem Steel Corp. continued development of its large manufacturing complex at Burns Harbor. A blast furnace, coke ovens, basic oxygen furnaces, and other facilities are to be built.

Pulaski.—The mineral industry of Pulaski County was concentrated in the Francesville area where clay was mined by Francesville Drain Tile Corp. for its own use and Francesville Stone Division of Western Indiana Aggregates, Inc., quarried and crushed limestone for road materials, railroad ballast, and agricultural use.

Putnam.—Lone Star Cement Corp. manufactured portland and masonry cements at Limedale. In January the company announced plans to construct a $25 million, 4-million barrel wet-process-cement plant to replace the present plant. About 2.4 million tons of limestone was produced from seven quarries and used for riprap, cement, flux, roadstone, filler, agriculture, and other uses. United Aggregate Corp. began producing limestone from a quarry near Cloverdale in 1966. Indiana State Farm, at Putnamville, mined clay for use at its brick plant. Sand and gravel was mined at Reelsville and used for building, road construction, and fill.

Randolph.—Limestone quarries were operated near Albany by Portland Stone Corp., and near Ridgeville by H. & R. Stone Co. With the exception of a few tons of riprap, the material was crushed for use as road material and aglime. Sand and gravel was produced at a fixed plant at Lynn by Hutchens Gravel Co. for building, road use, and fill. S & L Gravel Co., Inc., produced road gravel with a portable plant.

Ripley.—About 338,000 tons of limestone was quarried near Napoleon, Osgood, and Versailles. The material was used for riprap and crushed for road and agricultural use.

Rush.—Dimension limestone was quarried and milled for use as house stone veneer at Milroy by Indiana Rubble Veneer Co. Also in the Milroy area, McCorkle Stone Co. and Rush County Stone Co. produced riprap, roadstone, railroad ballast, and aglime. Gravel was mined with portable plants at pits near Carthage, Mays, and Rushville and used for building, paving, and fill.

St. Joseph.—About 749,000 tons of sand and gravel was produced from pits near Mishawaka and South Bend, and used for building, paving, and fill. Marl was dipped from a pit near North Liberty and sold for soil improvement.

Scott.—Limstone was quarried by Scott County Stone Co., Inc., near Scottsburg and crushed for road and agricultural use. At Vienna, Airlite Processing Corp. expanded perlite, mined in Western States, for use in plaster, insulation, concrete aggregate, soil conditioning, and other purposes.

Shelby.—Limestone for flagging and house stone veneer was quarried and milled at Waldron by Blue Ridge Quar-

ries. Limestone was quarried near Morristown, St. Paul, and Waldron and used for riprap and crushed for use as fluxstone, railroad ballast, roadstone, and aglime. About 308,000 tons of sand and gravel was produced at several fixed plants in the county and sold for building use, paving, and fill.

Spencer.—Coal was produced from five strip mines. The Graham strip mine was closed in April. The C. Loran Day Coal Mining Co., Santa Claus mine, began operating in August. Sandstone was quarried at St. Meinrad's Arch Abbey. The material was fabricated at a mill in Dubois County for building use. The Hardy Sand Co., which had produced molding sand for 50 years near Richland, closed down in September.

Steuben.—Marl was dipped from three pits (Abbott, Delaney, and German) by Taylor & Son, and sold for agricultural use. Sand and gravel was produced in the Angola and Fremont areas and used principally for building, road construction, and fill.

Sullivan.—More than 2.9 million tons of coal was produced from two strip and two underground mines. The largest production was reported from Ayrshire Collieries Corp., Minnehaha strip mine and Thunderbird Collieries Corp., Thunderbird underground mine. The Pandora underground mine remained closed during the year. Limestone, for agricultural use, was quarried and crushed near Freelandville by Kixmiller Bros., Inc. Sand and gravel for building, paving, railroad ballast, and fill was produced near Carlisle, Graysville, and Sullivan.

Switzerland.—Tri-County Stone Co. quarried and crushed limestone for roadstone and agricultural use at a site 4 miles south of Cross Plains. Gravel was produced with portable plants for building and road use.

Vanderburgh.—Shale was mined near Evansville by Standard Brick & Tile Corp. The material was used in building brick manufacture. The West Franklin limestone quarry of Mulzer Bros. which was idle in 1965, was permanently abandoned.

Vermillion.—Coal was produced from the Black Diamond underground mine near Blanford. The Public Service Co. of Indiana announced plans to build a large coal-fired electric powerplant on the Wabash River near Cayuga. When in full operation, it is estimated that 3 million tons of coal will be consumed annually. The first unit is scheduled to be in service by 1970, and the second unit by 1972. Arketex Ceramic Corp. mined fire clay near Hillsdale and manufactured structural tile. Colonial Brick Corp. mined miscellaneous clay and manufactured brick at Cayuga. Sand and gravel was produced at fixed plants at Cayuga and Clinton and used for building, paving, and fill.

Vigo.—Coal was produced from one strip and one underground mine. Shale was mined at West Terre Haute by Terre Haute Vitrified Brick Works, Inc., for its own use. More than 1 million tons of sand and gravel was produced, mostly in the Terre Haute area. It was used principally for building, paving, railroad ballast, and fill.

Wabash.—A limestone quarry was operated at Wabash by Mill Creek Stone & Gravel Corp. The material was crushed and sold for road and agricultural use. Gravel was produced at sites throughout the county, mostly with portable plants. Most of the material was used for road construction and maintenance.

Warren.—Moss peat was dug from a bog near Otterbein and sold in packaged and bulk form for general soil improvement. Sand and gravel was produced from a fixed plant near Covington and by the county highway department. In addition to road construction and maintenance, the material was used for building purposes, railroad ballast, and fill.

Warrick.—Nearly 7.5 million tons of coal was mined, the largest county output in the State. Coal was produced from eight strip mines and three underground mines. The Decker and Kennedy No. 1 strip mines did not operate in 1966. The Purity underground mine of R. & K. Coal Co., Inc., was abandoned in June. The Peabody Coal Co. quarried and crushed limestone north of Boonville for its own use.

Washington.—A limestone quarry was operated near Salem by Hoosier Lime & Stone Co., Inc. The material was crushed for road and agricultural use. The county highway department mined road gravel for its own use.

Wayne.—DeBolt Concrete Co., Inc., operated Middleboro and Richmond limestone

quarries and produced material for riprap, roadstone, and aglime. About 401,000 tons of sand and gravel was produced, mostly in the Richmond area. Most of it was used for road construction and maintenance, and the remainder for building purposes and fill.

Wells.—Moss peat, used for general soil improvement, was produced for bulk sale near Warren. Erie Stone, Inc., (Irving Bros. Gravel Co., Inc.) operated the Bluffton quarry and crushing plant and produced fluxstone, roadstone, concrete aggregate, and aglime. Road gravel was produced with a portable plant by S & L Gravel Co., Inc.

White.—The Monon Crushed Stone Co., Inc., operated a limestone quarry and crushing plant near Monon and produced roadstone, railroad ballast, and aglime.

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 James H. Aase [1] and Ronald W. Michelson [2]

Iowa mineral production continued at an accelerated pace, setting a record in 1966. The total value of the State mineral production was $119.3 million, an increase of 6 percent over the 1965 figure. Value of production for all commodities increased. Nonmetals, the major commodity group, accounted for 97 percent of the State total value. The remaining 3 percent was supplied by mineral fuels.

No production of, nor exploration for, metallic minerals was recorded during the year. Oil and gas exploration activities consisted of one test hole drilled in Davis County, no production was reported.

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Table 1.—Mineral production in Iowa [1]

Mineral		1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Cement:					
Portland	thousand 376-pound barrels	13,643	$46,273	14,058	$46,736
Masonry	thousand 280-pound barrels	608	1,867	633	1,890
Clays	thousand short tons	1,085	1,347	1,130	1,438
Coal (bituminous)	do	1,043	3,694	1,025	3,783
Gypsum	do	1,254	5,554	1,285	5,577
Sand and gravel	do	18,205	17,152	19,644	18,213
Stone	do	25,891	35,468	27,729	40,081
Value of items that cannot be disclosed: Other nonmetals and peat		XX	1,428	XX	1,595
Total		XX	112,783	XX	119,313

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957–59 dollars
(Thousands)

Year	Value [1]	Year	Value [1]
1955	$70,452	1961	$93,303
1956	71,210	1962	94,812
1957	73,035	1963	96,728
1958	89,722	1964	105,102
1959	91,715	1965	112,469
1960	96,684	1966	p 117,641

p Preliminary.
[1] Data for 1955–64 revised.

Table 3.—Employment 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
1965:								
Coal and peat	270	214	58	491	---	13	26.48	756
Nonmetal	1,018	289	294	2,379	---	28	11.77	1,261
Sand and gravel	1,374	201	276	2,432	---	46	18.92	1,450
Stone	2,553	281	717	6,091	1	75	12.48	1,437
Total	5,215	258	1,345	11,393	1	162	14.31	1,374
1966: p								
Coal and peat	255	224	57	492	1	15	32.52	13,079
Nonmetal	1,065	272	290	2,338	---	53	22.67	1,630
Sand and gravel	1,405	208	292	2,592	3	49	20.06	7,506
Stone	2,455	280	687	5,905	1	98	16.77	1,573
Total	5,180	256	1,326	11,327	5	215	19.42	3,442

p Preliminary.

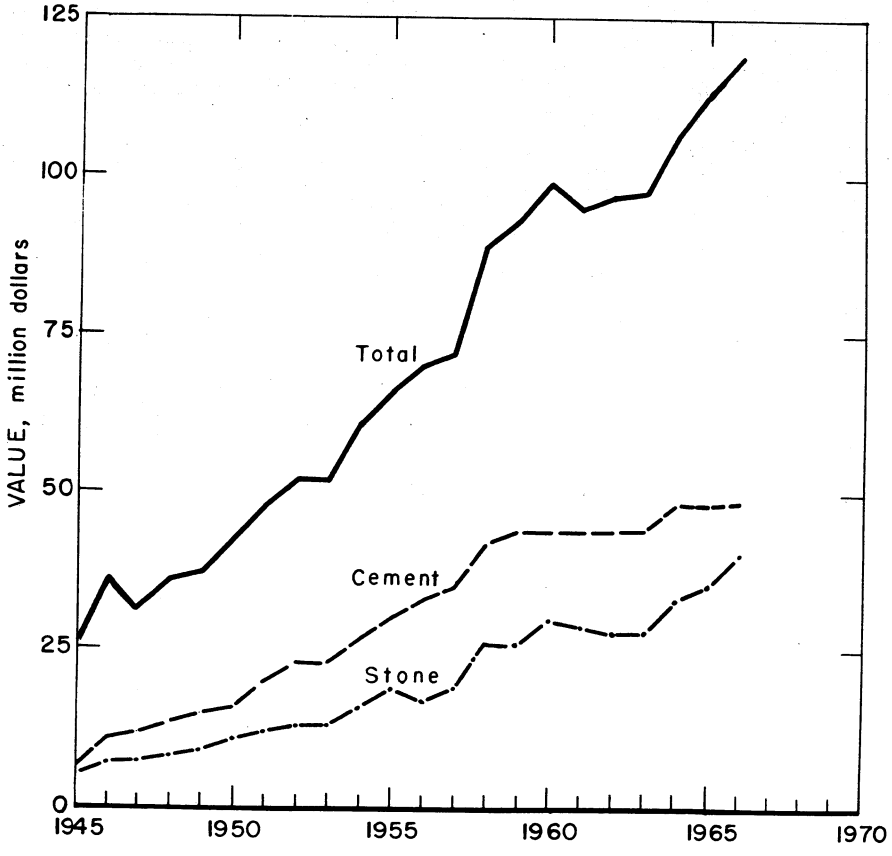

Figure 1.—Value of cement, stone, and total value of mineral production in Iowa.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—The 14 million barrels of portland cement production during the year represented approximately 89 percent of the combined capacities of the five cement plants operating 19 kilns in the State. Shipments of portland cement increased 3 percent in quantity and 1 percent in value, compared with 1965 totals. The average value per barrel decreased to $3.32 from $3.39 in 1965. Types I, II, (general-use and moderate-heat) and III (high-early-strength) cements were produced by: Lehigh Portland Cement Co. and Northwestern States Portland Cement Co. in Cerro Gordo County; Marquette Cement Manufacturing Co. and Penn-Dixie Cement Corp. in Polk County; and Dewey Portland Cement Co. Division, Martin Marietta Corp. in Scott County. Northwestern States Portland Cement Co. replaced 10 of its kilns during the year with one 594-by 16-foot kiln, reducing the number of operating kilns to 2, from 11 in 1965.

Types I and II cements accounted for 94 percent of total portland cement production, 13 percent was air-entrained and 87 percent non-air-entrained. Type III cement accounted for 6 percent of total production; 42 percent was air-entrained and 58 percent was non-air-entrained. The wet process was used in manufacturing cement in three plants, and the dry process was used in two plants. Electrical energy consumed in all plants totaled 335.9 million kilowatt-hours; 80 percent was purchased, and 20 percent was home generated. The marketing area for the portland cement was principally in Minnesota and Iowa, which received 85 percent of the total. Other States, in order of shipments, were Wisconsin, Illinois, North Dakota, South Dakota, Nebraska, and Missouri. About 52 percent of the total shipments were by rail and 48 percent by truck. Of the total shipments, 92 percent were in bulk form and the remaining 8 percent in packaged containers. Approximately 62 percent of the State shipments were to ready-mixed concrete companies, 16 percent to concrete product manufacturers, 13 percent to highway contractors, 6 percent to building material dealers, and 3 percent to other users.

Shipments of masonry cement increased 4 percent in quantity and 1 percent in value over those in 1965. The average value per 280-pound barrel, f.o.b. mill, declined to $2.99 from $3.07 in 1965, a 3-percent decrease. About 76 percent of the masonry cement marketed went to Iowa and Minnesota. Other States, in order of receipts, were Illinois, Wisconsin, North Dakota, South Dakota, Nebraska, and Missouri. All of the State cement plants except the Penn-Dixie Cement Corp. plant No. 8 in West Des Moines, Polk County, produced masonry cement.

Clays.—Clay and shale production during the year increased 4 percent in quantity and 7 percent in value over that of 1965. A total of 25 firms operated shale and clay pits in 17 counties and utilized their entire output in their own manufacturing plants.

The principal use of the State clay and shale output was for cement manufacture, accounting for 49 percent of the production, followed by 21 percent for building brick, 19 percent in other heavy clay products, and 11 percent in vitrified sewer pipe, lightweight aggregate, mortar mix, floor and wall tile, and other uses.

No fire clay was produced in the State in 1966. The sole producer in recent years, Ver Steeg Coal Co., discontinued operations in 1965.

Gypsum.—Iowa continued as one of the Nation's major producers of gypsum and gypsum products, ranking second in quantity of crude gypsum produced in 1966. State output of crude gypsum increased nearly 3 percent in quantity and slightly in value compared with 1965.

Production was from an underground mine, operated by United States Gypsum Co. in Des Moines County, and four open-pit mines, operated in Webster County by Bestwall Gypsum Division of Georgia-Pacific Corp., The Celotex Corp., National Gypsum Co., and United States Gypsum Co. All companies produced a wide variety of gypsum products, including base-coat plasters, premixed perlite plasters, gaging and molding plasters, prepared finishes, roof deck plasters, gypsum lath, wallboard, sheathing, tile, and other preformed items.

Lime.—Total production of quicklime and hydrated lime increased 8 percent in quantity and 10 percent in value over that of 1965.

Sales of lime were principally to markets in Iowa, which received 39 percent of the shipments. Other important markets, in order of shipments received, were Illinois, Indiana, and Michigan; remaining quantities were sold in surrounding States. Water purification accounted for 44 percent of the lime production, steelmaking for 24 percent, sewage treatment for 13 percent, and construction, paper and pulp manufacture, and sugar refining for 19 percent.

American Crystal Sugar Co. produced quicklime for internal use in sugar refining at its Mason City plant in Cerro Gordo County. Purchased limestone was burned in a shaft kiln using coke as fuel.

The sole commercial producer of quicklime and hydrated lime in the State was Linwood Stone Products Co., Inc. The company operated three rotary kilns at its plant near Buffalo, in Scott County, burning high-calcium limestone mined at its nearby quarry. The kilns used coal and natural gas as fuel.

Perlite.—Gypsum producers in Webster County expanded crude perlite, mined outside the State, at their plants. The expanded perlite was used in manufacturing lightweight building plaster.

Sand and Gravel.—Sand and gravel production increased 8 percent in quantity and 6 percent in value compared with 1965 figure. Production was reported in 79 counties from 261 commercial operations and 71 Government-and-contractor operations. The overall average unit value for sand and gravel decreased to $0.93 per ton from $0.94 in 1965. Trucks were used in handling 97 percent of the shipments; the remainder were by rail and water.

Production for building use increased 12 percent and that for paving use, 9 percent. These two uses accounted for 91 percent of the total sand and gravel produced in the State, followed by 7 percent for fill and 2 percent for other uses.

Major producers of sand and gravel in the State during the year follow:

Acme Fuel & Material Co. (W. G. Block Co.)
Concrete Materials Division, Martin Marietta Corp.
G. A. Finley, Inc.
Hallett Construction Co.
Keefner-White Materials Corp.
Ronald Kenyon Construction Co.
Maudlin Construction Co.
Peters Construction Co.
Stevens Sand & Gravel Co., Inc.
Welp & McCarten, Inc.

Stone.—Production of stone, consisting entirely of limestone, increased 7 percent in quantity and 13 percent in value over that of 1965. The largest single increase in use of stone was for agricultural purposes.

Limestone was produced in 64 of the State's 99 counties from 239 commercial operations and 5 government operations.

The average unit value of crushed and broken stone was $1.44 per ton, a 6-percent increase from $1.36 per ton in 1965.

Production of dimension limestone decreased 29 percent in quantity but increased 9 percent in value compared with 1965 figures.

The State total stone output was used principally in concrete aggregate and roadstone, accounting for 71 percent of the production, followed by 13 percent for cement manufacturing and 16 percent for agricultural purposes and other uses.

The five leading limestone-producing counties, listed in descending order of production, were Madison, Scott, Linn, Cerro Gordo, and Humboldt.

The five largest producers of crushed and broken limestone during the year follow:

Concrete Materials Division, Martin Marietta Corp.
Dewey Portland Cement Co. Division, Martin Marietta Corp.
Kaser Construction Co.
The River Products Co.
Weaver Construction Co.

MINERAL FUELS

Coal (Bituminous).—Coal production increased 2 percent in value, but decreased 2 percent in quantity, compared with the 1965 figures. Average value per ton increased to $3.69 from $3.54 in 1965.

The only new mine opening during the year was the Jude Coal Co., Inc., strip mine in Mahaska County. Mine closings reported in 1966 included one each by Clarke Coal Co., D. C. Coal Co., New

Table 4.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	2,609	$2,559	3,054	$2,899
Paving	2,470	2,446	2,715	2,659
Railroad ballast	---	---	4	2
Fill	1,064	632	1,112	721
Other [1]	262	635	204	532
Total	6,405	6,272	7,089	6,813
Gravel:				
Building	1,257	2,043	1,278	2,213
Paving	6,149	6,071	7,032	6,524
Railroad ballast	W	W	69	46
Fill	498	330	336	198
Other [2]	70	94	32	41
Total	7,974	8,538	8,747	9,022
Total sand and gravel	14,379	14,810	15,836	15,835
Government-and-contractor operations:				
Sand:				
Paving	474	248	98	51
Fill	22	8	15	5
Other	---	---	2	1
Total	496	256	115	57
Gravel:				
Building	15	8	---	---
Paving	3,315	2,078	3,680	2,317
Other	---	---	13	4
Total	3,330	2,086	3,693	2,321
Total sand and gravel	3,826	2,342	3,808	2,378
All operations:				
Sand	6,901	6,528	7,204	6,870
Gravel	11,304	10,624	12,440	11,343
Grand total	18,205	17,152	19,644	18,213

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes blast, molding, and other construction sand.
[2] Includes railroad ballast (1965) and other construction gravel.

Table 5.—Limestone sold or used by producers, by uses

Use	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough construction, thousand short tons	8	$18	---	---
Rubble, do.	1	10	3	$28
Sawed stone, thousand cubic feet	4	15	2	10
House stone veneer, do.	14	37	24	61
Cut stone, do.	72	119	73	116
Flagging, do.	2	4	4	5
Total, approximate thousand short tons [1]	17	203	12	220
Crushed and broken:				
Riprap, thousand short tons	450	575	991	1,436
Concrete aggregate and roadstone, do.	19,622	26,283	19,746	27,899
Agriculture, do.	1,848	2,861	2,857	4,831
Railroad ballast, do.	144	128	164	156
Cement, do.	3,359	4,001	3,628	4,232
Other [2], do.	451	1,417	331	1,308
Total, do.	25,874	[3] 35,266	27,717	[3] 39,861
Grand total, do.	25,891	[3] 35,468	27,729	[3] 40,081

[1] Average weight of 170 pounds per cubic foot used to convert cubic feet to short tons.
[2] Includes limestone for asphalt filler, fertilizer, flux, lime, mineral food, and other purposes.
[3] Data do not add to total shown because of rounding.

Block Coal Co., Appanoose Coal Co., and L. & M. Coal Co. in Appanoose County; Angus Coal & Hauling Co. in Mahaska County; Hopkins Coal Co. and Jude Coal Co., Inc., in Mariion County; New Lanning Coal Co., Inc., and South Iowa Coal Co. in Wapello County; and Silvers Coal Co. and Lundy & Sons Coal Co. in Keokuk County.

Approximately 74 percent of the coal production from the State's 8 underground and 15 strip mine operations was used in electric powerplants. Of the total State production, nearly 70 percent was shipped to consumers by rail, and the remainder by truck.

Coal seams mined in underground operations during the year ranged in thickness from 32 to 68 inches. Thickness of the coal seams mined in strip mine operations ranged from 36 to 60 inches, and overburden thickness reported ranged from 20 to 70 feet. No mechanical cleaning plants were operated in the State during 1966.

Peat.—Peat production increased in quantity and value in 1966. The Colby Pioneer Peat Co. and Eli Colby Co. mined peat from deposits in Worth and Winnebago Counties, respectively. Processing plants were operated by both firms in Hanlontown.

Petroleum and Natural Gas.—No production of petroleum or natural gas was reported in the State. According to the Iowa Geological Survey, exploration activities consisted of the drilling of one exploratory test well in Davis County.

Table 6.—Coal (bituminous) production in 1966, by counties
(Excludes mines producing less than 1,000 short tons)

County	Number of mines operated		Production (short tons)			Value
	Underground	Strip	Underground	Strip	Total	
Appanoose	5	---	14,781	---	14,781	$101,240
Lucas	1	---	81,756	---	81,756	346,576
Mahaska	---	7	---	339,492	339,492	1,231,736
Marion	1	6	2,714	403,767	406,481	1,471,651
Monroe	1	---	164,691	---	164,691	552,000
Van Buren	---	1	---	16,121	16,121	72,755
Wapello	---	1	---	1,942	1,942	6,603
Total	8	15	263,942	761,322	1,025,264	3,782,561

REVIEW BY COUNTIES

Adair.—Limestone was produced by Schildberg Construction Co., Inc., at three quarries near Greenfield. Production was principally for highway construction, agricultural limestone (aglime), and riprap.

Appanoose.—Limestone for road construction and aglime was produced by Beryl Farnsworth from a stationary plant near Cincinnati and by L. & W. Construction Co., Inc., and Porter & Magnall Construction Co., Inc., from portable plants near Centerville.

The Carter-Waters Corp. produced lightweight aggregate from expanded shale at its plant near Centerville. The Adel Clay Products Co. mined clay near Centerville for manufacturing building brick and other heavy clay products.

Bituminous coal was produced from five underground mines. Four were operated near Centerville by Clarke Coal Co., D. C. Coal Co., New Block Coal Co., and the No. 4 Coal Co. The other was operated by New Gladstone Coal Co. near Numa. Clarke Coal Co., D. C. Coal Co., and New Block Coal Co. all discontinued operations in the year. L. & M. Coal Co., which operated the only strip mine in the county in 1965, and Appanoose Coal Co., which operated an underground mine, ceased mining operations in late 1965.

Paving gravel was produced by Ewing Gravel Pit, near Cincinnati.

Black Hawk.—Crushed limestone was produced from quarries near Janesville, La Porte City, and Waterloo by Concrete Materials Division, Martin Marietta Corp. and from a quarry near Raymond by DeWees Potthoff Stone Co. Output was used principally for road construction and aglime.

Sand and gravel was produced by seven companies from six stationary plants and

Table 7.—Value of mineral production in Iowa, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Adair	W	W	Stone.
Adams	W	W	Do.
Allamakee	W	W	Stone, sand and gravel.
Appanoose	$868,288	$650,639	Stone, clays, coal, sand and gravel.
Audubon	336,000	152,000	Sand and gravel.
Benton	W	W	Sand and gravel, stone, clays.
Black Hawk	1,410,082	1,702,347	Stone, sand and gravel.
Boone	W	W	Sand and gravel, clays.
Bremer	W	W	Stone, sand and gravel.
Buchanan	304,044	346,537	Stone.
Buena Vista	211,000	308,000	Sand and gravel.
Butler	381,968	426,487	Stone, sand and gravel.
Calhoun	47,000	32,000	Sand and gravel.
Carroll	130,000	201,000	Do.
Cass	W	W	Stone.
Cedar	W	W	Do.
Cerro Gordo	28,293,014	26,200,513	Cement, stone, clays, sand and gravel, lime.
Cherokee	336,000	324,000	Sand and gravel.
Chickasaw	W	131,775	Stone, sand and gravel.
Clarke	W	W	Stone.
Clay	208,000	135,000	Sand and gravel.
Clayton	693,227	723,044	Sand and gravel, stone.
Clinton	582,102	W	Stone, sand and gravel.
Crawford	W	W	Sand and gravel.
Dallas	547,236	1,770,255	Sand and gravel, stone, clays.
Decatur	739,316	679,746	Stone.
Delaware	324,281	327,053	Stone, sand and gravel.
Des Moines	1,909,600	2,134,574	Gypsum, stone, sand and gravel.
Dickinson	168,000	166,000	Sand and gravel.
Dubuque	626,513	683,457	Stone, sand and gravel.
Emmet	310,000	269,000	Sand and gravel.
Fayette	726,642	716,511	Stone, sand and gravel.
Floyd	267,503	363,934	Stone, sand and gravel, clays.
Franklin	310,881	317,438	Sand and gravel, stone, clays.
Fremont	W	2,000	Sand and gravel.
Greene	292,000	W	Do.
Grundy	W	135,147	Stone, sand and gravel.
Guthrie	W	W	Sand and gravel.
Hamilton	113,783	W	Sand and gravel, stone.
Hancock	406,755	406,934	Stone, sand and gravel.
Hardin	1,428,811	1,482,373	Do.
Harrison	W	1,292,072	Do.
Henry	W	W	Do.
Howard	W	219,392	Do.
Humboldt	994,442	1,310,955	Do.
Ida	10,000	20,000	Sand and gravel.
Iowa	W	W	Do.
Jackson	310,189	406,282	Stone, sand and gravel.
Jasper	512,732	W	Sand and gravel, stone.
Jefferson	W	W	Stone, sand and gravel.
Johnson	1,287,590	1,457,155	Do.
Jones	439,186	539,209	Do.
Keokuk	W	W	Stone, clays.
Kossuth	271,000	365,000	Sand and gravel.
Lee	383,199	W	Stone, sand and gravel.
Linn	2,714,831	2,754,116	Do.
Louisa	W	W	Stone.
Lucas	248,645	346,576	Coal.
Lyon	W	224,000	Sand and gravel.
Madison	3,159,307	3,615,011	Stone, clays.
Mahaska	1,537,083	1,601,099	Coal, stone, sand and gravel, clays.
Marion	2,543,155	2,740,729	Coal, stone, sand and gravel.
Marshall	W	W	Stone, sand and gravel.
Mills	W	W	Do.
Mitchell	489,855	W	Do.
Monona	W	W	Sand and gravel.
Monroe	356,000	552,000	Coal.
Montgomery	W	W	Stone.
Muscatine	1,010,000	1,111,468	Sand and gravel, stone.
O'Brien	171,000	132,000	Sand and gravel.
Osceola	212,000	251,000	Do.
Page	W	W	Stone, sand and gravel.
Palo Alto	87,000	W	Sand and gravel.
Plymouth	270,000	574,000	Do.
Pocahontas	W	W	Stone, sand and gravel.
Polk	15,572,331	17,264,121	Cement, sand and gravel, clays.
Pottawattamie	W	W	Stone, sand and gravel.
Poweshiek	W	W	Stone.
Sac	511,000	665,000	Sand and gravel.
Scott	13,393,895	14,992,308	Cement, stone, lime, clays, sand and gravel.

See footnotes at end of table.

Table 7.—Value of mineral production in Iowa, by counties [1]—Continued

County	1965	1966	Minerals produced in 1966 in order of value
Shelby	$ 461,000	$ 565,000	Sand and gravel.
Sioux	540,000	603,000	Do.
Story	W	1,121,415	Sand and gravel, stone, clays.
Tama	198,639	W	Stone, sand and gravel.
Taylor	W	W	Stone.
Union	W	W	Do.
Van Buren	705,776	802,301	Stone, coal, sand and gravel.
Wapello	632,487	523,271	Stone, sand and gravel, clays, coal.
Warren	W	82,847	Sand and gravel, clays.
Washington	W	W	Stone.
Webster	5,154,968	5,474,157	Gypsum, stone, clays, sand and gravel.
Winnebago	W	W	Sand and gravel, peat.
Winneshiek	313,987	439,596	Stone, sand and gravel.
Woodbury	257,000	224,632	Sand and gravel, clays.
Worth	322,752	W	Stone, peat, sand and gravel.
Wright	185,000	171,000	Sand and gravel.
Undistributed [2]	15,554,905	16,084,524	
Total	112,783,000	119,313,000	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Davis, Ringgold, and Wayne Counties are not listed because no production was reported.
[2] Includes some sand and gravel and stone that cannot be assigned to specific counties and values indicated by symbol W.

one portable plant near Cedar Falls, Dunkerton, La Porte City, and Waterloo and also by the City of Waterloo. Total output of 453,000 tons was used for building and road construction, railroad ballast, fill, and other purposes.

Cass.—Limestone was produced for concrete aggregate, roadstone, aglime, and riprap by Schildberg Construction Co., Inc., from two quarries near Atlantic.

Cerro Gordo.—Ranking first, the county produced over 21 percent of the State total mineral value. The major commodities, portland and masonry cements, were produced by Lehigh Portland Cement Co. and Northwestern States Portland Cement Co. at their plants near Mason City. Both companies also operated limestone quarries and clay pits, producing raw material for manufacturing cement. Northwestern States Portland Cement Co. completed installation of a new 594-foot-long, dry-process cement kiln at its plant. This kiln, along with an older 390-foot kiln, is operating under complete computer process control.

Mason City Brick & Tile Co. produced clay and shale for the manufacture of building brick and other heavy clay products near Mason City.

Limestone was also produced for concrete, roadstone, and aglime by Grupp Construction Co., Green Limestone Co., Ideal Sand & Gravel Co., and Weaver Construction Co. Quarries were operated near Portland, Swaledale, and Mason City, respectively.

American Crystal Sugar Co. produced lime for use at its sugar plant in Mason City.

Approximately 254,000 tons of sand and gravel was produced by five companies, operating plants near Clear Lake, Fertile, Mason City, Portland, and Swaledale, and by the Cerro Gordo County Highway Department. The material was used for building, paving, fill, and other purposes.

Clayton.—Sand was mined from a friable sandstone deposit near Clayton by Concrete Materials Division, Martin Marietta Corp. for use as molding sand. Sand produced by Enno Burrack, H. Leslie Leas Co., Roverud Construction Co., and Swales Concrete Products near Elkader and Strawberry Point was used for paving and other purposes.

Enno Burrack, Harold Hartman, Kuhlman Construction Co., H. Leslie Leas Co., and Paul Niemann Construction Co. produced 204,000 tons of limestone from 15 quarries. The material was used for road construction and aglime.

Clinton.—Limestone was produced at 11 quarries operated by Lowe & Eschman Construction Co. at various locations throughout the county, and at a quarry near Grand Mound by the Techau Limestone Co. The material was produced principally for roadbuilding and aglime.

Sand and gravel was produced at one stationary plant operated by Acme Aggregates (Acme Fuel & Material Co.) near Clinton and at two portable plants operat-

ed by Bandixen Gravel Pit near Camanche and Lowe & Eschman Construction Co. near DeWitt. Output was for building, road construction, and fill.

Dallas.—Limestone was produced by Gendler Stone Products Co. at a portable plant near Dexter, for roadbuilding and aglime.

Adel Sand & Gravel Co., Booneville Gravel Co., K. H. Buttler, Hallett Construction Co., Ronald Kenyon Construction Co., and Perry Sand & Gravel Co. produced approximately 1 million tons of sand and gravel from 11 plants. The material was used for building, road construction, railroad ballast, and fill.

Adel Clay Products Co., Redfield Brick & Tile Co., and United Brick & Tile Co. of Iowa produced clay and shale and used the material for manufacturing building brick and other heavy clay products.

Decatur.—Limestone was produced by Grand River Quarries, Inc., Jackson Quarries, Inc., and E. I. Sargent Quarries, Inc., for use principally in roadbuilding and aglime. Quarries were operated near Davis City, Decatur, Grand River, and Weldon.

Des Moines.—Limestone was produced by Kaser Construction Co., operating a stationary plant near Mediapolis, and by Raid Quarries, Inc., operating portable plants in quarries near Burlington, Danville, Mediapolis, and Oakville. The material was used principally for road construction, aglime, and riprap.

United States Gypsum Co. produced gypsum from an underground mine near Sperry and processed the material at its plant at the same location.

Sand and gravel was produced by Spring Sand & Gravel Co. at a stationary plant near Burlington for use in building construction, paving, and fill.

Dubuque.—Sand and gravel was produced by Molo Sand & Gravel Co. near Dubuque for building, road construction, and other uses.

Wm. Becker & Sons Stone Co. produced limestone from a stationary plant near Dubuque for architectural purposes, rough construction, and riprap. Crushed limestone for road construction, railroad ballast, and aglime was produced near Dubuque by Beecher West Dubuque Quarry, Dubuque Stone Products Co. (Spahn & Rose Lumber Co.), and L. A. Light, Inc. The county highway department produced and contracted for limestone for use in road construction.

Fayette.—Five companies produced about 73,000 tons of sand and gravel from seven plants near Alpha, Clermont, Eldorado, Fayette, Randalia, and West Union.

Limestone for roadbuilding and aglime was produced by Fayette Stone Co., Inc., Paul Niemann Construction Co., and the county highway department.

Hardin.—About 353,000 tons of sand and gravel, principally for road construction and fill, was produced by five companies at two stationary and nine portable plants near Alden, Eldora, Gifford, Hubbard, Iowa Falls, and New Providence.

The Iowa Limestone Co. and Weaver Construction Co. produced limestone from quarries near Alden. The material was used principally for roadbuilding, aglime, and various fillers.

Harrison.—Clark Limestone Co. and W. A. Schemmer Limestone Quarry, Inc., from stationary plants near Logan produced limestone for road construction, aglime, riprap, and rubble.

Sand and gravel was produced by three companies operating seven plants near Logan, Little Sioux, Pisgah, and Woodbine. Production was principally for road construction.

Humboldt.—Nearly 1.1 million tons of limestone was produced by Hallett Construction Co., P & M Stone Co., Inc., and Welp & McCarten, Inc., at portable and stationary plants near Bradgate, Dakota City, Gilmore City, and Humboldt. The material was used for concrete, roadstone, railroad ballast, aglime, and riprap.

Approximately 152,000 tons of sand and gravel was produced for buidling construction, paving, and other purposes. Humboldt Concrete Products Division (Zeidlers, Inc.), Midwest Limestone Co., Inc., and Welp & McCarten, Inc., produced sand and gravel from plants near Bradgate, Gilmore City, and Humboldt.

Johnson.—Limestone was produced by Concrete Materials Division, Martin Marietta Corp. from two quarries near Fairfax and Iowa City, and by The River Products Co. from a stationary plant near Coralville. Production was used principally for road building and aglime.

The River Products Co. and Stevens Sand & Gravel Co., Inc., produced sand and gravel from dredging operations near

Iowa City for use in building and road construction and fill.

Jones.—Nearly 270,000 tons of limestone was produced by three companies, operating seven quarries near Monticello, Olin, Scotch Grove, and Stone City.

About 39,000 tons of sand and gravel was produced for concrete aggregate and road material by Eganhouse Sand & Gravel, Jensen Ready Mix, and Serbousek Sand & Gravel, operating two stationary plants and one portable plant, respectively. Plants were located near Wyoming, Olin, and Monticello.

Keokuk.—Kaser Construction Co. produced limestone from three quarries near Harper, Keswick, and Ollie for concrete, roadstone, and aglime.

Oskaloosa Clay Products Co. and Silver Leaf Pipe Plant produced clay for the manufacture of building brick and vitrified sewer pipe, respectively. Both operations were near the town of What Cheer.

No coal was produced in the county in 1966. Strip mines formerly operated by Lundy & Sons Coal Co. and Silvers Coal Co. were closed.

Linn.—Over 1.7 million tons of limestone was produced by B. L. Anderson, Inc., Concrete Materials Division, Martin Marietta Corp., Lee Crawford Quarry Co., DeWees Potthoff Stone Co., and G. W. Gaines & Son. The companies operated portable and stationary plants near Cedar Rapids, Center Point, Central City, Marion, Mt. Vernon, Robins, and Springville. The material was used for concrete, roadstone, riprap, and agricultural purposes.

Approximately 473,000 tons of sand and gravel was produced from one portable and four stationary plants located near Cedar Rapids, Marion, and Mt. Vernon, operated by B. L. Anderson, Inc., Concrete Materials Division, Martin Marietta Corp., DeWees Potthoff Stone Co., King's Concrete Co., and Frank J. Meyer Sand & Gravel. Production was principally for building, paving, and fill.

Lucas.—Big Ben Coal Co. produced about 82,000 tons of bituminous coal from an underground mine near Chariton.

Madison.—Six companies and the county highway department produced over 2.2 million tons of limestone from portable and stationary plants operating in quarries near Earlham, Greenfield, Peru, and Winterset. Marquette Cement Manufacturing Co. and Penn-Dixie Cement Corp. were the principal producers, using the output in their Polk County cement plants. Substantial tonnages of crushed limestone was also produced for roadbuilding and aglime.

Marquette Cement Manufacturing Co. mined shale near Earlham for use in its cement plant.

Mahaska.—Six companies produced over 339,000 tons of bituminous coal from strip operations near Bussey, Oskaloosa, and Pella. Operators were Angus Coal & Hauling Co., Jude Coal Co., Inc., Lost Creek Coal Co., Mich Coal Co., New Lanning Coal Co., Inc., and Star Coal Co. Angus Coal & Hauling Co. discontinued operations, but Jude Coal Co., Inc., initiated its operations in the county during the year.

Clay was mined by Oskaloosa Clay Products Co. for use in manufacturing building brick.

Concrete Materials Division, Martin Marietta Corp. produced sand and gravel from a stationary plant near Eddyville for use in building and road construction.

Crushed limestone for road and agricultural purposes was produced by Kaser Construction Co. from its portable plant near Oskaloosa.

Marion.—Over 406,000 tons of bituminous coal was produced by six companies. Walter Coal Co. operated an underground mine near Bussey, and Beard Coal Co., Hopkins Coal Co., Jude Coal Co., Inc., Otley Coal Co., and Weldon Coal Co. produced from strip mines near Bussey, Hamilton, Knoxville, Melcher, and Pella. Otley Coal Co. acquired the mine formerly operated by Newton Coal Co. Hopkins Coal Co. and Jude Coal Co., Inc., discontinued operations in the county during the year.

Durham Quarry, Inc., C. D. Hess & Son Rock Materials Co., and Pella Limestone Co. produced crushed limestone from stationary and portable plants in quarries located near Harvey, Melcher, and Pella. The material was used chiefly for roadbuilding and aglime.

About 281,000 tons of sand and gravel for building, road construction, fill, and other uses was produced from plants near Knoxville, Pella, and Harvey by Knoxville Sand & Gravel, Pella Construction Co., Ltd., and Riggen Bros., respectively, and by the county highway department.

No fire clay was produced in the county, Ver Steeg Coal Co. having closed its operation in 1965.

Marshall.—Crushed limestone for roadbuilding and aglime, was produced by Concrete Materials Division, Martin Marietta Corp. from a stationary plant near Ferguson.

Concrete Materials Division, Martin Marietta Corp. and Hallett Construction Co. produced sand and gravel from stationary plants near Marshalltown and Clemons for building construction, paving, and fill.

Mitchell.—L. R. Falk Construction Co., Grupp Construction Co., and Kollman Quarries, Inc., produced limestone from portable plants located at quarries near Graston, Little Cedar, New Haven, Osage, and St. Ansgar. Production was principally for concrete, roadstone, and aglime.

Sand and gravel for building, road construction, and fill was produced by L. R. Falk Construction Co. from portable plants near Little Cedar, Mitchell, Osage, and St. Ansgar, and by Seeber & Wetter from a stationary plant near Osage.

Monroe.—Lovilia Coal Co., the only mining operation in the county, produced about 165,000 tons of bituminous coal from its No. 4 underground mine near Melrose.

Muscatine.—A total of 550,000 tons of sand and gravel was produced by Acme Fuel & Material Co. (W. G. Block Co.), Hahn Brothers Sand & Gravel Co., and Northern Gravel Co. from stationary plants near Muscatine and by Harold F. Storm and Wending Quarries, Inc., from portable plants near Lone Tree and Moscow.

Crushed and broken limestone was produced by Wendling Quarries, Inc., from a stationary plant near Atalissa for concrete, roadstone, aglime, and riprap.

Plymouth.—Higman Sand & Gravel Co. and Maudlin Construction Co. produced sand and gravel from plants near Akron and Kingsley, respectively. The principal use was for road construction and maintenance.

Pocahontas.—Crushed limestone was produced by Midwest Limestone Co., Inc., and Welp & McCarten, Inc., from quarries near Gilmore City. The material was principally for road construction, concrete, and agricultural purposes.

Polk.—The county ranked second in the State in value of minerals produced with over 14 percent of the State value.

Marquette Cement Manufacturing Co. and Penn-Dixie Cement Corp. produced portland cement at plants in Des Moines and West Des Moines. The former company also produced masonry cement.

Clay and shale was produced by Des Moines Clay Co. and Iowa Clay Pipe Co. at plants near Des Moines for use in manufacturing building brick and vitrified sewer pipe.

Nearly 2.5 million tons of sand and gravel was produced by seven companies operating portable and stationary plants in the Des Moines area.

Pottawattamie.—Schildberg Rock Products Co., Inc. (Missouri Valley Limestone Co.) produced crushed and broken limestone from portable plants operating near Council Bluffs and Macedonia. The material was used principally for roadbuilding, aglime, and riprap.

G. A. Finley, Inc., operated a portable plant near Oakland and produced 23,000 tons of sand and gravel for building, road construction, and other uses.

Poweshiek.—Limestone was produced at a portable plant operated by Kaser Construction Co. near New Sharon and at a stationary plant operated by Malcom Stone Co. near Malcom. Production was principally for roadbuilding and aglime.

Sac.—Approximately 575,000 tons of sand and gravel was produced by six companies operating portable and stationary plants near Auburn, Early, Lake View, and Sac City. The material was produced primarily for building, road construction, and railroad ballast. The Ida and Sac County Highway Departments contracted for 138,000 tons of gravel for road construction and maintenance.

Scott.—The value of Scott County mineral production ranked third in the State, comprising over 12 percent of the total State value.

Dewey Portland Cement Co. Division, Martin Marietta Corp. produced portland and masonry cements near Davenport.

Lime was produced by Linwood Stone Products Co., Inc., near Buffalo.

Sand and gravel was produced by Builders Sand & Gravel Co. and Le Claire Quarries, Inc., from dredging operations near Princeton and Le Claire, respectively.

Clay and limestone were produced by Dewey Portland Cement Co. Division, Mar-

tin Marietta Corp. for use in cement manufacturing at its plant near Davenport.

Crushed limestone was also produced by Le Claire Quarries, Inc., Linwood Stone Products Co., Inc., and Weaver Construction Co. at plants near Le Claire, Davenport, and McCausland, respectively.

Shelby.—Approximately 354,000 tons of sand and gravel was produced from a stationary plant near Corley by G. A. Finley, Inc. The material was used for building, road construction, and other purposes.

Sioux.—Six companies and the county highway department produced about 700,000 tons of sand and gravel for building, paving, and fill. Stationary and portable plants were operated near Boyden, Chatsworth, Hawarden, Ireton, and Rock Valley.

Story.—Sand and gravel was produced by Ray Cook Construction Co., Inc., Hallett Construction Co., and Maudlin Construction Co. from portable and stationary plants near Ames and Maxwell. The material was principally for building and road construction and fill.

Clay was produced by Nevada Brick & Tile Co. from a pit near their plant at Nevada for use in manufacturing draintile.

Ray Cook Construction Co., Inc., and Weaver Construction Co. produced limestone from a stationary plant near Ames and a portable plant near Roland, respectively. Production was chiefly for road construction and aglime.

Van Buren.—Over 16,000 tons of bituminous coal was produced from a strip mine operated near Eldon by Laddsdale Coal Co., Inc.

Limestone was produced from an underground mine near Douds by Douds Stone, Inc., and from open quarries operated by Kaser Construction Co. and Triangle Quarries, Inc., near Selma and Farmington, respectively. The material was used for road construction, railroad ballast, and aglime. The county highway department produced limestone for road use.

Valley Limestone & Gravel, Inc., produced sand and gravel from a stationary plant near Farmington for use in building and paving.

Wapello.—South Iowa Coal Co. produced about 1,900 tons of bituminous coal from a strip operation near Eddyville. The company discontinued its operation in the county during the year.

Clay was produced by Ottumwa Brick & Tile Co. for the manufacture of building brick and floor and wall tile.

Douds Stone, Inc., produced crushed limestone for road construction and aglime from a stationary plant near Ottumwa.

Sand and gravel was produced by Concrete Materials Division, Martin Marietta Corp. from a portable plant near Ottumwa and by a new operator, Materials Service, Inc., from a stationary plant near Ottumwa. Output was for building and road construction.

Washington.—Limestone was produced by Kaser Construction Co. and The River Products Co. from portable plants at quarries near Keota, Washington, and West Chester. Production was used principally for concrete, road construction, and aglime.

Webster.—Gypsum was mined by open pit methods near Fort Dodge by The Celotex Corp., Bestwall Gypsum Division of Georgia-Pacific Corp., National Gypsum Co., and United States Gypsum Co. Processing and fabricating facilities were operated by each company.

Sand and gravel was produced by Scheideman Sand & Gravel and from eight portable plants operated by Welp & McCarten, Inc., near Clare, Coalville, Duncombe, Fort Dodge, and Lehigh. Sand and gravel was produced under contract for the Calhoun County Highway Department and the city of Fort Dodge. The Webster County Highway Department also produced 14,000 tons of paving gravel.

Clay was produced by Fort Dodge Brick & Tile Co. (formerly Johnston Clay Works, Inc.), Kalo Brick & Tile Co., and Vincent Clay Products Co. for the manufacture of building brick, draintile, and other heavy clay products.

Fort Dodge Limestone Co., Inc., produced limestone from an underground mine near Fort Dodge for road construction and aglime. Northwest Limestone Co., Inc., also produced limestone for road construction from a stationary plant at a quarry near Fort Dodge.

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 Joseph C. Arundale,[1] A. L. Hornbaker,[2] Margaret O. Oros,[2] and R. G. Hardy [2]

For the sixth consecutive year, the value of mineral output in Kansas increased and reached a new record high—$568 million. Principal mineral commodities produced in order of value were petroleum, natural gas, natural gas liquids, helium, cement, and stone. Mineral fuels and related products comprised 87.4 percent of the total mineral value, nonmetals 12.3 percent, and metals 0.3 percent.

Crude oil output decreased slightly from 1965 levels despite increased allowables, higher prices, and relaxed restrictions on exploration. Oil well drilling activity in the State dropped below that in any recent year, with development drilling accounting for all of the decline. The number of exploratory wells increased. Success ratios improved in both categories of drilling.

Much of the oil industry drilling in 1966 was again in the Central Uplift area. About one-fourth of the State's wildcats in 1966 were drilled in six counties—Barton, Ellis, Graham, Rooks, Russell, and Stafford.

An estimated 1,139 secondary recovery and pressure maintenance projects in 70 counties had State approval for operation in 1966.

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Table 1.—Mineral production in Kansas [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Portland cement—thousand 376-pound barrels	8,801	$26,972	8,979	$27,246
Masonry cement—thousand 280-pound barrels	404	1,178	395	1,151
Clays—thousand short tons	789	953	847	1,006
Coal—do	1,310	6,072	1,122	5,355
Helium: Grade A—thousand cubic feet	19,763	904	75,500	1,885
Crude—do	2,551,026	29,518	2,624,200	30,951
Lead (recoverable content of ores, etc.)—short tons	1,644	513	1,109	335
Natural gas—million cubic feet	793,379	105,519	847,495	114,412
Natural gas liquids:				
Natural gasoline—thousand gallons	153,485	7,791	175,053	9,399
LP gases—do	587,416	22,322	664,164	25,902
Petroleum (crude)—thousand 42-gallon barrels	104,733	305,820	103,738	306,027
Salt [2]—thousand short tons	1,053	12,376	969	13,388
Sand and gravel—do	12,544	8,473	11,627	8,374
Stone—do	15,270	20,538	14,027	18,789
Zinc (recoverable content of ores, etc.)—short tons	6,508	1,900	4,769	1,383
Value of items that cannot be disclosed: Natural cement, gypsum, pumice, and salt (brine)	XX	2,642	XX	2,789
Total	XX	553,491	XX	568,392

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes salt in brine included with "Value of items that cannot be disclosed."

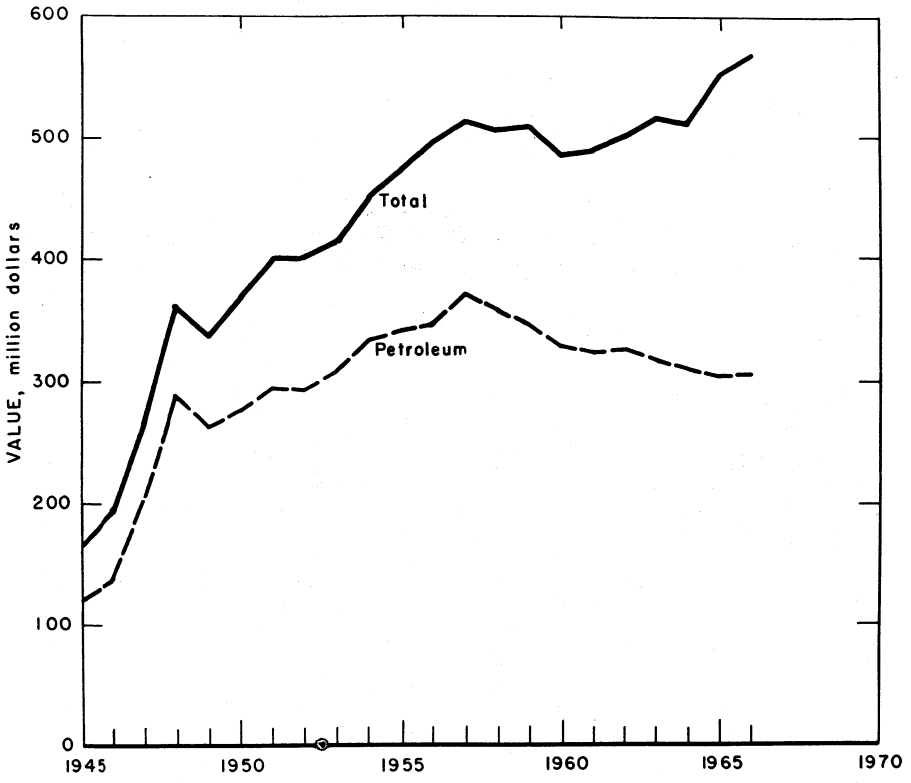

Figure 1.—Value of petroleum, and total value of mineral production in Kansas.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]
1957	508,785
1958	506,198
1959	516,678
1960	486,415
1961	485,341
1962	493,899
1963	512,526
1964	536,444
1965	550,115
1966	[p] 554,442

[p] Preliminary.
[1] 1957–65 figures revised.

Refinery capacity continued to increase along with the demand for crude oil. With the Kansas output declining and refinery demands rising, increased quantities of crude oil were shipped in from other States.

Natural gas, which has a better reserve-to-production ratio and a better discovery rate than oil in Kansas, responded better to increased demand and higher prices. Production of natural gas reached a record level, accounting for corresponding gains in helium, natural gasoline, and liquefied petroleum (LP) gas products.

Helium extraction from natural gas in Kansas has increased steadily in the past several years because of the Federal Government's conservation program and increasing demand by commercial users. The Government conservation program allowed storing only crude helium; private industry was expanding production for the increasing needs of refined helium.

The Kansas Geological Survey proposed expanded activities for the future.[3] As part of a national program sponsored by the American Association of Petroleum Geolo-

[3] Hambleton, W. W. New Dimensions for Mineral Resources Studies. Kansas Geol. Survey, Lawrence, Kans., paper pres. at AIME Ann. Meeting, New York, Mar. 1, 1966.

gists, the Kansas Geological Survey was collaborating with a number of groups in developing computer files of oil well information, to cover all exploration and development wells. Information was to be put on a standard form and sent to Oklahoma City for key punching and entering onto magnetic tape. The information included location, formation top elevations, and certain production and test data.

The oil discovery bill, passed by the Kansas Legislature in 1965, was amended to increase the number of development wells affected and the time for which bonus production allowables could be granted.

In 1966, Kansas oil groups were again considering the advisability of unitization and pooling legislation. A bill was being prepared to empower the Kansas Corporation Commission to approve a unit operation with agreement of at least 75 percent of both working and royalty interests. Such a law was considered to improve the changes of reviving the State's declining oil and gas production by permitting establishment of secondary recovery projects that had been held up by dissent of minority interests.

The Kansas program of planning for economic development progressed in 1966. As a part of "Phase I" of the program, nine counties in southeast Kansas were selected for a pilot project to be conducted under the leadership of the Southeast Kansas Regional Planning Committee with cooperation of several State agencies. A plan was prepared which included an inventory and analysis of existing conditions and characteristics of the area, a statement of long-range development goals, a summary of regional development policies, and recommendations on implementing the plan. Mineral, metal, and water resources were an integral part of the plan. Methodology developed in this pilot project was expected to assist in general planning and development of other regions of the State. The Kansas Geological Survey provided a "study design" for optimum development and conservation of natural resources as an integral part of the State Planning Program.

Employment and Injuries.—According to the Employment Security Division of the Kansas Department of Labor, average annual employment in crude petroleum and natural gas production industries in 1966 was 11,100, compared with 11,800 in 1965. An additional 4,000 were employed in petroleum refining and related industries. The stone, clay, and glass manufacturing industries employed an average of 7,300 workers and the primary metal industries an average of 1,800. Except for a slight increase in 1959, mining employment has declined steadily since its post-World War II peak in 1956.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Carbon Black.—One firm, Columbian Carbon Co., produced carbon black in Kansas. The company used more natural gas liquids and natural gas to steadily increase output, in response to an upward trend in the principal use of carbon black; the manufacture of automobile tires and tubes.

Coal (Bituminous).—The quantity and value of bituminous coal produced in Cherokee and Crawford Counties declined from 1965 totals.

Helium.—Two new helium plants, privately owned and operated, were completed. The plant of Kansas Refined Helium Co. near Otis became operational in April, and the Greenwood plant of Alamo Chemical Co.-Gardner Cryogenics, Inc., went onstream in December. Both produced grade A helium for sale to commercial (non-Federal) customers, and were capable of producing liquid helium. Neither plant was part of the Government program.

Combined production of grade A helium from the two plants was estimated at 75.5 million cubic feet valued at about $1.9 million. Most of the liquid helium from the Kansas Refined Helium Co. plant was distributed by Air Reduction Sales Co. The liquid helium was transported in 10,000-gallon trailers to several redistribution centers in various parts of the country. At the centers, the helium was regasified, packaged, and ultimately distributed to the consumer. The liquid trailer method of transportation effected economies in shipping.

Table 3.—Employment 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
1965:								
Coal	235	263	62	506	----	13	25.70	413
Metal	61	280	17	137	----	2	14.61	424
Nonmetal	1,199	280	335	2,685	1	49	18.62	2,538
Sand and gravel	869	216	187	1,610	----	21	13.05	371
Stone	2,001	228	456	3,745	----	35	9.35	469
Total	4,365	242	1,057	8,683	1	120	13.94	1,086
1966: p								
Coal	210	268	56	436	----	10	22.94	367
Metal	60	283	16	131	----	4	30.53	794
Nonmetal	1,110	282	312	1,495	2	64	26.45	5,498
Sand and gravel	875	217	190	1,619	----	42	25.94	715
Stone	1,830	233	426	3,516	3	38	11.66	5,522
Total	4,085	245	1,000	7,197	5	158	19.89	4,215

p Preliminary.

Table 4.—Coal (bituminous) production [1]

Year	Number of mines			Short tons (thousands)	Value (thousands)
	Underground	Strip	Total		
1957–61 (average)	-----	-----	-----	779	$3,590
1962	1	10	11	915	4,249
1963	1	9	10	1,169	5,311
1964	-----	7	7	1,263	5,749
1965	-----	6	6	1,310	6,072
1966	-----	5	5	1,122	5,355

[1] Excludes mines producing less than 1,000 short tons.

As part of a long-range helium conservation program, crude helium (purity 50 to 80 percent) was produced at four plants in the State. These plants—Northern Helex Co. plant near Bushton, Ellsworth County; Cities Service Helex, Inc., plant near Ulysses, Grant County; National Helium Corp. plant near Liberal, Seward County; and Federal Bureau of Mines plant at Otis, Rush County—produced a combined total of 2,624.2 million cubic feet of crude helium valued at $30.95 million. This production compared with the 2,551.0 million cubic feet (value $29.51 million) produced in 1965. The entire output of the three privately owned conservation plants was purchased by the Bureau of Mines, and transported by pipeline to the Cliffside gasfield near Amarillo, Tex., where it was pumped into a partially depleted underground natural gas reservoir for storage. As needed, the helium can be withdrawn, purified, and sold.

The Kansas-Nebraska Natural Gas Co. and Cities Service, Inc., announced a joint venture, Cities Service Cryogenics, Inc., to build a new helium plant near Scott City. The plant has a designed capacity of about 150 million cubic feet of helium a year and was expected to be operational in the spring of 1968.

Natural Gas.—The Kansas Corporation Commission listed 58 firms producing natural gas in the State in 1966. Marketed production of natural gas continued a long, steady increase and approached the trillion-foot-per-year rate. The number of producing natural gas wells also increased to 8,874 in 1966, compared with 8,534 in 1965. A higher unit price at the wellhead improved the position of the Kansas gas industry.

Natural Gas Liquids.—Natural gas liquids production continued to increase. Output of natural gasoline, which has remained fairly steady over the past several years, was only slightly higher. Liquefied petroleum gas production, which has been increasing rapidly, rose 13 percent in 1966.

A refrigeration-type gasoline plant was added to the Kansas-Nebraska Natural Gas Co. facilities at Scott City. The new instal-

Table 5.—Marketed production of natural gas

Year	Million cubic feet	Value (thousands)
1957–61 (average)	607,282	$71,764
1962	694,352	86,100
1963	732,946	97,482
1964	764,073	96,031
1965	793,379	105,519
1966	847,495	114,412

lation can handle 200 million cubic feet of natural gas per day to produce 55,000 gallons of product per day. Subsidiary companies of Cities Service Oil Co. and Kansas-Nebraska Natural Gas Co. planned to build a gas processing plant west of Scott City—Kansas-Nebraska Natural Gas Co. will supply the gas for the plant that will be operated by Cities Service Oil Co. The plant was to have capacity to process 75 million cubic feet of natural gas daily and to extract 51 million gallons of natural gas liquids per year. The gas liquids will be transported by pipeline to the Cities Service Oil Co. plant in Hutchinson for further processing. A 70-mile pipeline will be built to connect with an existing Cities Service natural gas liquids pipeline.

Petroleum.—Output of petroleum dropped slightly to continue a slow, steady decline that began a decade ago. Value of the output was up slightly, reflecting higher unit prices. The average price of crude oil sold in Kansas during 1966 was $2.95 per barrel. At yearend, prices ranged from $3.05 to $3.08 for top gravity crude.

Table 6.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	117,081	$6,172	121,291	$5,630	238,372	$11,802
1962	151,360	7,696	166,769	6,295	318,129	13,991
1963	165,370	9,811	395,877	15,481	561,247	25,292
1964	162,725	8,713	512,747	18,121	675,472	26,834
1965	153,485	7,791	587,416	22,322	740,901	30,113
1966	175,053	9,399	664,164	25,902	839,217	35,301

The falling capabilities of Kansas oil wells caused producers to be unable to meet the allowables set by the Corporation Commission. The commission provided bonus incentives that apparently were giving some well producers higher runs; it was considering a proposition that would not restrict the number of wells eligible for discovery allowables in newly found fields and reservoirs.

At yearend, 12 refineries were operating in Kansas. Crude capacity was up to 376,860 barrels per stream day from 350,585 barrels in 1965.[4] About 123 million barrels of crude went to refineries during 1966, compared with 113 million in 1965.

Table 7.—Crude petroleum production

(Thousand 42-gallon barrels and thousand dollars)

Year	Quantity	Value
1957–61 (average)	117,759	$346,633
1962	112,076	326,141
1963	109,107	317,501
1964	106,252	310,256
1965	104,733	305,820
1966	103,738	306,027

Kansas had 41,923 stripper wells producing oil on January 1, 1966, up 261 wells from 1965. Petroleum recovered from stripper wells totaled 68.3 million barrels in 1966, compared with 69.1 in 1965. Oil reserves attributed to stripper wells totaled

[4] The Oil and Gas Journal. V. 65, No. 14, Apr. 3, 1967, p. 180.

Table 8.—Crude petroleum production, indicated demand and stocks in 1966 by months

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Kansas (end of month)
January	8,560	9,029	5,911
February	8,022	7,619	6,314
March	9,016	8,737	6,593
April	8,696	8,153	7,136
May	8,928	8,606	7,458
June	8,671	8,562	7,567
July	8,726	9,548	6,745
August	8,910	8,336	7,319
September	8,622	8,883	7,058
October	8,717	9,204	6,571
November	8,586	8,806	6,351
December	8,284	8,893	5,742
Total:			
1966	103,738	104,376	XX
1965	104,733	105,897	XX

XX Not applicable.

Table 9.—Crude petroleum production by fields [1]

(Thousand 42-gallon barrels)

Field [2]	1963	1964	1965	1966	Cumulative Dec. 31, 1966
Bemis-Shutts [3]	3,812	3,594	3,371	3,267	197,802
Chase-Silica [3]	2,876	2,799	2,690	2,579	237,642
El Dorado [3]	3,773	3,329	2,899	2,534	266,905
Fairport	1,035	1,196	1,121	1,012	38,159
Geneseo-Edwards	1,327	1,299	1,212	1,187	74,072
Gladys	1,135	1,065	1,177	967	14,307
Gorham	1,186	1,375	1,328	1,275	72,647
Hall-Gurney [3]	3,232	3,396	3,345	3,290	107,495
Kraft-Prusa [3]	2,023	1,988	1,942	1,992	101,461
Lost Springs	1,396	933	722	701	25,120
Marcotte	1,047	1,014	948	947	28,028
Morel	1,161	1,162	1,068	975	34,205
Pleasant Prairie	1,443	1,110	1,221	1,057	12,015
Ray	1,315	1,214	1,147	1,132	32,527
Spivey-Grabs	3,731	3,457	3,168	2,796	32,708
Trapp [3]	2,540	2,758	2,772	3,055	188,682
Other fields [4]	76,075	74,563	74,602	74,972	NA
Total	109,107	106,252	104,733	103,738	NA

NA Not available.
[1] Fields with annual production in excess of 1 million barrels.
[2] Breakdown for individual fields from the Oil and Gas Journal.
[3] Giant fields.
[4] Bureau of Mines figures.

Table 10.—Oil and gas well drilling in 1966, by counties

County	Proved field wells			Exploratory wells			Total
	Oil	Gas	Dry	Oil	Gas	Dry	
Allen	17	-----	6	2	-----	1	26
Anderson	11	-----	1	-----	-----	3	15
Atchison	-----	-----	-----	-----	-----	1	1
Barber	9	12	17	3	2	12	55
Barton	48	-----	76	11	-----	37	172
Bourbon	-----	3	6	-----	-----	4	13
Brown	1	-----	-----	-----	-----	1	2
Butler	39	-----	14	2	-----	77	132
Chase	-----	-----	-----	-----	-----	2	2
Chautauqua	13	-----	9	3	-----	10	35
Clark	8	1	3	-----	-----	7	19
Coffey	2	-----	1	-----	-----	2	5
Comanche	-----	3	1	-----	-----	3	7
Cowley	29	1	20	1	-----	18	69
Crawford	2	-----	2	-----	-----	1	5
Decatur	6	-----	4	3	-----	3	16
Dickinson	2	-----	1	-----	-----	1	4
Douglas	1	-----	-----	-----	-----	2	3
Edwards	1	1	-----	-----	-----	8	10
Elk	7	-----	6	-----	---	4	17
Ellis	52	-----	52	12	-----	40	156
Ellsworth	13	1	10	-----	-----	15	39
Finney	-----	-----	-----	-----	-----	2	2
Ford	3	-----	-----	1	-----	10	14
Franklin	-----	-----	3	-----	-----	3	6
Gove	1	-----	7	1	-----	10	19
Graham	16	-----	17	5	-----	22	60
Grant	1	8	2	-----	-----	1	12
Gray	-----	1	-----	-----	-----	1	2
Greeley	-----	-----	-----	-----	-----	1	1
Greenwood	92	-----	35	5	-----	15	147
Hamilton	-----	6	-----	-----	-----	1	7
Harper	12	5	9	5	2	25	58
Harvey	6	-----	9	-----	-----	4	19
Haskell	7	5	5	3	-----	1	21
Hodgeman	2	-----	-----	1	-----	13	16
Jefferson	1	4	2	-----	1	2	10
Johnson	3	-----	1	1	-----	2	7
Kearny	1	2	5	1	-----	4	13
Kingman	10	5	22	3	1	31	72
Kiowa	11	2	5	4	1	9	32
Labette	3	1	2	-----	-----	-----	6
Lane	-----	-----	-----	-----	-----	1	1
Linn	6	-----	15	-----	-----	-----	21
Lyon	5	-----	1	-----	-----	3	9
McPherson	33	-----	7	2	-----	18	60
Marion	10	-----	3	1	3	8	25
Meade	2	5	6	-----	6	10	29
Miami	16	-----	13	-----	-----	3	32
Montgomery	18	-----	5	-----	2	1	26
Morris	-----	-----	-----	-----	-----	2	2
Morton	4	7	-----	1	3	8	23
Neosho	30	-----	18	-----	-----	2	50
Ness	35	-----	19	17	-----	30	101
Norton	1	-----	2	-----	-----	5	8
Osborne	-----	-----	-----	-----	-----	5	5
Pawnee	1	1	6	3	-----	10	21
Phillips	19	-----	3	1	-----	4	27
Pratt	5	-----	2	-----	-----	9	16
Rawlins	3	-----	3	2	-----	5	13
Reno	20	4	8	2	-----	15	49
Rice	37	-----	31	7	1	25	101
Riley	-----	-----	-----	-----	-----	3	3
Rooks	46	-----	26	4	-----	17	93
Rush	10	5	12	4	-----	14	45
Russell	63	2	27	5	-----	23	120
Saline	8	-----	2	-----	-----	4	14
Scott	-----	-----	1	2	2	1	6
Sedgwick	4	-----	7	-----	-----	15	26
Seward	6	3	7	2	1	3	22
Sheridan	5	-----	4	2	-----	7	18
Stafford	43	1	38	11	-----	15	108
Stanton	-----	-----	1	-----	-----	3	4
Stevens	1	14	4	-----	-----	3	22
Sumner	18	-----	16	4	-----	30	68
Thomas	-----	-----	-----	-----	-----	1	1
Trego	14	-----	13	3	-----	20	50
Wabaunsee	-----	-----	2	-----	-----	3	5
Wichita	-----	-----	-----	-----	-----	4	4
Wilson	8	1	5	-----	-----	1	15
Woodson	30	-----	17	4	-----	9	60
Total	931	104	677	144	25	749	2,630

Source: American Association of Petroleum Geologists.

Table 11.—Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

Product	Proved reserves, Dec. 31, 1965	Changes in proved reserves, owing to extensions and new discoveries, in 1966	Proved reserves, Dec. 31, 1966 (production was deducted)	Changes from 1965, percent
Crude oil—thousand barrels	751,629	77,265	726,429	−3.2
Natural gas liquids [1]—do	200,317	70,993	256,848	+28.2
Natural gas—million cubic feet	16,596,404	196,017	15,923,275	−4.1

[1] Includes condensate, natural gasoline, and LP gases.
Source: American Gas Association, American Petroleum Institute, and Canadian Petroleum Association Proved Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas. Tulsa Daily World, 62d yr., No. 201, Apr. 3, 1967, p. 27.

456 million barrels as of January 1, 1966, compared with 475 million at the beginning of 1965.[5]

NONMETALS

A seeming incongruity—increased output of cement and decreased sales of sand and gravel and stone—is explained by cutbacks in building and highway construction for 1966, a reduction in cement stocks in the boom period of 1965, and anticipated gains in construction and building in the year ahead.

Cement.—Shipments of portland cement again increased and approached the records attained in 1956 and 1959. Seven plants produced during 1966—four wet process and three dry process. Cement stocks were up slightly at yearend and represented about 2 months production. About 65 percent of cement output was used in ready-mix concrete and 17 percent in highway construction.

Clays.—Fourteen firms produced clay from 22 pits in Kansas. About 15 percent of the clay mined was fire clay. About one-third of the clay and shale was used in making cement at plants in eastern Kansas. The balance went into building brick, pipe, lightweight aggregate, pottery, and other clay products.

Gypsum.—National Gypsum Co. operated an underground gypsum mine in Barber County and Georgia-Pacific Corp. in Marshall County. Crude gypsum was used largely as a retarder in portland cement, for agricultural purposes, and in making plasters and wallboard.

Pumice.—Small tonnages of pumice were produced by Ernest Hanzlicek and San Ore Construction Co. in Lincoln County and by Wyandotte Chemical Corp. in Norton County for use in scouring compounds and soaps and as aggregate in asphaltic mixtures. Output was considerably less in 1966 than in 1965. The Kansas Geological Survey was actively searching for new uses and markets for the volcanic ash.

[5] The Oil and Gas Journal. V. 64, No. 45, Nov. 7, 1966, p. 56.

Table 12.—Portland cement production and shipments

(Thousand 376-pound barrels and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1957–61 (average)	8,773	8,625	$26,825
1962	8,235	8,058	25,134
1963	8,248	8,201	25,372
1964	8,335	8,483	25,959
1965	8,877	8,801	26,972
1966	9,174	8,979	27,246

Table 13.—Shipments of portland cement to Kansas consumers

Year	Thousand 376-pound barrels
1957–61 (average)	5,821
1962	5,331
1963	5,024
1964	5,132
1965	5,041
1966	5,129

Table 14.—Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	930	$1,221
1962	895	1,091
1963	893	1,104
1964	785	935
1965	789	953
1966	847	1,006

Table 15.—Evaporated and rock salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Evaporated salt		Rock salt	
	Quantity	Value	Quantity	Value
1957–61 (average)	389	$8,559	505	$2,508
1962	432	9,446	512	2,208
1963	435	9,669	489	2,324
1964	438	9,485	492	2,314
1965	453	9,828	600	2,548
1966	452	10,836	517	2,552

Table 16.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total sand and gravel	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	8,474	$6,152	1,940	$942	10,414	$7,094
1962	9,274	6,953	2,278	1,086	11,552	8,039
1963	9,763	7,603	2,299	1,073	12,062	8,676
1964	10,227	7,788	2,741	1,320	12,968	9,108
1965	9,960	7,494	2,584	979	12,544	8,473
1966	9,316	7,193	2,311	1,181	11,627	8,374

Table 17.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	4,065	$3,138	4,026	$3,186
Paving	2,768	1,937	2,636	1,980
Fill	940	425	869	398
Other [1]	186	199	220	236
Total	7,959	5,699	7,751	5,800
Gravel:				
Building	494	487	219	229
Paving	1,353	1,131	1,184	995
Fill	36	34	66	43
Other [2]	118	143	96	126
Total	2,001	1,795	1,565	1,393
Total sand and gravel	9,960	7,494	9,316	7,193
Government-and-contractor operations:				
Sand:				
Building	65	45	108	108
Paving	1,314	485	1,096	510
Other [3]	156	48	4	2
Total	1,535	578	1,208	620
Gravel:				
Building	18	16	-----	-----
Paving	966	371	1,006	521
Other [4]	65	14	97	40
Total	1,049	401	1,103	561
Total sand and gravel	2,584	979	2,311	1,181
Grand total	12,544	8,473	11,627	8,374

[1] Includes railroad ballast, other construction, and industrial sand (ground and unground).
[2] Includes railroad ballast (1966), other construction, and miscellaneous gravel.
[3] Includes fill and other construction sand (1965).
[4] Includes fill and other construction gravel (1965).

Salt.—Six companies produced rock or evaporated salt in the central Kansas counties of Barton, Ellsworth, Reno, and Rice.

Table 18.—Sand and gravel production in 1966, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value
Barber	103	$52
Barton	326	193
Chase	29	21
Cherokee	62	31
Clark	39	14
Comanche	23	11
Cowley	274	195
Decatur	13	11
Dickinson	15	14
Doniphan	1	1
Elk	18	7
Ellis	182	106
Finney	135	152
Ford	151	99
Gove	71	42
Greeley	22	18
Greenwood	8	3
Hamilton	27	11
Haskell	72	29
Hodgeman	61	24
Kearny	21	10
Kiowa	150	87
Leavenworth	16	22
Linn	24	12
Logan	1	1
McPherson	35	17
Meade	12	9
Nemaha	25	23
Ness	72	29
Osborne	164	138
Ottawa	14	7
Pawnee	106	74
Phillips	6	4
Rawlins	8	4
Reno	421	261
Rooks	2	1
Sedgwick	1,510	927
Seward	79	56
Shawnee	552	406
Sheridan	18	9
Sherman	20	22
Sumner	166	86
Wabaunsee	1	1
Wyandotte	2,018	1,734
Other counties [1]	4,554	3,400
Total	11,627	8,374

[1] Includes Butler, Cheyenne, Clay, Cloud, Coffey, Douglas, Edwards, Ellsworth, Geary, Grant, Gray, Harper, Harvey, Johnson, Kingman, Lyon, Marshall, Mitchell, Morris, Neosho, Pottawatomie, Pratt, Republic, Rice, Riley, Rush, Russell, Saline, Stafford, Thomas, Trego, Washington, and Wichita Counties, combined to avoid disclosing individual company data. Undistributed amounts from various counties are also included.

Another producer pumped brine in Sedgwick County for use in making chlorine and caustic soda.

Sand and Gravel.—Production of sand and gravel was widespread across the State with most counties recording output. Largest tonnages came from Wyandotte, Sedgwick, Shawnee, and Reno Counties to supply the State's larger cities—Kansas City, Wichita, Topeka, Hutchinson, and Lawrence. The slight drop in output of sand and gravel was attributable largely to decreased highway construction.

Stone.—Output of stone in Kansas decreased. Consumption of stone is cyclical in highway construction—clearing and grading predominating 1 year and surfacing in the following year. Road and highway maintenance tends to level out this variation.

Water.—In accordance with the Federal Water Quality Act of 1965, Kansas developed water quality standards for all river basins in the State.

In October 1966, Congress authorized $43 million for U.S. Army Corps of Engineers and Bureau of Reclamation projects in Kansas. The Milford Dam was completed, and the Almena irrigation project was nearly completed. Detailed planning was to start on the Hays project, and Clinton Reservoir was allotted initial construction funds.

In addition to the Kansas projects, $8.3 million was scheduled for construction on the Missouri River navigation project downstream from Sioux City, Iowa.

The Kansas and Oklahoma Legislatures approved the Kansas-Oklahoma Arkansas River Compact which was designed to permit harmonious development of the water resources of streams common to the two States.

Table 19.—Stone sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Limestone [1]		Other stone		Total stone	
	Quantity	Value	Quantity	Value	Quantity	Value
1962	13,098	$17,106	429	$168	[2] 13,527	[2] $17,274
1963	12,904	17,600	654	883	13,558	18,483
1964	13,412	17,747	726	1,165	14,138	18,912
1965	14,673	19,566	597	972	15,270	20,538
1966	13,503	17,886	524	903	14,027	18,789

[1] Includes diatomaceous marl, limestone for cement, and limestone for lime.
[2] Excludes crushed sandstone.

Table 20.—Stone sold or used by producers, by kinds and uses

(Short tons)

Uses	1965		1966	
	Quantity	Value	Quantity	Value
Limestone: [1]				
Riprap	1,189,802	$1,081,812	1,202,347	$1,175,814
Concrete aggregate and roadstone	9,927,107	13,356,196	8,826,102	11,618,915
Agriculture	521,579	850,086	581,979	949,974
Cement	2,558,595	2,686,353	2,515,582	2,672,949
Dimension	16,129	614,830	21,085	647,802
Other [2]	459,933	976,500	355,713	821,046
Total	14,673,145	19,565,777	13,502,798	17,886,500
Sandstone: Dimension	514	10,349	305	5,823
Total stone [3]	15,269,846	20,537,795	14,027,004	18,789,408

[1] Includes diatomaceous marl.
[2] Includes railroad ballast, cement rock, coal dust, whiting, and other uses.
[3] Includes dimension sandstone and miscellaneous stone.

METALS

The Kansas lead and zinc producing area in Cherokee County is part of the Tri-State District which also includes northeastern Oklahoma and southwestern Missouri. Further details on Tri-State activity are in the Oklahoma chapter.

Lead and Zinc.—Ten small lead-zinc mines operated in the Kansas portion of the Tri-State District, but output of both metals was down sharply from 1965. Falling prices and depletion of reserves may further reduce activity. Lead prices were low enough to reactivate the Lead-Zinc Mining Stabilization Program.

Zinc-lead mining began in southeastern Kansas about 1876, and the industry expanded steadily until 1926 when peak annual production was valued at $23.5 million. Total recorded output through 1966 was about 2,875,000 tons of zinc and 650,000 tons of lead, with a combined value of over $500 million.

REVIEW BY COUNTIES

Mineral production was reported in all 105 counties in Kansas. Petroleum was produced in 83 counties and natural gas in 56. One-third of the State total value of mineral output came from seven counties—Grant, Stevens, Seward, Russell, Ellis, Barton, and Ellsworth.

Allen.—This county was the State's leading clay and cement producer and third largest stone producer. Lehigh Portland Cement Co. at Iola and The Monarch Cement Co. at Humboldt produced portland and masonry cements; limestone and clay for the cement were obtained nearby.

Table 21.—Mine production of lead and zinc, in terms of concentrate and recoverable metals [1]

Year	Mines producing	Lead concentrate (galena)		Zinc concentrate (sphalerite)		Recoverable metal content [2]			
						Lead		Zinc	
		Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1957–61 (average)	----	2,311	$342	9,652	$717	1,653	$423	5,172	$1,185
1962	10	1,290	138	7,237	493	970	178	3,943	907
1963	8	1,402	172	6,433	514	1,027	222	3,508	807
1964	10	1,603	228	8,636	768	1,185	310	4,665	1,269
1965	9	2,304	380	12,003	1,157	1,644	513	6,508	1,900
1966	9	1,574	242	8,911	849	1,109	335	4,769	1,383

[1] Based on Kansas ore and old tailing treated at mills during calendar year indicated.
[2] In calculating metal content of the ores from assays, allowance made for smelting losses of both lead and zinc. In comparing values of concentrate (ore) and metal, value given for concentrate is that actually received by producer, whereas value of lead and zinc is calculated from average price for all grades.

Table 22.—Value of mineral production in Kansas, by counties

County	1965 r	1966	Minerals produced in 1966 in order of value
Allen	$12,948,729	$12,978,013	Cement, petroleum, stone, clays, natural gas.
Anderson	1,266,849	1,259,461	Petroleum, stone, natural gas.
Atchison	W	W	Stone, petroleum.
Barber	9,040,161	9,279,204	Natural gas, petroleum, gypsum, natural gas liquids, sand and gravel.
Barton	24,152,319	24,175,220	Petroleum, sand and gravel, natural gas, clays, salt.
Bourbon	692,484	692,409	Stone, petroleum, cement.
Brown	12,976	12,985	Petroleum.
Butler	16,620,064	16,557,973	Petroleum, stone, sand and gravel, natural gas.
Chase	385,250	437,846	Stone, petroleum, sand and gravel, natural gas.
Chautauqua	2,622,605	2,669,274	Petroleum, stone, natural gas.
Cherokee	6,426,891	5,931,127	Coal, zinc, lead, clays, stone, sand and gravel.
Cheyenne	W	W	Sand and gravel.
Clark	2,394,429	2,498,530	Natural gas, petroleum, sand and gravel.
Clay	536,537	272,286	Stone, sand and gravel, petroleum.
Cloud	318,712	280,004	Clays, sand and gravel, stone.
Coffey	437,742	445,087	Petroleum, stone, sand and gravel, natural gas.
Comanche	1,141,947	1,191,460	Natural gas, petroleum, sand and gravel.
Cowley	9,974,451	9,942,233	Petroleum, natural gas, stone, sand and gravel.
Crawford	2,427,922	1,682,325	Coal, petroleum, clays, natural gas.
Decatur	1,322,146	1,316,029	Petroleum, sand and gravel.
Dickinson	829,289	807,626	Stone, petroleum, sand and gravel, natural gas.
Doniphan	W	731,620	Stone, sand and gravel.
Douglas	301,846	301,505	Petroleum, sand and gravel, stone, natural gas.
Edwards	1,161,479	1,190,668	Petroleum, natural gas, sand and gravel.
Elk	1,347,499	1,252,979	Stone, petroleum, natural gas, sand and gravel.
Ellis	25,499,413	25,528,950	Petroleum, sand and gravel, stone.
Ellsworth	22,601,264	22,079,917	Natural gas liquids, helium, petroleum, salt, clays, natural gas, sand and gravel.
Finney	9,477,757	9,724,241	Natural gas, petroleum, natural gas liquids, sand and gravel.
Ford	360,579	284,056	Natural gas liquids, sand and gravel, petroleum, natural gas.
Franklin	1,052,704	1,007,655	Petroleum, stone, clays, natural gas.
Geary	470,731	734,393	Stone, sand and gravel, petroleum.
Gove	896,834	908,421	Petroleum, sand and gravel.
Graham	15,096,690	15,115,896	Petroleum, stone.
Grant	31,639,894	36,731,391	Natural gas, natural gas liquids, helium, petroleum, sand and gravel.
Gray	W	W	Sand and gravel.
Greeley	7,000	18,000	Do.
Greenwood	9,715,261	9,726,086	Petroleum, stone, helium, natural gas, sand and gravel.
Hamilton	1,974,170	2,081,030	Natural gas, petroleum, sand and gravel.
Harper	4,864,037	4,657,774	Petroleum, natural gas, natural gas liquids, sand and gravel.
Harvey	2,844,458	2,832,539	Petroleum, natural gas, sand and gravel, natural gas liquids.
Haskell	11,783,345	12,104,972	Natural gas, petroleum, sand and gravel.
Hodgeman	5,581,745	5,569,496	Petroleum, sand and gravel.
Jackson	359,685	302,502	Petroleum, stone.
Jefferson	W	W	Stone.
Jewell	1,086,242	883,880	Do.
Johnson	1,891,184	2,339,843	Stone, sand and gravel, petroleum, natural gas.
Kearny	11,263,025	11,885,997	Natural gas, petroleum, natural gas liquids, sand and gravel.
Kingman	14,730,439	14,929,548	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kiowa	3,203,899	3,289,277	Petroleum, natural gas, sand and gravel.
Labette	474,800	456,182	Petroleum, stone, natural gas.
Lane	292,940	293,138	Petroleum.
Leavenworth	304,613	455,512	Stone, natural gas, sand and gravel, petroleum.
Lincoln	888,828	W	Stone, pumice.
Linn	365,073	278,310	Petroleum, stone, natural gas, sand and gravel.
Logan	3,000	1,000	Sand and gravel.
Lyon	713,454	573,439	Petroleum, stone, sand and gravel.
McPherson	6,540,975	6,544,001	Petroleum, natural gas, clays, sand and gravel.
Marion	4,899,649	4,659,737	Petroleum, natural gas, stone, natural gas liquids.
Marshall	883,096	970,423	Gypsum, sand and gravel, stone.
Meade	3,852,836	3,959,160	Natural gas, petroleum, sand and gravel.
Miami	730,949	756,609	Petroleum, stone, natural gas.
Mitchell	21,000	W	Sand and gravel.
Montgomery	7,310,338	7,125,715	Cement, petroleum, stone, natural gas, clays.
Morris	1,169,939	1,205,940	Petroleum, stone, natural gas, sand and gravel.
Morton	18,108,496	19,657,222	Natural gas, petroleum, natural gas liquids.
Nemaha	115,599	93,041	Petroleum, sand and gravel, stone.
Neosho	8,048,232	8,825,432	Cement, petroleum, stone, sand and gravel, clays, natural gas.
Ness	5,255,664	5,075,033	Petroleum, sand and gravel, stone.
Norton	1,773,668	1,744,700	Petroleum, pumice.
Osage	W	W	Stone.

See footnotes at end of table.

Table 22.—Value of mineral production in Kansas, by counties—Continued

County	1965 r	1966	Minerals produced in 1966 in order of value
Osborne	$125,835	$253,030	Sand and gravel, petroleum, stone.
Ottawa	2,000	7,000	Sand and gravel.
Pawnee	3,407,360	3,434,051	Petroleum, natural gas, sand and gravel.
Phillips	6,138,656	6,073,856	Petroleum, stone, sand and gravel.
Pottawatomie	331,967	130,297	Stone, sand and gravel.
Pratt	4,307,696	4,219,126	Petroleum, natural gas, sand and gravel.
Rawlins	1,610,805	1,603,140	Petroleum, stone, sand and gravel.
Reno	17,360,398	18,768,670	Salt, natural gas liquids, petroleum, natural gas, sand and gravel.
Republic	118,750	W	Sand and gravel.
Rice	20,223,505	20,934,075	Petroleum, salt, natural gas, stone, sand and gravel.
Riley	654,753	709,830	Petroleum, stone, sand and gravel.
Rooks	15,590,361	15,588,905	Petroleum, sand and gravel.
Rush	2,422,387	3,914,667	Helium, petroleum, natural gas, sand and gravel.
Russell	25,615,080	25,785,185	Petroleum, sand and gravel, natural gas, stone.
Saline	2,195,629	2,418,936	Petroleum, sand and gravel.
Scott	259,730	261,319	Petroleum, natural gas.
Sedgwick	11,218,504	11,065,871	Petroleum, natural gas liquids, salt, sand and gravel, natural gas, stone.
Seward	26,849,788	27,355,444	Helium, natural gas liquids, natural gas, petroleum sand and gravel.
Shawnee	1,541,856	1,413,881	Stone, sand and gravel.
Sheridan	1,009,078	979,335	Petroleum, sand and gravel.
Sherman	113,512	101,565	Do.
Smith	4,923	15,648	Stone.
Stafford	14,740,798	14,749,817	Petroleum, natural gas, sand and gravel.
Stanton	4,131,803	4,345,804	Natural gas, petroleum.
Stevens	25,398,136	27,510,307	Natural gas, petroleum, natural gas liquids.
Sumner	7,643,510	7,645,433	Petroleum, natural gas, sand and gravel.
Thomas	100,000	W	Sand and gravel.
Trego	4,475,684	4,427,677	Petroleum, sand and gravel.
Wabaunsee	746,697	745,910	Petroleum, stone, sand and gravel.
Wallace	W	W	Stone.
Washington	165,307	159,000	Sand and gravel, stone.
Wichita	13,850	20,852	Sand and gravel, petroleum.
Wilson	5,344,964	4,874,078	Cement, petroleum, stone, clays, natural gas.
Woodson	2,757,646	2,812,384	Petroleum, stone, natural gas.
Wyandotte	8,419,583	7,903,149	Cement, stone, sand and gravel.
Undistributed	4,034,617	6,847,436	
Total	553,491,000	568,392,000	

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

Humboldt Shale Mining Co. mined shale for Humboldt Brick & Tile Co. Limestone was quarried and crushed for concrete aggregate by Allen County Highway Department and The Monarch Cement Co.

Barber.—Barber County ranked first in gypsum production. Gypsum was mined and processed at Medicine Lodge by National Gypsum Co. Natural gas liquids were recovered by Skelly Oil Co. at its Medicine Lodge plant. Sand and gravel for building and paving was processed by Whitfield Sand & Concrete, Burl Gaunt, and the county highway department.

Barton.—Barton County ranked sixth in overall value of mineral production and third in value of petroleum output. Evaporated salt from brine wells was produced by Cargill, Inc. Kansas Brick & Tile Co. used fire clay to make building brick. Sand and gravel was recovered for building, paving, and fill by Stone Sand Co., Arkansas Sand Co., Klepper Sand Co., and the county highway department.

Bourbon.—Portland and masonry cement were produced near Fort Scott by Fort Scott Hydraulic Cement Co., Inc. Dimension sandstone was quarried and sawed near Redfield by Bandera Stone Co., Inc. Limestone was quarried and crushed for concrete aggregate, roadstone, agricultural lime (aglime), and coal mine dusting by Cullor Limestone Co., Inc., and Fort Scott Hydraulic Cement Co., Inc. Coal was strip mined by Palmer Coal Co.

Butler.—Mobil Oil Co., Inc., operated its refinery at Augusta. Mobil Chemical Co. added a 1,400-barrel-per-day propylene alkylation unit and a 1,200-barrel-per-day LPG unit to its existing 2,400-barrel-per-day butylene alkylation facility. Skelly Oil Co. operated its refinery and an aromatics complex to produce phenol acetone, benzene, toluene, and other naptha compounds, using naphtha fractions as feedstock. American Petrofina Co. of Texas operated a refinery at El Dorado.

More than 2 million barrels of oil was

produced by secondary recovery methods from nearly 1 thousand wells in the county. George M. Myers, Inc., Carr Rock Products Co., and Starnes Rock Products Co. quarried and crushed limestone for concrete aggregate, roadstone, aglime, and riprap.

Chase.—Dimension limestone was quarried and prepared by J. T. Lardner Cut Stone Co. and Bayer Stone, Inc. Crushed limestone was produced by Hallet Construction Co. and Anderson-Oxandale Co. The county highway department processed limestone for riprap and gravel for paving and road maintenance.

Cherokee.—The county ranked first in the State in coal production. Wilkinson Coal Co. and Pittsburg & Midway Coal Co. strip mined coal. All lead and zinc operations in Kansas were in Cherokee County. Gulf Chemical Corp. produced ammonia, nitric acid, fertilizers, dry ice, and methanol near Baxter Springs, using natural gas as feedstock. The Eagle-Picher Co. produced lead and zinc pigments and sulfuric acid at Galena from concentrates shipped in from the Tri-State District and from Illinois and Kentucky. It also roasted zinc concentrates for the smelter at Henryetta, Okla., which was not equipped to take raw concentrates. Southwest Rock & Chat Co. sold chat for concrete aggregate and roadstone. Barnard Clay Co. and Victor Wilkinson, Inc., mined clay for various products.

Cloud.—The county ranked first in value of clay production. Fire clay for building brick was mined by Cloud Ceramics. Fyfe Sand & Gravel Co. processed sand and gravel for building. Dimension limestone was quarried and prepared by Prickett Quarry.

Cowley.—Apco Oil Corp. operated its refinery at Arkansas City. Limestone was quarried and dressed by H. J. Born Stone Co. and Silverdale Limestone Co. Crushed limestone for concrete aggregate, roadstone, and agricultural stone (agstone) was produced by Daniels Stone Co. Building, paving, and fill sand and gravel, railroad ballast, and engine sand were produced.

Crawford.—Crawford County ranked second in coal and clay production. Clemens Coal Co. operated two strip mines and Cliff Carr Coal Co. operated one. W. S. Dickey Clay Manufacturing Co. and Barnard Clay Co. mined clay for sewerpipe and other clay products.

Ellsworth.—The county was the leading producer of natural gas liquids. Northern Gas Products Co., subsidiary of Northern Natural Gas Co., operated an extraction plant at Bushton. Northern Helex Co., also a subsidiary of Northern Natural Gas, recovered helium in the same area. Independent Salt Co. mined rock salt near Kanopolis. Truhlars Ready Mix Concrete and Stoppel Construction Co. processes sand and gravel for building and paving. Acme Brick Co. and Kansas Brick & Tile Co., Inc., made building brick from locally mined clay.

Franklin.—Buildex, Inc., expanded shale for lightweight aggregate near Ottawa. Fogle Quarry Co., Inc., Concrete Materials Division of Martin Marietta Corp. and Killough-Clark, Inc., quarried and crushed limestone for concrete aggregate, roadstone, and agstone.

Geary.—Junction City Stone Co. prepared dimension limestone. Walker Cut Stone Co., Bayer Construction Co., Inc., Grosshans & Petersen, Inc., and Anderson-Oxandale Co. quarried and crushed limestone for concrete aggregate and roadstone. More Sand Co., Inc., and Junction City Sand & Gravel Co. produced sand and gravel for building, paving, fill, and other construction purposes. Milford Dam, on the Republican River, was completed by the U.S. Army Corps of Engineers.

Grant.—The county ranked second in value of natural gas liquids, natural gas, and helium production, and first in overall value of mineral production. Four natural gasoline plants were in operation, two by Pan American Petroleum Corp., and one each by Hugoton Production Co. and Mobil Oil Co. Helium was extracted by Cities Service Helex at its Jayhawk plant near Ulysses. Columbian Carbon Co. produced carbon black at its Hickok plant.

Harper.—The Bauer oilfield, discovered early in 1966. had 10 producing oil wells by yearend.

Jefferson.—Limestone was quarried and crushed for concrete aggregate, roadstone, riprap, and agstone by N. R. Hamm Quarry, Inc., and Roy Baker Quarry, Inc. The U.S. Army Corps of Engineers was constructing Perry Dam on the Delaware River.

Marion.—Rounds & Stewart Natural Gasoline Co., Inc., recovered natural gas liquids at its plant near Marion. Hallet Con-

struction Co., Anderson-Oxandale Co., and The Walt Keeler Co., Inc., quarried and crushed limestone for concrete aggregate, roadstone, agstone, and riprap. The U.S. Army Corps of Engineers was constructing Marion Dam on the Cottonwood River.

Mitchell.—Glen Elder Dam was being constructed on Solomon River by the Federal Bureau of Reclamation. Completion was scheduled for 1968.

Montgomery.—Shale and limestone were mined and processed into cement by Universal Atlas Cement Division of U.S. Steel Corp. Nelson Bros. Quarries and Carr Rock Products, Inc., quarried and crushed limestone for concrete aggregate, roadstone, and riprap. CRA, Inc., formerly Cooperative Refinery Association, operated its petroleum refinery at Coffeyville. Elk City Dam, constructed on Elk River by the U.S. Army Corps of Engineers, began impounding water in the summer of 1966. Ozark Smelting & Mining Co. produced various pigments from metals and nonmetal raw materials at Coffeyville. Cherryvale Zinc Co. recovered a variety of metals from drosses and residues at its Cherryvale plant.

Morton.—The county ranked third in value of natural gas production. Natural gas liquids were recovered by Anadarko Production Co. at its Interstate plant near Elkhart, and Cities Service Oil Co. at its Wilburton plant. Alamo Chemical Co., subsidiary of Phillips Petroleum Co., was building a 76-million-cubic-foot-per-day gas processing plant near Elkhart. The plant will recover helium.

Neosho.—Ash Grove Lime & Portland Cement Co. produced cement at its recently rebuilt plant. Harry Byers & Sons, Inc., and O'Brien Rock Crusher quarried and crushed limestone for concrete aggregate, roadstone, and agstone. Hy-Grade Construction & Materials produced sand and gravel for building, paving, fill, and filtration uses. Mid-America Refining Co., Inc., operated its petroleum refinery at Chanute.

Reno.—Reno County ranked first in salt production and third in natural gas liquids output. The Carey Salt Co., Morton Salt Co., and The Barton Salt Co., and The Barton Salt Co. recovered salt from brine wells. The Carey Salt Co. also mined rock salt. Sand and gravel was processed by several firms for building, paving, and fill. Cities Service Oil Co. recovered natural gas liquids at its fractionation plant in Hutchinson.

Rice.—The county ranked fourth in value of petroleum production. American Salt Corp. produced evaporated salt from brine wells and mined rock salt near Lyons. Tobias & Birchenough, Inc., and Arensman Sand & Gravel Co. produced building and paving sand. Limestone was quarried and crushed for concrete aggregate, roadstone, agstone, and riprap by Hallett Construction Co.

Rush.—Kansas Refined Helium Co. completed its 24-million-cubic-foot-per-day gas processing plant during 1966. The plant will recover 500,000 cubic feet of helium per day.

Russell.—The county ranked first in value of petroleum production. Nearly 3 million barrels of oil were recovered by secondary methods from 740 producing wells. The Wilson Reservoir on the Saline River was completed.

Scott.—Kansas-Nebraska Natural Gas Co. completed a 200-million-cubic-foot-per-day refrigeration plant, that can produce 15,000 gallons of butane and 40,000 gallons of gasoline per day. Century Refining Co. operated its petroleum refinery at Shallow Water.

Sedgwick.—The county ranked second in value of sand and gravel production. Frontier Chemicals Division of Vulcan Materials Co., was expanding its facilities at Wichita for producing chlorine and caustic soda from brine pumped from wells in the area. The company also produced ammonia from natural gas. Cities Service Oil Co. recovered natural gas liquids at its Wichita plant. Derby Refining Co. operated its petroleum refinery at Wichita. Dodson Manufacturing Co., Inc., of Wichita exfoliated crude vermiculite from Montana.

Seward.—National Helium Corp. operated its helium extraction plant near Liberal to rank the county first in helium production value. Natural gas liquids were recovered by National Helium Corp., Anadarko Production Co., and Northern Natural Gas Co.

Sumner.—The Bates field was reportedly one of the most important oil discoveries in Kansas in 1966.

Wyandotte.—The county ranked first in value of sand and gravel production and second in value of stone production. Lone Star Cement Corp. quarried limestone and

processed it into cement at its Bonner Springs plant. Thompson-Strauss Quarries and J. A. Tobin Construction Co. quarried and crushed limestone for concrete aggregate, riprap, and roadstone. Sand and gravel for building and paving was processed by seven producers. Crude perlite, mined out-of-State, was expanded by Lite Weight Products, Inc., at its Kansas City plant for use as building material. Phillips Petroleum Co. operated its petroleum refinery at Kansas City. The company produced rubber extender and process oils, using petroleum fractions as feedstock.

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 [1] and Preston McGrain [2]

Mineral production value in Kentucky increased 7 percent, the second highest production value on record, but was 1 percent below that of 1948, the record year. The value of coal production increased 12 percent, and the total tonnage increased 9 percent for a new record. Among the States, Kentucky ranked second in production of bituminous coal, with 17 percent of the national total, and second in production of ball clay and second in shipments of fluorspar, with 11 percent of the national total.

Coal mining dominated the Kentucky mineral industry and supplied 73 percent of the total value, compared with 70 percent in 1965. Leading companies based on value of production were Peabody Coal Co., Island Creek Coal Co., Pittsburgh and Midway Coal Co., and U.S. Steel Corp.

Legislation and Government Programs.—The U.S. Geological Survey and the Kentucky Geological Survey continued the cooperative program of mapping the geology of the State on 7.5-minute quadrangles. At yearend, 235 maps involving all or parts of 252 quadrangles had been published. The Kentucky Geological Survey issued the first of a new series of county economic reports. The publications will be prepared for counties covered by geologic quadrangle maps, and will emphasize proven and potential mineral resources.

At yearend, a total of 343.9 miles of Interstate highway and toll facilities had

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Table 1.—Mineral production in Kentucky [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Clays [2] thousand short tons	1,059	$2,580	1,152	$2,277
Coal (bituminous) do.	85,766	324,523	93,156	363,440
Fluorspar short tons	31,992	1,485	28,725	1,361
Lead (recoverable content of ores) do.	756	236	484	146
Natural gas million cubic feet	78,976	18,638	76,536	18,139
Petroleum (crude) thousand 42-gallon barrels	19,386	55,638	18,066	51,488
Sand and gravel thousand short tons	6,742	6,332	8,064	7,524
Silver (recoverable content of ores) troy ounces	1,931	2	1,086	1
Stone thousand short tons	[3] 26,029	[3] 34,533	22,667	31,179
Zinc (recoverable content of ores) short tons	5,654	1,651	6,586	1,910
Value of items that cannot be disclosed: Asphalt (1966), cement, ball clay, natural gas liquids, and dimension sandstone (1965)	XX	20,763	XX	20,899
Total	XX	466,381	XX	498,364

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes ball clay, included with "Value of items that cannot be disclosed."
[3] Excludes dimension sandstone.

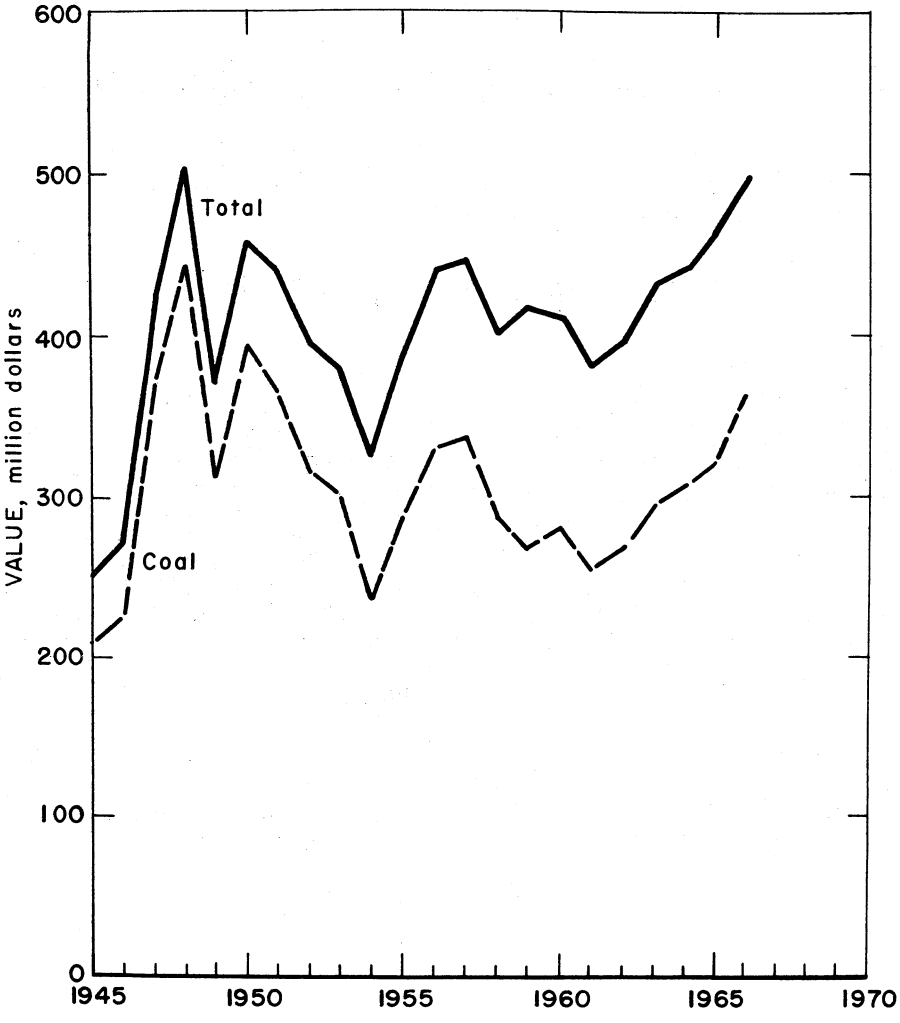

Figure 1.—Value of coal and total value of mineral production in Kentucky.

Table 2.—Value of mineral production in constant 1957–59 dollars
(Thousands)

Year	Value
1957	$438,939
1958	405,300
1959	429,146
1960	429,407
1961	401,868
1962	423,142
1963	467,604
1964	474,351
1965	r 498,871
1966	p 524,872

p Preliminary. r Revised.

been completed to full or acceptable standards and was open to traffic. An additional 389.0 miles either was under construction or work was in progress on engineering or obtaining right-of-way.

The Tennessee Valley Authority (TVA) had three 437-foot-high cooling towers under construction at the Paradise Steam Plant. TVA purchased the coal rights under-lying Camp Breckenridge for $7.4 million. A total of 24.6 million tons of coal was delivered to TVA's steamplants; of

Table 3.—Employment 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
1965:								
Coal	24,726	181	4,484	35,640	41	1,609	46.30	9,346
Metal and nonmetal	511	257	131	1,051	---	70	66.60	1,296
Sand and gravel	318	254	81	807	1	26	33.46	8,210
Stone	2,227	227	506	4,128	3	107	26.65	5,886
Total	27,782	187	5,202	41,626	45	1,812	44.61	8,778
1966: p								
Coal	25,200	171	4,311	34,980	42	1,650	48.37	9,751
Metal and nonmetal	485	225	109	875	1	49	57.14	9,018
Sand and gravel	380	270	103	958	---	25	26.10	364
Stone	2,160	237	512	4,188	4	109	26.98	6,625
Total	28,225	178	5,035	41,001	47	1,833	45.85	9,197

p Preliminary.

this, 15.4 million tons was shipped from western Kentucky and 1.8 million tons from eastern Kentucky.

The commonwealth of Kentucky enacted more restrictive legislation relating to regulations and control of strip mining.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

The value of bituminous coal, natural gas, and crude petroleum was $433 million, 87 percent of the total mineral value of the State, compared with 86 percent in 1965.

Coal (Bituminous).—Production of coal increased 9 percent above that of the 1965 record year. The value of production was, however, $363 million, 18 percent below that of the 1948 record year. Bituminous coal was mined at 1,704 mines in 37 counties, compared with 1,827 mines in 41 counties in 1965. Leading producing counties on basis of tonnage were Muhlenberg, Pike, Hopkins, Harlan, and Letcher. Leading producing companies on the same basis were Peabody Coal Co., Island Creek Coal Co., Pittsburgh & Midway Coal Co., and Gibraltar Coal Co.

In the eastern Kentucky coalfield, 1,623 mines in 27 counties produced almost 51 million tons, compared with 1,735 mines in 31 counties and 46.6 million tons in 1965. Average production per mine increased from 27,000 tons to 31,400 tons. Underground mines produced 80 percent, auger mines 10 percent, and strip mines 10 percent of the total. Shipments were 87 percent by rail or water and 13 percent by truck. Captive tonnage was 10 percent of the total.

Equipment used at 1,423 underground mines included 1,068 cutting machines, which cut 76 percent of the tonnage; 1,561 power drills, which drilled 84 percent of the tonnage; 514 mobile loading machines, which loaded 58 percent of the tonnage; 67 continuous mining machines, with six mobile loaders used in conjunction, which produced 16 percent of the tonnage; and 12 hand-loaded conveyors. Other equipment included 627 locomotives, 646 shuttle cars, 582 shuttle buggies, and 156 gathering conveyors.

Equipment used at 74 strip mines included 105 power shovels, three draglines, 93 bulldozers, 29 power drills, and 193 trucks. An estimated 32 million cubic yards of overburden was removed.

Equipment used at 126 auger mines included 130 coal recovery augers, three power shovels, 73 bulldozers, one carryall scraper, 11 power drills, and 143 trucks.

Of the total coal production from the eastern Kentucky field, 34 percent was cleaned at 29 cleaning plants, 25 percent was crushed, and 11 percent was treated with oil or other materials.

In the western Kentucky coalfield, 81 mines in 10 counties produced 42.2 million tons compared with 92 mines in 10 counties that produced 39.2 million tons in 1965. Average production per mine increased from 426,000 tons to 521,000 tons. Underground mines produced 35 percent and strip mines produced 65 percent of the total. Shipments were 85 percent by rail or water and 15 percent by truck. All coal was sold on the open market.

Equipment used at 42 underground mines included 91 cutting machines, which cut 98 percent of the tonnage; 93 power drills, which drilled 98 percent of the tonnage; 88 mobile loading machines, which loaded 98 percent of the tonnage; and five continuous mining machines, which mined 2 percent of the tonnage.

Equipment used at 37 strip mines included 87 power shovels, 33 draglines, 128 bulldozers, two carryall scrapers, 53 power drills, and 233 trucks. An estimated 212 million cubic yards of overburden was removed.

Equipment used at two auger mines included two recovery augers and one bulldozer.

Twenty-five cleaning plants cleaned 70 percent of the coal; 59 percent was crushed and 4 percent was treated with oil.

Natural Gas Liquids.—Production of natural gasoline increased 20 percent, whereas output of liquefied petroleum gases decreased 2 percent. Natural gasoline output was 41 percent below its 1958 record and that for LPG 16 percent below its 1956 record.

Table 4.—Coal (bituminous) production, by counties

County	1965		1966	
	Short tons	Value	Short tons	Value
Bell	2,247,149	$6,891,231	2,678,746	$8,491,469
Boyd	30,736	121,038	16,171	71,152
Breathitt	470,833	1,415,484	834,439	2,246,043
Butler	170,000	657,760	W	W
Caldwell	-------	-------	17,230	54,619
Carter	19,155	77,769	28,800	127,584
Christian	36,354	132,423	26,530	86,500
Clay	1,482,991	5,906,475	1,207,659	5,059,713
Clinton	11,500	46,690	12,200	48,800
Daviess	1,052,780	2,717,377	W	W
Elliott	8,251	36,799	1,500	6,240
Floyd	4,957,516	26,123,150	5,348,456	29,506,620
Hancock	4,000	12,000	-------	-------
Harlan	5,634,624	29,065,220	6,268,082	32,235,695
Henderson	154,901	399,644	158,396	454,596
Hopkins	9,794,918	33,874,689	9,752,003	34,426,391
Jackson	21,581	86,324	30,463	152,315
Johnson	214,092	622,782	675,803	1,719,907
Knott	2,371,683	7,456,233	2,942,782	8,904,293
Knox	W	W	177,121	609,926
Laurel	W	W	16,100	71,001
Lawrence	2,800	9,408	-------	-------
Lee	23,900	119,500	20,500	102,500
Leslie	1,864,239	7,776,388	1,483,114	5,748,127
Letcher	5,787,726	24,062,912	6,117,820	28,081,686
Magoffin	62,333	193,232	190,395	535,986
Martin	406,180	1,313,916	519,834	1,864,154
McCreary	466,532	1,665,519	586,654	2,123,687
Morgan	62,199	286,246	30,808	159,200
Muhlenberg	17,613,846	56,482,664	18,853,730	62,508,627
Ohio	5,039,971	16,343,167	5,997,654	19,812,991
Owsley	3,500	10,500	-------	-------
Perry	3,922,686	16,297,408	4,763,729	19,685,521
Pike	15,420,122	60,808,493	16,307,862	66,984,912
Pulaski	272,524	1,230,412	303,443	1,391,042
Rockcastle	-------	-------	1,000	4,160
Union	5,315,584	19,198,873	5,089,434	19,914,248
Wayne	21,384	60,819	4,000	16,640
Webster	16,711	51,527	997,581	2,996,134
Whitley	541,230	2,140,772	398,086	1,684,701
Wolfe	4,000	16,240	-------	-------
Undistributed	235,180	811,769	1,297,752	5,552,997
Total	85,765,711	324,522,853	93,155,877	363,440,177
Earliest record to date	3,089,766,000	NA	3,182,922,000	NA

NA Not available.
W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Petroleum.—Crude oil production totaled 18.1 million barrels, a decrease of 1.3 million barrels from the 1965 production. Of the State's 120 counties, 62 contributed to total production.

Henderson County in western Kentucky continued to be the leading oil-producer with 3.1 million barrels. Other western Kentucky counties producing more than 1 million barrels were Union, Daviess, Hopkins, McLean, and Webster. Lee County led eastern Kentucky counties with 2.2 million barrels.

According to State records a total of 2,244 wells was drilled during 1966; 655 were completed as oil wells; 159 were completed as gas wells; 12 were injection wells for gas storage and oil field water supply; five were classified as stratigraphic tests, and 1,301 were reported as dry holes. Basement tests were drilled in Campbell, Carter, Clark, Jessamine, and Metcalfe Counties; all five were reported dry and abandoned.

There were no outstanding new oil discoveries in Kentucky in 1966. Important development, however, continued to take place on the former Camp Breckinridge tract in western Kentucky.

Table 5.—Crude petroleum production by counties

County	1965		1966	
	Barrels	Value	Barrels	Value
Adair	2,213	$6,351	1,155	$3,292
Allen	65,039	186,661	59,993	170,980
Barren	18,355	52,678	16,907	48,185
Bath	4,216	12,099	4,168	11,879
Bell	259	743	82	234
Boyd	37	106	39	111
Breathitt	52,506	150,692	44,541	126,942
Breckinridge	35,504	101,896	24,659	70,278
Butler	117,865	338,272	94,789	270,149
Casey	12,118	34,778	8,366	23,843
Christian	429,771	1,233,442	296,415	844,783
Clay	16,643	47,765	32,355	92,212
Clinton	52,902	151,828	58,182	165,819
Crittenden	251	720	232	661
Cumberland	54,972	157,769	43,270	123,319
Daviess	1,479,103	4,245,025	1,325,548	3,777,812
Edmonson	945	2,712	965	2,750
Elliott	55,298	158,705	54,155	154,342
Estill	164,216	471,300	174,713	497,932
Floyd	30,107	86,407	28,070	79,999
Green	136,022	390,383	138,338	394,293
Greenup	833	2,390	2,063	5,880
Hancock	165,246	474,256	139,780	398,373
Hart	44,433	127,522	40,839	116,391
Henderson	3,610,474	10,362,269	3,134,702	8,905,304
Hopkins	1,089,817	3,127,774	1,233,665	3,515,945
Jackson	835	2,396	253	721
Johnson	536,630	1,540,128	635,467	1,811,081
Knott	11,134	31,954	10,337	29,460
Knox	1,953	5,605	2,636	7,513
Laurel	1,485	4,261	2,727	7,772
Lawrence	521,578	1,496,928	509,572	1,452,280
Lee	2,604,011	7,473,511	2,193,978	6,252,837
Leslie	3,328	9,551	2,596	7,399
Letcher	13,599	39,029	16,606	47,327
Lincoln	4,332	12,432	2,071	5,902
Logan	927	2,660	819	2,334
Magoffin	734,018	2,106,631	603,948	1,721,252
Marion	------	------	123	351
Martin	14,187	40,716	13,331	37,993
McCreary	4,290	12,312	2,690	7,666
McLean	1,502,797	4,313,027	1,220,582	3,478,659
Menifee	1,199	3,441	878	2,502
Metcalfe	273,433	784,752	172,764	492,377
Monroe	22,988	65,975	221,709	631,871
Morgan	1,077	3,090	1,466	4,178
Muhlenberg	675,556	1,938,845	677,877	1,931,949
Ohio	747,190	2,144,435	620,390	1,796,611
Owsley	994	2,852	977	2,784
Perry	25,315	72,654	25,400	72,390
Pike	34,087	97,829	33,118	94,386
Powell	146,979	421,829	108,329	308,738
Russell	1,876	5,384	965	2,750
Simpson	6,282	18,029	5,391	15,364

Table 5.—Crude petroleum production by counties—Continued

County	1965		1966	
	Barrels	Value	Barrels	Value
Taylor	1,218	3,495	1,393	3,970
Todd	1,434	4,115	1,007	2,870
Union	2,507,590	7,196,783	2,766,633	7,884,904
Warren	36,842	105,736	31,475	89,704
Wayne	20,539	58,946	18,299	52,152
Webster	1,249,244	3,585,330	1,173,616	3,344,806
Whitley	19,793	56,806	14,768	42,088
Wolfe	18,115	51,990	13,818	39,381
Total	19,386,000	55,638,000	18,066,000	51,488,000
Earliest record to date	510,833,000	1,210,384,000	528,899,000	1,261,872,000

Source: Kentucky Geological Survey.

NONMETALS

Production of nonmetals accounted for 9 percent of the total value of mineral production in the State.

Cement.—Kosmos Portland Cement Co. operated the Kosmosdale plant throughout the year. Shipments of portland cement decreased 10 percent, from those of 1965 and masonry cement shipments decreased 5 percent below the 1965 record. Raw materials used in portland cement included limestone (76 percent), miscellaneous clay (20 percent), gypsum (3 percent), and iron ore (1 percent).

Clays.—Kentucky ranked second in the United States in ball clay production. Kentucky-Tennessee Clay Co. and Old Hickory Clay Co. mined ball clay at three mines in Graves County. Eight companies mined fire clay at 11 mines in three counties for firebrick, mortar, and other uses. Leading producers were General Refractories Co., Harbison-Walker Refractories Co., and Burchett Clay Co. Total fire clay production was 178,000 tons valued at $1.1 million, 20 percent below that of 1965.

Miscellaneous clay was mined by 12 companies at 14 mines in nine counties for heavy clay products, leightweight aggregate, and cement. Leading producers were Ohio River Sand Co., Inc., Kosmos Portland Cement Co., and General Shale Products Corp. Production increased 16 percent over that of 1965, the previous record year and totaled 974,000 tons valued at $1.2 million.

Fluorspar.—In Livingston and Crittenden Counties, fluorspar was mined for use in manufacturing hydrofluoric acid, glass, steel, ceramics, ferroalloys, and for use in iron foundries. Shipments were 29,000 tons valued at $1,361,000, a decline of 14 percent, from the previous year.

Lime.—National Carbide Co. regenerated lime by calcining sludge at plants in Marshall and Jefferson Counties.

Perlite.—Great Lakes Carbon Corp. of Kentucky expanded perlite mined in the Western States at its Florence plant. The perlite was used in the manufacture of insulation board. W. R. Grace & Co. expanded perlite at the Wilder plant near Newport.

Sand and Gravel.—Sand and gravel was mined by 25 producers, including State and County highway departments, at 33 operations in 21 counties. Leading counties were Jefferson, Boone, and Trimble. Leading commercial producers were Standard Materials Corp., Ohio River Sand Co., Owensboro River Sand & Gravel, Inc., and Nugent Sand Co. Producetion increased 20 percent over the 1965 record. Of the commercial production 92 percent was processed, 62 percent was hauled by truck, 32 percent by water, and 6 percent by rail.

Stone.—Eighty-one producers crushed limestone at 113 quarries in 67 counties. Leading counties were Livingston, Jefferson, and Warren. Leading producers were Kentucky Stone Co. (Anderson, Breckinridge, Hardin, Jessamine, Laurel, Lee, Logan, Rockcastle, and Todd Counties), Reed Crushed Stone Co., Inc. (Livingston County), and Vulcan Materials Co. (Fayette and Jefferson Counties).

Table 6.—Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1965		1966	
	Quantity	Value	Quantity	Value
Ballard	30	$18	32	$19
Boone	1,357	1,340	2,027	1,922
Carlisle	25	16	27	16
Fulton	27	14	W	W
Gallatin	W	W	299	W
Graves	56	28	57	29
Henderson	W	W	550	W
Hickman	28	14	29	14
Jefferson	2,012	1,693	2,161	1,848
Livingston	----	----	28	14
Lyon	----	----	21	11
Marshall	76	38	77	38
Martin	23	20	20	20
Mason	71	111	81	116
McCracken	W	W	319	W
Pike	4	4	----	----
Trimble	W	W	895	W
Union	34	36	349	377
Other counties [1]	2,999	3,000	1,092	3,100
Total	6,742	6,332	8,064	7,524

W Withheld to avoid disclosing individual company confidential data; included with "Other counties."
[1] Includes Breckinridge, Calloway, Daviess, Floyd (1966), and Oldham (1965) Counties, and counties indicated by symbol W.

Table 7.—Sand and gravel sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1965			1966		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	2,104	$2,119	$1.01	2,809	$2,945	$1.05
Paving	1,499	1,308	.87	1,352	1,296	.96
Fill	800	475	.59	1,007	489	.49
Gravel:						
Structural	1,383	1,423	1.03	1,302	1,355	1.04
Paving	745	823	1.10	1,205	1,097	.91
Fill	161	89	.55	153	82	.54
Total sand and gravel [1]	6,742	6,332	.94	8,064	7,524	.93

[1] Includes molding, engine, and other sands; railroad ballast (1965) and other gravel.

Vermiculite.—W. R. Grace & Co. exfoliated vermiculite from other States at the Wilder plant.

METALS

Mining and milling of metallic ores accounted for less than 1 percent of the total value of mineral production in Kentucky.

Ferroalloys.—Shipments of ferroalloys, including ferromanganese, silicomanganese, silvery pig iron, ferrosilicon, ferrochromium, and ferrochromium-silicon, increased 51 percent over those of 1965.

Lead.—Byproduct recovery of lead concentrate from fluorspar milling decreased 36 percent.

Pig Iron and Steel.—Armco Steel Corp. produced foundry and basic pig iron at Ashland; production declined 10 percent below the 1965 record. Steel was produced by Armco Steel Corp. at Ashland, Interlake Steel Corp. at Newport, Green River Steel Co. at Owensboro, and Kentucky Electric Steel Co. near Princess. Iron ore consumed was 1 percent domestic and 99 percent imported.

Table 8.—Crushed limestone sold or used by producers, by counties

County	1965		1966	
	Short tons	Value	Short tons	Value
Allen	W	W	114,098	W
Barren	W	W	213,000	W
Bourbon	W	W	153,351	W
Boyle	228,248	$354,637	209,625	$324,634
Butler	W	W	81,611	W
Calloway	208,606	312,787	W	W
Carter	415,605	571,625	504,414	667,016
Casey	91,123	155,273	115,210	204,585
Christian	943,876	1,118,265	949,244	1,076,514
Fayette	1,073,420	1,530,961	1,191,833	1,483,610
Fleming	W	W	218,261	W
Franklin	W	W	593,474	801,000
Garrard	97,984	149,200	63,499	82,548
Grayson	W	W	189,374	W
Greenup	-------	-------	53,476	80,200
Hardin	2,280,628	2,580,672	1,271,428	1,629,000
Harrison	W	W	185,304	W
Hart	W	W	134,449	201,673
Jackson	W	W	73,600	110,000
Jefferson	1,652,606	2,529,036	1,561,450	2,255,147
Kenton	5,734	8,585	1,732	2,598
Marion	139,000	273,000	W	W
Meade	887,271	1,328,747	991,155	1,336,500
Menifee	85,845	138,922	88,434	136,160
Mercer	W	W	108,000	170,800
Monroe	125,000	156,040	156,073	311,676
Montgomery	76,800	91,460	71,144	83,258
Morgan	478,067	564,072	445,408	712,232
Nelson	W	W	197,600	W
Nicholas	44,000	88,000	63,000	126,000
Oldham	508,000	620,200	853,877	1,172,000
Powell	W	W	209,564	309,938
Simpson	W	W	81,250	W
Trigg	W	W	172,000	215,000
Warren	W	W	1,231,331	1,519,335
Wayne	W	W	90,311	W
Other counties [1]	16,686,761	21,960,902	10,029,264	16,167,331
Total	26,028,574	34,532,384	22,666,844	31,178,755

W Withheld to avoid disclosing individual company confidential data; included with "Other counties."
[1] Includes Adair, Anderson, Breckinridge, Caldwell, Clinton, Crittenden, Cumberland, Edmonson, Estill, Green, Harlan, Henry, Jessamine, Laurel, Lee, Letcher, Livingston, Logan, Madison, Metcalfe, Muhlenberg, Ohio, Pendleton, Pike, Pulaski, Rockcastle, Rowan (1965), Scott, Taylor (1966), Todd, Washington, and Wolfe Counties, and counties indicated by symbol W.

Table 9.—Crushed limestone sold or used by producers, by uses

Use	1965			1966		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	19,969,952	$27,345,994	$1.37	17,964,878	$24,424,998	$1.36
Agstone	2,221,865	3,120,335	1.40	1,923,659	2,929,806	1.52
Railroad ballast	W	W	W	341,078	407,400	1.19
Stone sand	32,400	35,246	1.09	W	W	W
Other uses [1]	3,804,357	4,030,809	1.06	2,437,229	3,416,551	1.40
Total	26,028,574	34,532,384	1.33	22,666,844	31,178,755	1.38

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."
[1] Includes riprap, asphalt filler (1965), cement, fertilizer filler (1966), and other uses, and uses indicated by symbol W.

Silver.—Byproduct recovery of silver from milling of fluorspar ore decreased 44 percent.

Zinc.—Production of zinc concentrates increased 16 percent above the 1965 record. Most of the zinc was produced by Eagle-Picher Co. at the Hutson mine. Some zinc was recovered as a byproduct of fluorspar milling.

REVIEW BY COUNTIES

Of the 120 counties, 108 reported production, one more than in 1965. The leading counties were the large coal and petroleum producers, Pike, Muhlenberg, Hopkins, Harlan, Floyd, Letcher and Union, which supplied 58 percent of the State total mineral value. In addition to detailed county production listed in table 10, natural gas and natural gas liquids, of undetermined county origin, were produced.

Adair.—Shamrock Stone Co. (Butler and Patton quarries) crushed limestone for concrete, roads, and agricultural stone (agstone).

Allen.—McLellan Stone Co. (Scottsville quarry) crushed limestone for concrete, roads, and agstone.

Anderson.—Kentucky Stone Co. (Tyrone mine) crushed limestone for concrete, roads, agstone, and railroad ballast.

Barren.—J. F. Pace Construction Co. crushed limestone for concrete, roads, agstone, and other uses.

Bell.—Leading producers of coal were Mountain Drive Coal Corp. (No. 1–C strip mine), Round Mountain Coal Co. Inc. (No. 1 strip mine), and Brownies Creek Colleries, Inc. (No. 1 strip mine).

Boone.—Standard Materials Corp. (Belleview mine), R. W. Greene, Jr., Sand & Gravel, Inc. (Burlington mine), Kentucky Sand Co. (Taylorsport mine) and Cooke Aggregate, Inc. (Petersburg mine) mined sand and gravel for structural, paving, and fill uses. Great Lakes Carbon Corp. of Kentucky expanded perlite at the Florence plant for use in manufacturing insulation board.

Bourbon.—Quincy Quarries, Inc., crushed limestone for concrete, roads, and agstone.

Table 10.—Value of mineral production in Kentucky, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value [2]
Adair	W	W	Limestone, petroleum.
Allen	W	W	Petroleum, limestone.
Anderson	W	W	Limestone.
Ballard	$18,000	$19,000	Sand and gravel.
Barren	W	W	Limestone, petroleum.
Bath	12,099	11,879	Petroleum.
Bell	6,891,974	8,491,703	Coal, petroleum.
Boone	1,340,000	1,922,000	Sand and gravel.
Bourbon	W	W	Limestone.
Boyd	195,544	120,263	Coal, miscellaneous clay, petroleum.
Boyle	354,637	324,634	Limestone.
Breathitt	1,566,176	2,372,985	Coal, petroleum.
Breckinridge	W	W	Limestone, petroleum, sand and gravel.
Bullitt	W	W	Miscellaneous clay.
Butler	W	W	Coal, petroleum, limestone.
Caldwell	W	W	Limestone, coal.
Calloway	W	W	Limestone, sand and gravel.
Carlisle	16,000	16,000	Sand and gravel.
Carter	1,367,955	1,288,200	Limestone, fire clay, coal.
Casey	190,051	228,428	Limestone, petroleum.
Christian	2,488,713	2,011,347	Limestone, petroleum, coal, miscellaneous clay.
Clay	5,954,240	5,151,925	Coal, petroleum.
Clinton	W	W	Petroleum, limestone, coal.
Crittenden	W	W	Limestone, fluorspar, zinc, petroleum, lead.
Cumberland	W	W	Petroleum, limestone.
Daviess	W	W	Coal, petroleum, sand and gravel, miscellaneous clay.
Edmonson	W	W	Native asphalt, limestone, petroleum.
Elliott	195,504	160,582	Petroleum, coal.
Estill	W	W	Petroleum, limestone.
Fayette	1,530,961	1,483,610	Limestone.
Fleming	W	W	Do.
Floyd	26,209,557	W	Coal, petroleum, sand and gravel.
Franklin	W	801,000	Limestone.
Fulton	14,000	W	Sand and gravel.
Gallatin	W	W	Do.
Garrard	149,200	82,548	Limestone.
Graves	W	W	Ball clay, sand and gravel.
Grayson	W	W	Limestone.
Green	W	W	Petroleum, limestone.
Greenup	322,990	W	Limestone, fire clay, petroleum.

Table 10.—Value of mineral production in Kentucky, by counties [1]—Continued

County	1965	1966	Minerals produced in 1966 in order of value [2]
Hancock	$790,956	$733,173	Petroleum, miscellaneous clay.
Hardin	2,580,672	1,629,000	Limestone.
Harlan	W	W	Coal, limestone.
Harrison	W	W	Limestone.
Hart	W	318,064	Limestone, petroleum.
Henderson	W	W	Petroleum, sand and gravel, coal.
Henry	W	W	Limestone.
Hickman	14,000	14,000	Sand and gravel.
Hopkins	37,002,463	37,942,336	Coal, petroleum.
Jackson	W	263,036	Coal, limestone, petroleum.
Jefferson	W	W	Cement, limestone, sand and gravel, miscellaneous clay.
Jessamine	W	W	Limestone.
Johnson	2,162,910	3,530,988	Petroleum, coal.
Kenton	8,585	2,598	Limestone.
Knott	7,488,187	8,933,753	Coal, petroleum.
Knox	W	W	Coal, miscellaneous clay, petroleum.
Laurel	W	W	Coal, limestone, petroleum.
Lawrence	1,506,336	1,452,280	Petroleum.
Lee	W	W	Petroleum, limestone, coal.
Leslie	7,785,939	5,755,526	Coal, petroleum.
Letcher	W	W	Coal, limestone, petroleum.
Lincoln	12,432	5,902	Petroleum.
Livingston	W	W	Limestone, zinc, fluorspar, lead, sand and gravel, silver.
Logan	W	W	Limestone, petroleum.
Lyon	---	11,000	Sand and gravel.
Madison	W	W	Limestone.
Magoffin	2,299,863	2,257,238	Petroleum, coal.
Marion	273,000	W	Limestone, petroleum.
Marshall	38,000	38,000	Sand and gravel.
Martin	1,374,632	1,922,147	Coal, petroleum, sand and gravel.
Mason	111,000	116,000	Sand and gravel.
McCracken	W	W	Do.
McCreary	1,677,831	2,131,353	Coal, petroleum.
McLean	4,313,027	3,478,659	Petroleum.
Meade	1,328,747	1,336,500	Limestone.
Menifee	142,363	138,662	Limestone, petroleum.
Mercer	W	170,800	Limestone.
Metcalfe	W	W	Petroleum, limestone.
Monroe	222,015	943,547	Do.
Montgomery	91,460	83,258	Limestone.
Morgan	853,408	875,610	Limestone, coal, petroleum.
Muhlenberg	W	W	Coal, petroleum, limestone.
Nelson	W	W	Limestone.
Nicholas	88,000	126,000	Do.
Ohio	W	W	Coal, petroleum, limestone.
Oldham	W	1,172,000	Limestone.
Owsley	13,352	2,784	Petroleum.
Pendleton	W	W	Limestone.
Perry	16,370,062	19,757,911	Coal, petroleum.
Pike	W	W	Coal, petroleum, limestone.
Powell	W	W	Limestone, petroleum, miscellaneous clay.
Pulaski	W	W	Coal, limestone.
Rockcastle	W	W	Limestone, coal.
Rowan	468,380	W	Fire clay, miscellaneous clay.
Russell	5,384	2,750	Petroleum.
Scott	W	W	Limestone.
Simpson	W	W	Limestone, petroleum.
Taylor	3,495	W	Do.
Todd	W	W	Do.
Trigg	W	215,000	Limestone.
Trimble	W	W	Sand and gravel.
Union	26,431,656	28,176,152	Coal, petroleum, sand and gravel.
Warren	W	1,609,039	Limestone, petroleum.
Washington	W	W	Limestone.
Wayne	W	W	Limestone, petroleum, coal.
Webster	3,636,857	6,340,940	Petroleum, coal.
Whitley	2,197,578	1,726,789	Coal, petroleum.
Wolfe	W	W	Petroleum, limestone.
Undistributed [3]	296,270,809	340,665,101	
Total	466,381,000	498,364,000	

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

[1] Excludes natural gas and natural gas liquids; included with "Undistributed." The following counties did not report production: Bracken, Campbell, Carroll, Clark, Grant, Larue, Lewis, Owen, Robertson, Shelby, Spencer, and Woodford.

[2] Other than natural gas and natural gas liquids.

[3] Includes natural gas, natural gas liquids, and values indicated by symbol W.

Table 11.—Oil and gas wells drilled, by counties

County	Development wells				Wildcat wells			
	Drilled	Total depth, feet	Completed		Drilled	Total depth, feet	Completed	
			Oil	Gas			Oil	Gas
Adair	8	3,241	2	--	23	13,642	--	--
Allen	23	8,723	7	--	11	6,096	--	--
Barren	10	4,327	3	--	85	40,973	1	1
Boyd	--	--	--	--	2	6,690	--	2
Breathitt	4	6,493	--	3	2	3,335	--	1
Breckinridge	9	4,267	--	--	2	2,286	--	--
Bullitt	--	--	--	--	1	150	--	--
Butler	15	6,585	10	--	3	3,301	--	--
Campbell	--	--	--	--	1	3,602	--	--
Carter	--	--	--	--	1	5,252	--	--
Casey	--	--	--	--	9	8,885	--	--
Christian	4	2,346	1	--	5	6,425	--	--
Clark	--	--	--	--	1	2,775	--	1
Clay	28	62,250	5	9	12	30,838	1	3
Clinton	20	15,955	11	--	11	15,316	3	--
Crittenden	--	--	--	--	4	4,967	--	--
Cumberland	34	16,019	11	--	29	16,397	5	--
Daviess	93	122,836	50	--	27	44,605	4	--
Edmonson	--	--	--	--	1	3,131	--	--
Elliott	9	9,782	7	--	5	4,505	2	--
Estill	21	19,281	19	--	5	5,053	--	--
Floyd	5	13,467	--	4	3	6,325	1	--
Garrard	5	458	3	--	2	2,532	--	--
Grant	--	--	--	--	1	3,557	--	--
Green	53	21,895	50	--	11	5,774	5	--
Greenup	1	829	1	--	2	2,460	1	--
Hancock	13	7,602	7	--	4	3,397	--	--
Hardin	--	--	--	--	7	7,461	--	--
Hart	6	4,269	2	--	4	3,707	1	--
Henderson	65	110,280	34	--	11	20,874	2	--
Hopkins	59	139,306	21	12	49	119,060	8	2
Jackson	--	--	--	--	2	3,983	--	--
Jessamine	--	--	--	--	1	5,800	--	--
Johnson	22	34,804	10	8	2	4,941	--	1
Knott	15	36,406	--	14	--	--	--	--
Laurel	--	--	--	--	5	15,179	3	--
Lawrence	15	21,629	6	9	4	7,763	1	2
Lee	11	11,261	11	--	--	--	--	--
Letcher	13	47,436	--	12	1	4,071	--	1
Logan	--	--	--	--	1	210	--	--
Magoffin	18	18,178	16	1	3	4,670	--	--
Marion	2	280	--	--	3	5,860	--	--
Martin	7	16,573	--	7	--	--	--	--
McCreary	2	740	1	--	3	4,452	--	--
McLean	46	77,496	17	--	19	39,814	2	1
Menifee	--	--	--	--	2	2,066	--	--
Metcalfe	52	17,471	20	--	50	28,170	3	1
Monroe	187	74,822	85	2	221	110,661	11	1
Montgomery	--	--	--	--	5	3,206	1	--
Muhlenberg	45	64,625	14	10	21	35,469	--	--
Ohio	69	48,900	28	1	18	21,494	1	--
Owen	--	--	--	--	3	4,003	--	--
Pendleton	--	--	--	--	1	400	--	--
Perry	28	96,302	1	26	1	2,715	1	--
Pike	19	65,989	--	18	--	--	--	--
Powell	5	3,541	3	--	2	5,074	--	--
Pulaski	--	--	--	--	2	3,682	1	--
Rockcastle	--	--	--	--	1	2,750	--	--
Rowan	2	785	2	--	1	3,353	--	--
Russell	--	--	--	--	2	2,051	1	--
Simpson	--	--	--	--	4	2,670	--	--
Taylor	1	587	--	--	1	485	--	--
Todd	--	--	--	--	2	2,641	--	--
Union	164	363,321	95	--	71	190,348	20	1
Warren	--	--	--	--	6	7,498	1	--
Wayne	8	8,749	6	--	14	13,484	1	--
Webster	46	102,807	23	--	14	37,310	7	--
Whitley	6	7,433	--	4	8	10,820	1	--
Wolfe	13	19,769	--	10	1	4,772	--	--

Source: American Association of Petroleum Geologists.

Boyd.—Big Run Coal & Clay Co. (Big Run strip mine) and Rush Coal Co. (No. 1 strip mine) mined bituminous coal. Big Run Coal & Clay Co. (Princess mine) mined miscellaneous clay for manufacturing brick.

Armco Steel Corp. produced pig iron and steel at the Ashland plant. Kentucky Electric Steel Co. produced steel near Princess. Allied Chemical Corp. produced by-product coke.

Boyle.—Caldwell Stone Co. Inc. (Danville quarry) and Boyle County Highway Department (Perryville quarry) crushed limestone for concrete, roads, and agstone.

Breathitt.—The leading producing coal mines were Trail Run Coal Co. (No. 1 strip mine), Breathitt County Coal Corp. (No. 1 strip mine), and Terry Elkhorn Mining Co. (No. 4 strip mine).

Breckinridge.—Kentucky Stone Co. (Webster quarry) and White Stone Co. (Hardinsburg quarry) crushed limestone for concrete, roads, railroad ballast, and agstone. Cloverport Sand & Gravel Co. produced sand and gravel.

Bullitt.—Ohio River Sand Co. (Shepherdsville mine) mined miscellaneous clay for lightweight aggregates.

Butler.—The leading coal producers were Key-Wilson Co. Inc. (Key No. 2 strip mine), Skoog & Stuart Coal Co. (No. 2 mine), and M. R. Melton Coal Co. (Green River No. 2 mine). Gary Bros. Crushed Stone Co. (Morgantown quarry) crushed limestone for concrete, roads, and agstone.

Caldwell.—Cedar Bluff Stone Co. Inc. (Princeton mine) and Fredonia Valley Quarries, Inc. (Fredonia quarry), crushed limestone for concrete, roads, and agstone. Auger Mining Co. (Caldco mine) mined coal.

Calloway.—Greenville Quarries, Inc., crushed limestone for concrete, roads, and agstone. Calloway County Highway Department and the State highway department mined paving gravel. Murray Silica Sand Co. mined molding and miscellaneous industrial sand.

Campbell.—W. R. Grace & Co. exfoliated crude vermiculite, and expanded perlite at the Wilder plant. Interlake Steel Corp. produced steel at Newport.

Carter.—Acme Stone Co. Inc. (Olive Hill quarry), Valley Stone Co., Inc. (Olive Hill quarry), Standard Slag Co. (Carter quarry), and Smith's Branch Stone Co. (Coalton quarry) crushed limestone for concrete, roads, and agstone. Eight mines produced fire clay for firebrick and block, and fire clay mortar. The leading producers were Harbison-Walker Refractories Co. (Brinegar strip mine) and General Refractories Co. (Grahn and Grefco Bennett strip mines) Elliott County Mining Co. (No. 6 mine) and Lost Creek Coal Co. (No. 1 mine) were the only coal producers.

Casey.—Casey Stone Co. (Bethel Ridge mine) crushed limestone for concrete, roads, and agstone.

Christian.—Hopkinsville Stone Co. Inc. (Hopkinsville quarry), Christian Quarries, Inc. (Hopkinsville quarry), and Harry Berry, Inc. (Fort Campbell quarry) crushed limestone for concrete, roads, agstone, and riprap. Auger Mining Co. (No. 2 and No. 3 mines) produced coal. Dalton Bros. Brick Co. mined miscellaneous clay.

Clay.—Shamrock Coal Co. (No. 15 mine), and Mountain Clay, Inc. (No. 1 strip mine) were the leading coal producers in the county.

Clinton.—Shamrock, Inc. (Caldwell quarry) crushed limestone for concrete, roads, and agstone. M & G Coal Co. (No. 3 mine) and Cross Coal Co. (No. 2A mine) produced coal.

Crittenden.—Alexander Stone Co. Inc. crushed limestone for concrete, roads, and agstone. Minerva Oil Co. and Marion Chemical Co. mined fluorspar.

Cumberland.—Shamrock Stone, Inc. (Wells quarry) crushed limestone for concrete, roads, and agstone.

Daviess.—The leading coal producers were Green Coal Co. (K–9 strip mine) and Morris Enterprises (Morris strip mine). Owensboro River Sand & Gravel Co. and Daviess County Sand & Gravel Co. mined sand and gravel for structural, paving and fill uses. Joseph L. Clark Tile Co. (Moselyville mine) mined miscellaneous clay for use in heavy clay products.

Edmonson.—McLellan Stone Co. (Park City quarry) and Nolin Stone Co. (Bee Springs quarry) crushed limestone for con-

crete, roads, and agstone. Gripstop Corp. (Indian Creek mine) mined asphaltic sandstone for road surfacing.

Estill.—Estill County Stone Co. Inc. mined limestone for concrete, roads, and agstone.

Fayette.—Vulcan Materials Co. (Lexington quarry), Central Rock Co. Inc. (Lexington quarry and mine), and Blue Grass Stone Co. crushed limestone for concrete, roads, and agstone.

Fleming.—Gorman Construction Co., Inc. (Carpenter quarry) crushed limestone for concrete, roads, and agstone.

Floyd.—Floyd County ranked fifth in the State in value of mineral production. The leading producing coal mines were Island Creek Coal Co. (Buckingham mine), Cedar Creek Coal Co. Inc. (Cedar Creek No. 9 mine), and Island Creek Coal Co., Inc. (Price No. 2 mine). Mare Creek Sand Co. (Allen mine) produced structural sand.

Franklin.—Falls City Concrete & Stone Co., at three mines, crushed limestone for concrete, roads, and agstone.

Fulton.—Hickman Sand & Gravel Co. and the State highway department produced sand and gravel.

Gallatin.—Standard Materials Corp. (Warsaw mine) mined sand and gravel for building and paving.

Garrard.—Camp Nelson Stone, Inc. (Lancaster quarry), crushed limestone for concrete and roads.

Graves.—Kentucky-Tennessee Clay Co. and Old Hickory Clay Co. (Hickory and Lampkin mines) mined ball clay for whiteware, art pottery, floor and wall tile, enameling, foundries and steel works, plastics, and other uses. The State highway department mined paving gravel.

Grayson.—Ragland Quarry, Inc. (Ragland No. 2 quarry) and Rogers and Brunnhoeffer (Grayson County quarry) crushed limestone for concrete and roadstone.

Green.—Nally & Gibson Quarries, Inc. (Greensburg quarry), crushed limestone for concrete, roads, and agstone.

Greenup.—Greenup Stone Co. crushed limestone for concrete, roads, and agstone. C. H. Chaney Clay Co. (No. 5 mine) mined fire clay.

Hancock.—Four mines produced miscellaneous clay for heavy clay products. Harsco Corp. (No. 1 mine) and Owensboro Brick & Tile Co. were the leading producing mines.

Hardin.—Four quarries produced limestone for concrete, roads, and agstone. The leading producers were Kentucky Stone Co. (Upton quarry), Osborn Bros. Quarry Co. and Waters Construction Co. (Elizabethtown quarry).

Harlan.—Harlan County ranked fourth in the State in value of mineral production. The leading producing coal mines were United States Steel Co. (No. 32 and No. 7 South Main mines) and International Harvester Co. (No. 10 mine). Nally & Boone Stone Co. (Harlan quarry) crushed limestone for concrete, roads, and agstone.

Harrison.—Genet Stone Co. Inc. (Cynthiana quarry) crushed limestone for concrete, roads, and agstone.

Hart.—Hart Stone Co. (Horse Cave quarry) crushed limestone for concrete, roads, and agstone.

Henderson.—Evansville Materials, Inc. dredged sand and gravel for construction and fill purposes. The leading coal producers were Dolph Hazelwood Coal Co. (No. 3 mine), Goldberry Coal Co. (No. 2 mine), and Peckenpaugh & Hazelwood Coal Co. (No. 1 mine).

Henry.—Geoghegan & Mathis, Inc. (Lockport quarry) crushed limestone for concrete, roads, and agstone.

Hopkins.—Hopkins County ranked third in the State in total value of mineral production. The leading producing coal mines were Island Creek Coal Co. (East Diamond mine), Pittsburg & Midway Coal Co. (Colonial strip mine) and Island Creek Coal Co. (Fies mine).

Jackson.—M. A. Walker Co., Inc. (Indian Creek and Clover Bottom mines) crushed limestone for concrete, roads, and agstone. The leading producing coal mines were Hamm Coal Co. (No. 4 mine), Hamm Coal Co. (No. 3 mine), and T. R. Marcum Coal Co. (No. 2 mine).

Jefferson.—Kosmos Portland Cement Co. produced masonry and portland cements at

the Kosmosdale plant. Limestone was crushed at three quarries and one mine. The major producers were Vulcan Materials Co. (Okolona quarry), Louisville Crushed Stone Co. Inc. (Louisville quarry), and Falls City Stone Co. (Fern Creek quarry). Four producers mined sand and gravel for structural, paving, fill, and other uses. Ohio River Sand Co. Inc., Nugent Sand Co., and E. T. Slider, Inc., were the leading producers. Kosmos Portland Cement Co. (Kosmosdale mine) and General Shale Products (Coral Ridge mine) mined miscellaneous clay for use in cement manufacture and heavy clay products. National Carbide Co. regenerated lime for chemical and industrial uses at its Louisville plant.

Jessamine.—Kentucky Stone Co. crushed limestone at High Bridge for concrete, roads, and agstone.

Johnson.—Geoglein Coal Co. (3G strip mine), Triple G Coal Co. (No. 1 strip mine), and Tudor Key Coal Co. (No. 1 mine) were the leading coal producers.

Kenton.—Franxman Bros. crushed limestone for roadstone.

Knott.—Leading coal producers were Mountain Top Stripping Co., Inc. (No. 1 strip mine), Caperton Coal Co. (Caperton mine), and Pine Bluff Coal Co. (No. 1 auger mine).

Knox.—Brownies Creek Coal Co. (No. 2 mine), Co-Op Coal Co. (No. 1 mine), and Hill Coal Co. (No. 1 mine) were the leading coal producers. Corbin Brick Co. Inc. mined miscellaneous clay for brick.

Laurel.—Kentucky Stone Co. (Laurel quarry) crushed limestone for concrete and roadstone. Coal was produced by Margin Coal Co. (No. 4 mine) and London Fuel Co. (No. 3 mine).

Lee.—Kentucky Stone Co. (Yellow Rock mine) crushed limestone for concrete, roadstone, railroad ballast, and agstone. Coal was produced by Congleton Bros. Coal Co., Inc. (No. 5 Pacemaker mine).

Leslie.—The leading producing coal mines were Deby Coal Co. (No. 2 mine) and Finley Coal Co. (No. 9 and No. 10 mines).

Letcher.—Beth-Elkhorn Corp. (No. 22 mine), Scotia Coal Co. (Scotia mine), and South East Coal Co. (Polly No. 4 mine) were the leading producing coal mines. Levisa Stone Corp. (Jenkins quarry) and Hurricane Gap Quarries, Inc., crushed limestone for concrete and roads.

Livingston.—Reed Crushed Stone Co. (Grand Rivers quarry) and Three Rivers Rock Co. (Smithland quarry) quarried limestone for riprap, concrete, roadstone, agstone, and railroad ballast. Calvert City Chemical Co. mined and milled fluorspar at the Dyer's Hill mine and treated the concentrate in the Mexico mill in Crittenden County to recover acid-grade fluorspar. Nancy Hanks Mines, Inc., produced fluorspar at the Nancy Hanks mine. Byproduct crushed limestone, and zinc and lead concentrates were recovered from fluorspar milling. A small quantity of silver was recovered from the concentrates. Eagle-Picher Co. mined and milled high-grade zinc ore at the Hutson mine. The State highway department mined gravel for paving.

Logan.—Kentucky Stone Co. (Russellville mine) and Kemp Stone Co. (Russellville quarry) crushed limestone for concrete, roadstone, agstone, and railroad ballast.

Madison.—Boonesboro Quarry, Inc., mined limestone at Boonesboro for concrete, roadstone, and agstone.

Magoffin.—The leading coal producers were Ken Lick Coal Co. (No. 1 auger mine), Terry Elkhorn Mining Co. (No. 3 strip mine), and Oakley Coal Co. (No. 1 mine).

Marion.—Lebanon Stone Co., Inc. and Ward & Montgomery (Lebanon quarry) crushed limestone at Lebanon for concrete, roadstone, and agstone.

Marshall.—The State highway department mined paving gravel. National Carbide Co. regenerated lime for chemical and industrial uses at the Calvert City plant. Pittsburgh Metallurgical Co. produced ferroalloys at the Calvert City plant. New York Mining & Manufacturing Co. produced metallurgical coke.

Martin.—The leading coal producers were Wolf Creek Colliers, Peter Cove Coal Co. (No. 1 mine) and Francis & Sons Coal Co. (No. 3 mine). Sands of Rockcastle Creek, Inc., mined sand for building and paving.

Mason.—J. F. Hardyman mined sand and gravel for structural, paving, and fill uses.

McCracken.—Federal Materials Co., Inc. (Paducah mine) mined sand and gravel for building and paving.

McCreary.—The leading producing coal mines were worked by B. R. Campbell & Son, Inc. (No. 16–2, No. 21, and No. 23 mines).

Meade.—Kosmos Portland Cement Co. crushed limestone for use in its cement plant at Kosmosdale. Owensboro River Sand & Gravel Co., Inc. (Riverside mine) and Osborne Bros. Quarry Co. (Doe Run quarry) crushed limestone for concrete, roads, and agstone.

Menifee.—A. W. Walker & Son (Indian Creek quarry) crushed limestone for concrete, roads, and agstone.

Mercer.—Mercer Stone Co. (Mercer quarry) and the county highway department crushed limestone for concrete, roadstone, and agstone.

Metcalfe.—Montgomery & Co. (Chapman quarry) crushed limestone for concrete, roadstone, and agstone.

Monroe.—Trico Stone, Inc. (Monroe quarry), crushed limestone for concrete, roadstone, and agstone.

Montgomery.—Montgomery County Stone Co. (Mount Sterling Quarry) crushed limestone for concrete, roadstone, and agstone.

Morgan.—Magoffin, Johnson & Morgan Stone Co., Kentucky Road Oiling Co. (Wrigley quarry), and Licking River Limestone Co. (Zag quarry) crushed limestone for concrete, roadstone, and agstone. Branham Coal Co. (No. 2 strip mine) was the leading coal producer.

Muhlenberg.—Muhlenberg County ranked second in the State in total value of mineral production. The leading producing coal mines were Peabody Coal Co. (Sinclair strip mine), and Peabody Coal Co. (Vogue strip mine). Greenville Quarries, Inc., and AAA Stone Co., Inc., crushed limestone at Greenville for concrete, roadstone, and agstone.

Nelson.—Geoghegan & Mathis, Inc. (Nelson quarry) crushed limestone for concrete, roadstone, and agstone.

Nicholas.—The county highway department crushed limestone for concrete and roadstone.

Ohio.—Peabody Coal Co.'s Homestead, Ken, and Ken No. 3 strip mines were the leading coal producers. Fort Hartford Stone Co., Inc. and State Contracting & Stone Co. crushed limestone for concrete, roadstone, railroad ballast, agstone, and riprap at Hartford.

Oldham.—Ohio River Stone Co. (Prospect mine), Liter's Quarry, Inc. (Crestwood mine), and Joe Clark Stone Co. (Clark quarry) crushed limestone for concrete, roadstone, and agstone.

Pendleton.—Geoghegan & Mathis, Inc. (Butler and Falmouth quarries) crushed limestone for concrete, roadstone, and agstone.

Perry.—Blue Diamond Coal Co. (Leatherwood No. 1 mine), Blair Fork Coal Co. (Blair Fork mine) and Black Eagle Coal Co. (No. 1 auger mine) were the leading coal producers.

Pike.—Pike County ranked first in total value of mineral production. Eastern Coal Corp. (Stone mine), Kentland Elkorn Coal Corp. (Kentland No. 1 mine) and Republic Steel Corp. (Republic mine) were the leading coal producers. Johnson Bros. Limestone Co. crushed limestone for concrete and roads.

Powell.—A. W. Walker & Son (No. 213 quarry) and Natural Bridge Stone Co., Inc. crushed limestone for concrete, roads, and agstone. H. B. Sipple Brick Co. (Ponderosa No. 1 mine) and Big Run Coal & Clay Co. (West Bend mine) mined miscellaneous clay for use in heavy clay products.

Pulaski.—Strunk Construction, Inc. (Tateville quarry) and Somerset Stone Co., Inc. crushed limestone for concrete, roads, and agstone. The leading coal producers were Cumberland River Coal Co., Inc. (No. 1 mine), and Ikerd & Bandy Coal Co., Inc. (No. 4H and No. 4I strip mines).

Rockcastle.—Kentucky Stone Co. (Mullins and Mt. Vernon mines) crushed limestone for concrete, roads, railroad ballast, and agstone. Crooked Creek Coal Co. (No. 1 mine) produced coal.

Rowan.—General Refractories Co. mined fire clay at two strip mines for use in making firebrick and block. Lee Clay Products Co., Inc., mined miscellaneous clay for use in heavy clay products.

Scott.—Nally & Gibson Stone Co. (Georgetown quarry) crushed limestone for concrete, roads, and agstone.

Simpson. — Southern Stone Co., Inc. (Franklin quarry), crushed limestone for concrete, roads, and agstone.

Taylor.—Nally & Gibson Stone Co. (Campbellsville quarry) crushed limestone for concrete, roads, and agstone.

Todd.—Kentucky Stone Co. (Todd quarry) crushed limestone for concrete, roads, and agstone.

Trigg.—Cedar Bluff Stone Co., Inc., crushed limestone for concrete, roads, and agstone.

Trimble.—Standard Materials Corp. (Milton mine) produced sand and gravel for building, paving, and fill uses.

Union.—The leading coal producers were Pittsburgh & Midway Coal Mining Co. (DeKoven mine), Island Creek Coal Co. (Uniontown mine), and Pittsburgh & Midway Coal Mining Co. (DeKoven No. 6 mine). Delta Materials Co. (Shawneetown Bar and Tradewater Bar mines) and Union Sand & Gravel Co. (Morganfield mine) mined sand and gravel for structural, paving, and fill uses.

Warren.—McLellan Stone Co. (Warren County quarry) and Gary Brothers Crushed Stone Co. crushed limestone for concrete, roads, and agstone.

Washington.—Nally & Gibson Stone Co. (Washington quarry) crushed limestone for concrete, roads, and agstone.

Wayne.—Reynolds Coal Co. (No. 2 mine), produced coal. Bassett Products Co. crushed limestone for concrete, roads, and agstone.

Webster.—Pyro Mining Co. (Pyro mine) was the leading coal producer.

Whitley.—Royal Jellico Coal Co. (No. 1 mine), Twin Peaks Coal Co. (No. 3 mine), and Collins & Peace Coal Co. (No. 5 mine) were the leading coal producers.

Wolfe.—Porter Construction Co. (Rogers quarry) crushed limestone for concrete and roads.

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 Owen W. Jones [1] and Leo W. Hough [2]

Louisiana's mineral industry, with an output value of $3.4 billion, 15 percent more than the 1965 value, maintained its important position in the economy of the State and of the Nation. For the ninth consecutive year Louisiana ranked second nationwide to Texas in value of mineral production. New records were achieved in output of crude petroleum, natural gas, natural gas liquids, sulfur, salt, sand and gravel, stone, and clay.

Hydrocarbon fuels — crude petroleum, natural gas, and natural gas liquids—furnished 94 percent of the total value of mineral output. Discovery of 60 oilfields and gasfields (34 onshore and 26 offshore) increased proved recoverable reserves of the fuels to new highs despite record production rates. In quantity of reserves added during 1966, Louisiana ranked first in the Nation in crude petroleum, second in natural gas liquids, and third in natural gas.

Trends and Developments.—Industrial investment and spending in Louisiana in 1966 continued its upward spiral to a record 10-year high. Since 1962, the State has experienced an unbroken rise in industrial spending. The Louisiana State Board of Commerce and Industry approved ad valorem tax exemption applications representing a total investment of $496.5 million. Not included in this total is more than $545.5 million in new facilities ($429.5 million of this involved chemical processing installations) announced in 1966 but not yet under construction at yearend.

Chemical and petroleum processing facilities accounted for 52.4 percent of the total industrial development investment during the year. More than $261 million went into

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Table 1.—Mineral production in Louisiana [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clay—thousand short tons	909	$936	1,005	$983
Lime—do	842	9,980	835	9,274
Natural gas—million cubic feet	4,466,786	812,955	5,081,435	929,902
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	1,431,836	102,731	1,562,075	113,802
LP gases—do	1,300,038	46,101	1,469,716	72,016
Petroleum (crude)—thousand 42-gallon barrels	594,853	1,841,714	674,318	2,097,129
Salt—thousand short tons	8,126	41,812	8,736	44,189
Sand and gravel—do	14,298	16,405	18,216	22,504
Stone (shell)—do	7,452	10,905	8,091	11,253
Sulfur (Frasch process)—thousand long tons	3,577	r 81,372	4,018	104,472
Value of items that cannot be disclosed: Cement, gypsum, and miscellaneous stone	XX	23,350	XX	24,616
Total	XX	r 2,988,261	XX	3,430,140

r Revised. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

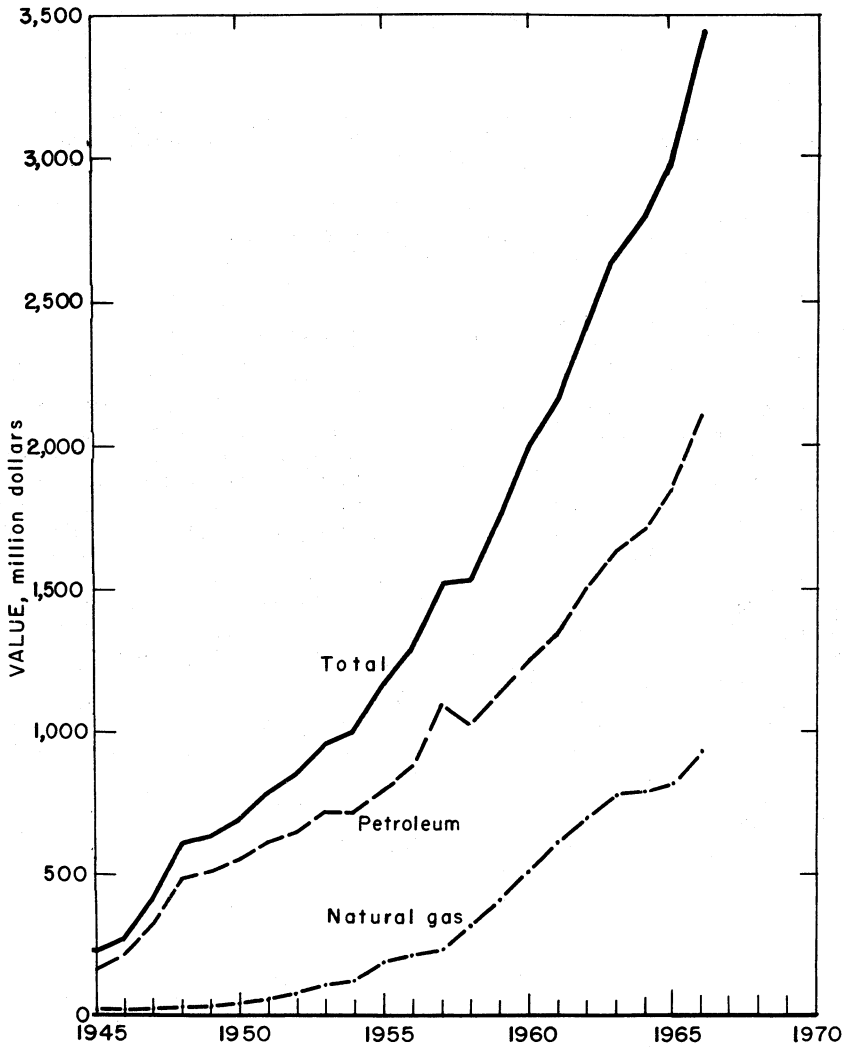

Figure 1.—Value of petroleum, natural gas, and total value of mineral production in Louisiana.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Millions)

Year	Value [1]	Year	Value [1]
1957	$1,502	1962	$2,392
1958	1,523	1963	2,606
1959	1,792	1964	2,777
1960	1,995	1965	2,968
1961	2,156	1966	3,363

[1] Data for 1957–65 revised.

construction of 106 new plants or additions, a continuation of a long-term trend. Since 1956, more than $2 billion—nearly two out of every three dollars invested by industry in that period—has gone into chemical or petroleum facilities. Among the major expenditures in these two categories in 1966 were the following: $68 million for three major petrochemical plants at Geismar to be built by Wyandotte Chemical Corp., Shell Chemical Co., and Allied Chemical Corp.; $31 million for a new plant to be built by Union Carbide Corp. at Taft; $9 million for a new natural gas processing plant at Creston to be built by Placid Oil Co.; and $9 million for expansion of the Humble Oil and Refining Co. refinery at Baton Rouge.

Other major investments of interest to the mineral industry, especially the mineral fuels industry, included electrical power generating facilities, $79 million; paper and paper products, $47.5 million; and stone, clay, and glass products, $2.5 million.

The electric utility companies of Louisiana were in the midst of a large construction program to provide constantly expanding service. Electrical transmission systems were being readied so the individual companies could supply each other's needs in an emergency.

In 1966, Louisiana Power and Light Co. made progress in construction of 147 miles of transmission line to be part of an $8 billion nationwide 500,000-volt transmission grid scheduled for completion by 1970. It was installing a third computer-controlled generating unit at Little Gypsy generating station 25 miles upriver from New Orleans in St. Charles Parish. The $37 million, 560,000 kilowatt generating unit, when completed in late 1968, will be one of the largest in the South.

Gulf State Utilities Co. began a $41.7 million expansion of the Iberville Parish generating plant.

During 1966, New Orleans Public Service, Inc., spent an estimated $40 million on new construction. The largest single project underway was installation of a third generating unit at Michoud generating station in eastern New Orleans. Started in 1965, this 560,000-kilowatt unit is scheduled to be completed in 1967.

Central Louisiana Electric Co., Inc. (CLECO), completed the $14 million generating unit at Coughlin power station, St. Landry, Evangeline Parish. This new 230,000-kilowatt unit increased the station capacity to 464,000 kilowatts.

The Federal Power Commission reported that the electric power generated in 1966 by all Louisiana plants was 21,691 million kilowatt-hours. This was 21.6 percent higher than the 1965 total and compared with a national increase of 8.7 percent. Louisiana's 1966 electricity output was about 1.9 percent of the national output (1.7 percent in 1965).

Louisiana ports expanded and updated facilities. In May, a $3.5 million Federal grant was approved to help install additional bulk-handling facilities at the Port of Lake Charles; local funds were to match those of the Federal grant for a $7 million project. Petroleum, petroleum products, and chemicals are the major commodities handled.

The Port of Baton Rouge, which completed a $9 million expansion program in 1965, handled increased tonnage in 1966 and general cargo movement increased. The port ranked seventh in the Nation in tonnage handled.

Louisiana and Texas continued a joint project at Toledo Bend to turn the Sabine River into a giant water reservoir and powerplant. The dam was partially closed in October and started backing up the riverwaters. The height of the present closure will back water approximately half the 65 miles of the final planned project. Target

date for completing the $65 million project was May 1968; at the end of 1966, the project was about 70 percent completed.

Capacity of Louisiana natural gas processing plants was increased 9 percent. Six new plants were completed and four old plants were closed. Storage space in salt dome caverns to be used for the recovered plant liquids was increased 4.0 million barrels (36 percent).

Of $620 million total tax collections in Louisiana for the Fiscal Year 1965–66, $204 million was from the severance tax levied on minerals ($200 million of this total was from the severance tax on mineral fuels). An additional $89 million was from gasoline, lubricating oil, special fuel, and other mineral-related taxes for a total of $293 million (or 47.5 percent of total tax collections).

Legislation.—The State of Louisiana and the U.S. Government awaited final adjudication of the May 31, 1960, U.S. Supreme Court decree fixing Louisiana's boundary at 3 geographical miles from the coastline. Exact location of the coastline is the point needing clarification. In late 1965, an interim agreement awarded Louisiana approximately 152,000 acres and some $37 million in escrowed revenue. Although negotiations continued, no final decision has been reached.

Employment and Injuries.—The petroleum production, refining, and related industries in 1966 employed 98,400 workers, 3,200 more than in 1965. The decline in petroleum refining employment, and the substantial increase in employment in chemicals and allied products industries, shown in table 4, results from a reclassification of workers by one large company. As a result, chemical workers were removed from the refining classification and added to the chemicals and allied products classification, somewhat distorting the employment growth picture of these two segments of the industry.

Covered [3] employment in the mineral production industry increased about 3 percent. Oil and gas operations provided 92.6 percent of employment and 93.3 percent of wages derived from mineral industries in 1966. Labor-management relations were considered good in the mineral industry for 1966.

Two men were killed and five severely burned near Larose, Lafourche Parish, in January when a newly constructed natural gas pipeline exploded. This was the second major pipeline explosion in Louisiana in less than a year. Three men were killed and six injured in March when an explosion and fire occurred on a compressor barge in the Delta Farms oilfield, Lafourche Parish. Also in March, one man was killed and another injured near Patterson, St. Mary Parish, when the superstructure of a drilling rig toppled in high winds. In April, a crude oil pipeline explosion near Ajax killed four men and injured two others. In the Bayou Sale area

[3] Coverage provisions under the Louisiana Employment Security Law are four or more employees.

Table 3.—Employment 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
1965:								
Metal	1,088	365	397	3,182	--	15	4.71	203
Nonmetal	1,727	292	505	4,563	2	99	22.14	5,050
Sand and gravel	1,280	274	351	2,943	--	35	11.89	345
Stone	438	344	151	1,295	--	38	29.35	1,037
Total	4,533	310	1,404	11,983	2	187	15.77	2,173
1966: [p]								
Metal	1,065	365	388	3,255	--	25	7.68	328
Nonmetal	1,745	293	511	4,638	--	100	21.56	585
Sand and gravel	1,560	261	408	3,480	1	64	18.68	3,670
Stone	515	327	169	1,430	--	31	21.68	611
Total	4,885	302	1,476	12,803	1	220	17.26	1,361

[p] Preliminary.

Table 4.—Total wage and salaried workers in petroleum production, refining, and related industries

Year	Crude petroleum and natural gas production	Petroleum refining [1]	Pipeline transportation (except natural gas)	Gas utilities	Petroleum bulk tank stations	Retail filling stations	Chemicals and allied products [2]	Total
1957–61 (average)	41,240	14,160	1,324	6,186	4,408	8,710	14,040	90,068
1962	40,400	12,000	1,000	6,250	3,900	8,900	16,100	88,550
1963	40,400	11,400	1,000	6,200	4,000	9,400	16,500	88,900
1964	43,100	10,400	950	6,100	4,100	9,650	17,100	91,400
1965	46,500	10,400	850	6,050	4,300	10,000	17,100	95,200
1966 [p]	47,600	[3] 9,200	900	5,950	4,350	10,200	[3] 20,200	98,400

[p] Preliminary.
[1] Employment in petroleum refineries and petrochemicals manufactured in petroleum refineries.
[2] Employment in petrochemical manufacturing facilities located outside petroleum refineries.
[3] Apparent decrease in "refining" and increase in "chemicals" due to separation of one refinery's activities into two firms, one in petroleum refining and one in chemicals.

Source: Louisiana State Department of Labor, Division of Employment Security.

Table 5.—Value of construction contracts awarded

(Thousands)

Type	1963	1964	1965	1966	Percent change from 1965
Residential [1]	$344,422	$419,174	$447,880	$374,650	−16.4
Nonresidential [2]	216,579	289,026	477,167	333,731	−30.1
Nonbuildings [3]	377,909	287,530	265,166	401,824	+51.5
Total	938,910	995,730	1,190,213	1,110,205	−6.7

[1] Includes apartments, hotels, dormitories, one- and two-family dwellings, and other residential buildings.
[2] Includes commercial, manufacturing, educational, and other nonresidential buildings.
[3] Formerly reported as Public Works and Utilities.

Source: Dodge Statistical Research Service. Louisiana Business Review. V. 31, No. 2, February 1967, p. 14.

near Franklin, St. Mary Parish, four men were killed in a gas-filled water disposal and storage tank. Apparently knocked unconscious by fumes, the workers drowned in 3 feet of water in the bottom of the tank.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

New records for production and value were established for all mineral fuels in 1966. Louisiana ranked second to Texas in petroleum, natural gas, and natural gas liquids production. At yearend, 1,252 oilfields and gasfields in the State had output from 40,040 wells (38,742 in 1965). North Louisiana had production from 14,259 oil wells and 4,640 natural gas wells; south Louisiana had production from 12,187 oil and 3,451 natural gas wells onshore, and 4,617 oil and 886 natural gas wells offshore.

Leasing Activity.[4]—In the north Louisiana area, leasing activity by oil companies was greater than in 1965. Block leasing was greatest in the northeast part of the district. Leasing in the Sligo trend continued very active in Winn, Natchitoches, and Jackson Parishes. Terms of leases and lease bonuses remained stable, bonus prices generally ranging from $1 to $50 per acre.

In south Louisiana, the onshore acreage leased for petroleum in 1966 decreased moderately; offshore lease activity maintained a high rate. Ten lease sales of public lands were held in 1966, eight by the State of Louisiana and two by the Federal Government. The State of Louisiana has undisputed ownership of Zone I acreage, and the Federal Government has undisput-

[4] Adapted from The American Association of Petroleum Geologists Bulletin, v. 51, No. 6 (June 1967).

ed ownership of Zone IV acreage. Ownership of acreage in Zones II and III remained in dispute. In 1966, offshore leasing was as follows: 54,329 acres in Zone I netted a $12.6 million bonus for the State; 61,964 acres in Zones II and III, the disputed area, netted a bonus of $123.4 million for the escrow account; and 69,662 acres in Zone IV netted a bonus of $64.6 million for the Federal Government. In addition, the State received approximately $4.1 million from onshore leases of State lands.

Several Federal units were established in the offshore area during 1966, comprising acreage where leases will expire in 1967. The Federal unit (drilling or producing) is merely a legal agreement whereby relief is given to the operator faced with exploring or developing vast acreage within a relatively short period.

Exploration, Development, and Reserves.—Of the 1,164 exploratory holes drilled (Statewide and offshore) for oil and gas, 22 percent were productive. Inland, 836 exploratory holes (18 percent productive) opened 34 new fields—nine oil and six gas discoveries in north Louisiana, and six oil and 13 gas discoveries in south Louisiana. Offshore, 328 exploratory holes (32 percent productive) opened 26 new fields—seven oil and 19 gas.

Of the 2,800 development wells drilled, 70 percent were productive. Inland, 2,121 development wells were drilled—67 percent were successful; offshore, 679 were drilled—78 percent were successful.

The Louisiana Department of Conservation granted 4,964 permits to drill during the year (6,349 in 1965). There were 1,195 producing wells abandoned, compared with 1,079 in 1965.

Table 6.—Oil and gas well drilling and total crew-weeks spent in geophysical oil and gas prospecting in 1966

Location	Drilling							Geophysical, crew-weeks		
	Proved field wells			Exploratory wells			Total	Gravity meter method	Reflection seismograph method	Total
	Oil	Gas	Dry	Oil	Gas	Dry				
Parish:										
Acadia	10	9	15	3	4	21	62	11	110	121
Allen	---	---	---	2	1	8	11	9	33	42
Ascension	14	---	7	---	1	1	23	---	5	5
Assumption	---	3	3	3	3	7	19	---	20	20
Avoyelles	1	---	3	2	---	14	20	---	2	2
Beauregard	4	1	3	7	1	11	27	---	30	30
Bienville	1	4	5	---	5	4	19	---	22	22
Bossier	4	---	8	---	---	8	20	---	---	---
Caddo	196	3	22	2	---	4	227	---	2	2
Calcasieu	6	8	9	3	2	13	41	---	51	51
Caldwell	---	2	1	---	---	4	7	---	12	12
Cameron	28	15	23	1	4	28	99	11	70	81
Catahoula	27	---	46	4	---	51	128	---	1	1
Claiborne	2	1	---	1	3	2	9	---	10	10
Concordia	57	1	93	4	---	73	228	---	---	---
De Soto	10	18	22	---	2	8	60	---	12	12
East Baton Rouge	---	---	1	---	---	2	3	---	19	19
East Carroll	---	---	---	---	---	1	1	---	8	8
East Feliciana	---	---	---	---	---	1	1	---	---	---
Evangeline	3	3	6	1	1	5	19	---	37	37
Franklin	1	---	6	1	1	15	24	---	2	2
Grant	17	---	4	---	---	3	24	---	10	10
Iberia	5	7	5	---	4	14	35	---	130	130
Iberville	14	---	13	3	---	19	49	---	57	57
Jackson	---	3	---	---	2	1	6	---	22	22
Jefferson	22	1	3	1	4	10	41	---	39	39
Jefferson Davis	12	7	9	1	1	13	43	---	45	45
Lafayette	---	2	4	1	2	5	14	---	18	18
Lafourche	63	11	19	7	7	34	141	---	88	88
La Salle	117	---	83	2	---	19	221	---	6	6
Lincoln	---	2	---	---	3	1	6	---	---	---
Madison	---	---	---	---	---	1	1	---	1	1
Morehouse	---	52	8	---	---	---	60	---	17	17
Natchitoches	38	4	9	---	---	10	61	---	15	15
Ouachita	---	20	2	---	2	1	25	---	1	1
Plaquemines	167	7	17	1	4	38	234	---	64	64
Pointe Coupee	18	---	9	4	---	4	35	---	11	11
Rapides	29	---	48	1	---	16	94	---	7	7
Red River	5	2	10	---	1	4	22	---	10	10
Richland	1	5	5	---	1	4	16	---	10	10

Table 6.—Oil and gas well drilling and total crew-weeks spent in geophysical oil and gas prospecting in 1966—Continued

Location	Drilling							Geophysical, crew-weeks		
	Proved field wells			Exploratory wells			Total	Gravity meter method	Reflection seismograph method	Total
	Oil	Gas	Dry	Oil	Gas	Dry				
Parish—Coutinued										
Sabine	43	1	82	2	1	13	142	---	3	3
St. Bernard	2	---	1	---	---	5	8	---	29	29
St. Charles	21	1	4	---	---	8	34	---	12	12
St. James	2	---	---	2	2	2	8	---	30	30
St. John the Baptist	---	---	---	---	1	3	4	---	---	---
St. Landry	10	4	6	1	---	18	39	---	28	28
St. Martin	20	8	9	1	3	21	62	---	62	62
St. Mary	64	20	15	2	6	19	126	---	281	281
St. Tammany	---	---	---	---	---	---	---	---	15	15
Tangipahoa	---	---	---	---	---	---	---	---	39	39
Tensas	10	3	15	---	---	16	44	---	3	3
Terrebonne	54	21	24	3	5	36	143	---	188	188
Union	---	47	4	---	1	2	54	5	8	13
Vermilion	4	13	11	1	7	28	64	---	174	174
Vernon	---	---	---	---	---	5	5	---	19	19
Webster	1	1	1	---	1	2	6	---	3	3
West Baton Rouge	---	---	1	---	---	1	2	---	23	23
West Carroll	---	---	---	---	---	1	1	---	10	10
Winn	8	---	6	---	1	24	39	---	39	39
Total:										
1966	1,111	310	700	67	87	682	2,957	36	1,963	1,999
1965	2,026	468	1,272	94	85	575	4,520	---	2,173	2,173
Offshore:										
Bay Marchand	17	1	4	2	---	2	26	---	---	---
Breton Sound	3	---	3	6	2	8	22	---	114	114
Cameron East	---	4	6	1	8	23	42	5	63	68
Cameron West	1	12	6	---	4	20	43	1	136	137
Chandeleur Sound	19	---	---	3	2	20	44	---	52	52
Delta West	73	5	17	6	5	14	120	---	47	47
Eugene Island	68	9	19	8	3	10	117	1	100	101
Grand Isle	24	4	8	3	3	12	54	---	46	46
Main Pass	62	5	9	6	1	21	104	---	130	130
Marsh Island, South	18	18	22	6	6	19	89	---	37	37
Pelto, South	3	---	3	---	---	1	7	---	7	7
Ship Shoal	33	12	13	6	9	26	99	1	104	105
South Pass	40	3	13	---	---	4	60	---	41	41
Timbalier, South	74	6	13	5	6	22	126	---	85	85
Vermilion	14	1	14	1	4	20	54	5	87	92
Total:										
1966	449	80	150	53	53	222	1,007	13	1,049	1,062
1965	453	97	158	20	28	111	867	---	978	978
Grand total:										
1966	1,560	390	850	120	140	904	3,964	49	3,012	3,061
1965	2,479	565	1,430	114	113	686	5,387	---	3,151	3,151

Source: International Oil Scouts Association. International Oil and Gas Development. Austin, Tex., v. 37 in 1966 Review.

Table 7.—Crude petroleum, natural gas, and natural gas liquids production and addition to reserves

Year	Crude petroleum (million barrels)		Natural gas (billion cubic feet)		Natural gas liquids (million barrels)	
	Production	Net additions to reserves	Production	Net additions to reserves	Production	Net additions to reserves
1962	477	155	3,525	5,906	45	204
1963	515	2	3,928	3,821	54	143
1964	550	74	4,153	3,711	62	101
1965	595	83	4,467	3,735	65	227
1966	674	163	5,081	873	72	114
	Total proved reserves by Dec. 31, 1966					
1966	5,408		83,684		2,282	

Source: Reserves based on American Gas Association, American Petroleum Institute, and Canadian Petroleum Association. Proved Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas. Tulsa Daily World, 62d yr., No. 20, April 3, 1967, p. 27.

The search for production from the Eocene Wilcox Formation continued in central and eastern north Louisiana Bayou Louis field in Catahoula Parish, with four oil producing wells at yearend, was probably the most important Wilcox discovery of the year, and development drilling was continuing. Exploration for Pettet (Sligo Formation) production, as found in Black Lake field of Natchitoches Parish, continued. Several tests were drilled in Jackson, Natchitoches, and Winn Parishes, all resulting in dry holes.[5]

North Louisiana experienced a general decline in all drilling activity, with all regions of north Louisiana being affected.

In south Louisiana, offshore exploratory drilling increased considerably although development drilling decreased. The most significant new fields discovered included Block 133 West Delta area; Coon Point, Block 38 Ship Shoal area; and St. Amelia, St. James Parish. All were on salt dome structures.

According to The Oil and Gas Journal, 30.5 million feet of hole (35.0 million in 1965) was drilled in the State during 1966. An average of 98 drilling rigs operated offshore in 1966 (95 in 1965); an average of 256 operated in the entire State in 1966 (270 in 1965).

According to the American Petroleum Institute, proved recoverable reserves of crude oil, natural gas, and natural gas liquids in Louisiana reached new highs in 1966. At yearend, the crude oil reserve (5,408 million barrels) comprised 17.2 percent of the U.S. reserve; the natural gas reserve (83,684 billion cubic feet) was 28.9 percent; the natural gas liquids reserve (2,282 million barrels) was 27.4 percent of the total. Of the gross additions to Louisiana's crude petroleum reserve in 1966, 13.9 percent was attributed to newly discovered reservoirs; the remainder to extensions and revisions of previously discovered reservoirs.

According to The Oil and Gas Journal, 29.4 percent of the Louisiana crude reserve was offshore; offshore production in 1966, according to the State Conservation Commission, accounted for 55.9 percent of total Louisiana production.

Carbon Black.—The carbon black industry produced 899 million pounds valued at $60.5 million in 1966, a 9.4-percent increase in value over that of 1965. This production represented 35 percent of the U.S. carbon black production. About 22,100 million cubic feet of natural gas was consumed by the industry for an average yield of 13 pounds of carbon black per thousand cubic feet of gas; 135 million gallons of liquid hydrocarbons was consumed for an average yield of 4.5 pounds per gallon.

All the carbon black produced in Louisiana was from furnace plants; none was from channel plants. St. Mary Parish had three plants; Ouachita Parish, two plants; and Avoyelles, Calcasieu, and Evangeline Parishes each had one plant. The product was mainly used as an additive in rubber manufacturing. Nationwide, 93.5 percent was directed to the rubber industry; nearly 3 percent was used for ink; 1 percent for plastics; and the remainder was for paint, paper, chemicals and food, and miscellaneous uses.

Table 8.—Carbon black production

Year	Million pounds
1957–61 (average)	570
1962	608
1963	649
1964	726
1965	821
1966	899

Natural Gas.—Marketed production of natural gas increased 14 percent over that of 1965, continuing a strong growth trend for the 21st consecutive year. Louisiana retained second position among the States as a supplier of natural gas, furnishing 29.5 percent of the total natural gas marketed.

Existing and new reserves entered the growing gas market as gas transmission companies installed more pipeline facilities and entered long-term purchase contracts for withdrawal and marketing of the huge gas supplies.

Transcontinental Gas Pipeline Co. proposed construction of facilities which would enlarge its capacity and, when completed, place it first in purchases of the State's natural gas, a position now held by Tennessee Gas Transmission Co. United Gas Pipeline Co. was the largest total purchaser, but approximately a third of its purchases were from natural gasfields and the remainder from casinghead gas.

[5] Work cited in footnote 4.

Table 9.—Natural gas data

(Million cubic feet)

Year	Withdrawals [1]			Marketed production [2]	Value at wells (thousands)	Disposition	
	From gas wells	From oil wells	Total			Repressuring	Vented and wasted [3]
1957–61 (average)	2,432,620	550,340	2,982,960	2,692,206	$416,634	203,140	87,614
1962	3,124,000	730,000	3,854,000	3,525,456	694,515	221,167	107,377
1963	3,540,100	710,000	4,250,100	3,928,427	777,829	212,116	109,557
1964	3,682,200	808,400	4,490,600	4,152,731	793,328	221,280	116,589
1965	3,912,300	852,000	4,764,300	4,466,786	812,955	174,951	122,563
1966	4,168,820	1,196,457	5,365,277	5,081,435	929,902	182,734	101,108

[1] Marketed production plus quantities used in repressuring, vented, and wasted.
[2] Comprises gas sold or consumed by producers, including losses in transmission, amounts added to storage, and increases in pipelines.
[3] Partly estimated. Includes direct waste on producing properties and residue blown to the air.

The application of Red Snapper Pipe Line Co. to construct a $127 million offshore pipeline system to serve natural gas producers off the coast of Louisiana was contested early in 1966, and the Federal Power Commission (FPC) was requested to dismiss the application. At the end of 1966, however, a preliminary decision by an FPC examiner gave approval to construct the line. The Red Snapper line, backed by 29 producers, was conceived as a common carrier to transport gas from distant reserves in the outer Continental Shelf, 75 miles or more offshore. The proposed line would be 229 miles long and serve an area with potential reserves estimated at 28 trillion cubic feet. Capacity of the line would be 1,113 million cubic feet per day. The two-phase line also would transport 8.8 million barrels of liquids per year.

The FPC authorized Texaco Inc. to sell Texas Gas Transmission Corp. 750 billion cubic feet of gas from Mound Point and Tiger Shoals fields, offshore Vermilion Parish, at 19 cents per thousand cubic feet for gas in the Federal domain and 20.65 cents for gas subject to State tax. The commission's guideline ceilings for the area were 19.5 and 21.25 cents per thousand cubic feet.

Natural Gas Pipeline Co. of America late in 1966 received approval to connect 1.4 trillion cubic feet of reserves from Texaco Inc. Erath field, Vermilion Parish. This would require a 114-mile, 30-inch pipeline estimated to cost $19.5 million.

Texas Eastern Transmission Co. was taking gas from Gulf Oil Corp.'s big West Delta area offshore from Plaguemines Parish. A 4.6-trillion-cubic-foot contract for this gas is the largest from any single field in the natural gas industry's history.

Shell Oil Co. contracted to sell 1 trillion cubic feet of gas to Truckline Gas Co. over the next 25 years, a $200 million transaction. The gas will be produced mainly from fields Shell found on acreage it acquired in the Federal Government's lease sales of 1962.

Purchaser nominations for gas during the final quarter of 1966 were at a record high, 17.88 billion cubic feet per day. Of this amount, 14.46 billion was scheduled to come from natural gasfields and 3.42 billion from gas produced in oilfields.

Increased sales are attributable to greater use of gas in industrial plants and to new customers.

United Gas Pipeline Co. continued construction of a gas storage reservoir to develop more than 102 billion cubic feet of gas storage in the old Bistineau gasfield of Bienville and Bossier Parishes in northwestern Louisiana. The company plans to store gas in the nearly depleted Pettet zone of the Sligo Formation. The Pettet, at 4,900- to 5,500-foot depth, has produced more than 131 billion cubic feet of gas since discovery in 1937. Gas from the gulf coast area will be transported and stored during seasons of low gas demand and held ready for immediate distribution to meet winter's peak demands. The company expects to withdraw up to 500 million cubic feet of gas daily during the 1969–70 heating season when the project should be completed.

Natural Gas Liquids.—The 1966 production of 3,032 million gallons of natural gas liquids valued at $186 million again ranked second in the Nation, but was a new production record for Louisiana. New

plants and expansions completed in 1966 raised the State's daily processing capacity from 13.1 to 14.3 billion cubic feet (23.1 percent of the Nation's total capacity).

Natural gasoline and cycle products were recovered at 107 gasoline plants, 16 recycling plants, and four fractionators (108 gasoline, 14 recycling plants, and three fractionators in 1965) in 33 parishes.

Recovery of natural gas liquids gained 11 percent and amounted to 15.4 percent of the Nation's annual output. Production was 51.5 percent natural gasoline and cycle products and 48.5 percent liquefied petroleum (LP) gases.

Although Louisiana ranked second in production of natural gas liquids, the average liquid content of the gas is below the national average. The State produced nearly 29 percent of the marketed production of gas in the United States during 1966 but produced only 20.7 percent of the natural gasoline and 12.1 percent of the LP gas and ethane fraction.

New plant construction continued its trend toward large capacity refrigeration absorption systems operating in low temperature ranges, more automation, and use of central fractionators.

Some of the major new facilities for processing natural gas and for recovering, delivering, and storing the plant liquids, put into service during the year, were as follows: (1) Cities Service Oil Co. at Lake Charles completed a fractionation and product treating plant to produce 563,000 gallons per day of ethane, propane, unsplit butane, and debutanized gasoline. (2) Continental Oil Co. at Grand Chenier built a 500-million-cubic-foot-per-day refrigerated absorption plant to handle offshore gas from fields in East Cameron and West Cameron areas; this plant replaced an old 350-million-cubic-foot-per-day plant. The company shut down a 115-million-cubic-foot-per-day plant at Ville Platte, Evangeline Parish. (3) Gulf Oil Corp. completed an 800-million-cubic-foot-per-day gas processing plant at Venice. The liquids produced will be used at Gulf's refinery nearing completion at the same location. (4) Humble Oil & Refining Co. early in 1966 completed the Delta gas plant, a 310-million-cubic-foot-per-day refrigerated absorption plant near Venice. In April it completed a 100-million-cubic-foot-per-day plant at Grand Isle and plans to complete a 45-million-cubic-foot-per-day plant at Thibodaux in early 1967. A $4.8 million contract for expansion of a gas processing plant at Garden City was let in November. The capacity of this plant, already the State's largest, will be increased by 350-million-cubic-feet-per-day to 1.25-billion-cubic-feet-per-day. It is planned to extract more than 20,000 barrels of liquids per day at the plant. (5) Placid Oil Co. was constructing a 130-million-cubic-foot-per-day plant in Black Lake field, Natchitoches Parish. The company planned to make the plant one of the most modern in the country.

Much new plant construction was devoted to increased recovery of ethane. Demand for the complete LP gas fraction during the year equaled or exceeded the supply. This posed a new situation for the LP gas producer as this product has, in recent years, gone from great surplus to scarcity, a situation which promises to last at least through 1975. The increased demand is due largely to fast-growing requirements of the petrochemical producers plus steady growth of other LP gas markets.

Capacity of underground storage facilities increased 36 percent. As reported by The Oil and Gas Journal's annual survey, capacity was 13.1 million barrels of natural gas liquids plus 2.2 million barrels of

Table 10.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline and cycle products		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	842,192	$60,510	539,728	$24,712	1,381,920	$85,222
1962	1,010,137	74,726	862,772	29,037	1,872,909	103,763
1963	1,143,707	81,332	1,113,670	41,043	2,257,377	122,375
1964	1,352,980	91,931	1,247,484	45,935	2,600,464	137,866
1965	1,431,836	102,731	1,300,038	46,101	2,731,874	148,832
1966	1,562,075	113,802	1,469,716	72,016	3,031,791	185,818

ethylene for a total capacity of 15.3 million barrels.

Petroleum.—The petroleum industry of Louisiana established a production record of 674 million barrels, 13 percent higher than last year's record production and second highest in the Nation. Daily allowable production at the end of 1965 was 34 percent of the per-well depth-bracket formula. This was changed to 35 percent in 1966 except for the May–June and November–December periods when 36 percent of the depth-bracket formula was the allowable. Production at the end of 1966 was at an alltime high rate of just under 2 million barrels per day. Petroleum was produced in all but eight of the 64 parishes in Louisiana.

Secondary recovery projects (water, gas, or other injection) accounted for 101.0 million barrels or 15 percent of the 1966 production.

In 1966, a survey[6] reported that Louisiana had 12,209 oil wells classified as stripper wells at the end of 1965. For 1965, stripper wells represented 30.5 percent of total oil wells but only 2 percent of the annual production and 3 percent of the State's recoverable oil reserves. Thus, normal production decline from stripper wells was not expected to affect appreciably the State's productive capacity and reserves in the immediate future.

In December, the State Conservation Commissioner announced formation of a new coastal or intermediate producing zone with higher oil production allowables. The zone includes an area from the shoreline northward to the Intracoastal Canal. January and February 1967 production rates scheduled for this coastal zone were raised 15 percent above onshore well rates and are to be raised later to 30 percent above onshore rates. The commissioner stated that results of a prolonged study showed operators in this area, in order to be compensated for the hazards of hurricanes and increased costs of operation, merited a 30-percent increase in allowable over that given the true onshore area. Some of the recent hurricanes and attendant enormous losses have focused attention on the reality of weather risks in the area.

Louisiana's drive to prevent disposal of oilfield waste in surface pits resulted in increased drilling of salt water disposal wells. Early in 1966, the Louisiana Conservation Commission issued shutdown orders to 23 oil operators in Caddo Parish because of their failure to comply with the State's antipollution order. The shutdown involved 142 marginal oil wells, mostly in the Caddo-Pine Island field of northwest Louisiana. Texas and Oklahoma also indicated determination to intensify controls on water pollution.

Table 11.—Crude petroleum production

(Thousand barrels and thousand dollars)

Year	Quantity	Value
1957–61 (average)	366,449	$1,171,957
1962	477,153	1,502,568
1963	515,057	1,608,120
1964	549,698	1,709,622
1965	594,853	1,841,714
1966	674,318	2,097,129
1902–66	8,753,127	23,003,161

Table 12.—Crude petroleum production, indicated demand, and stocks in 1966, by months

(Thousand barrels)

Month	Production	Indicated demand	Stocks (end of month)
January	55,418	56,399	24,099
February	51,563	51,752	23,910
March	56,454	54,934	25,430
April	54,570	53,199	26,801
May	56,911	57,766	25,946
June	55,412	55,954	25,404
July	56,681	56,902	25,183
August	56,924	57,047	25,060
September	55,276	55,800	24,536
October	57,441	56,230	25,747
November	57,412	53,117	30,042
December	60,256	63,548	26,749
Total:			
1966	674,318	672,648	XX
1965	594,853	592,345	XX

XX Not applicable.

Table 13.—Number of producing oil wells and average production per well

Year	Number of producing wells Dec. 31	Average production per well per day (barrels)
1957–61 (average)	23,581	43.0
1962	26,382	49.6
1963	27,638	51.8
1964	29,452	51.0
1965	30,179	r 54.0
1966	31,063	59.5

r Revised.

[6] Interstate Oil Compact Commission. National Stripper Well Survey, Jan. 1, 1966. Oklahoma City, Okla., October 1966.

Table 14.—Production of crude petroleum by districts and selected fields

(Thousand barrels)

District and field [1]	1965	1966
Gulf Coast:		
Onshore: [2]		
Bastian Bay	3,874	5,493
Bay St. Elaine	7,431	7,447
Bayou Sale	8,365	9,325
Caillou Island	23,500	26,521
Cote Blanche Bay West	5,437	6,953
Delta Farms	2,545	2,366
Erath	2,772	2,890
Garden Island Bay	6,682	8,772
Golden Meadow	3,163	4,064
Grand Bay	6,188	6,374
Hackberry West	3,840	4,085
Iowa	1,022	1,093
Jennings	455	405
La Fitte	6,443	7,642
Lake Barre	12,414	15,049
Lake Washington	9,661	10,203
Leeville	3,863	3,907
Paradis	2,585	3,630
Quarantine Bay	5,506	6,708
Venice	5,466	5,803
Vinton	1,692	1,789
Weeks Island	6,310	6,883
West Bay	9,122	10,692
Other	184,761	218,831
Total onshore	323,097	376,925
Offshore: [2]		
Bay Marchand	25,298	27,211
Eugene Island Block 126	4,702	5,145
Grand Isle Block 16	11,743	12,963
Grand Isle Block 47	3,813	4,069
Grand Isle Block 43	3,609	6,645
Main Pass Block 35	4,301	4,393
Main Pass Block 41	3,438	8,486
Main Pass Block 69	10,946	11,807
South Marsh Island Block 73	538	1,469
South Pass Block 24	21,576	22,163
South Pass Block 27	18,323	20,179
South Timbalier Block 135	6,753	9,310
Timbalier Bay	19,037	23,775
West Delta Block 24	3,437	5,948
West Delta Block 30	21,103	20,556
West Delta Block 73	6,467	10,689
Other	47,374	48,368
Total offshore	212,458	243,176
Total Gulf Coast	535,555	620,101
Northern:		
Black Lake	10	1,560
Caddo-Pine Island	6,297	5,691
Cotton Valley	3,171	3,059
Delhi	4,530	4,634
Haynesville	2,005	2,033
Homer	459	546
Lake St. John	1,709	1,959
Pendleton-Many	4,178	2,261
Rodessa	812	694
Other	36,127	31,780
Total Northern	59,298	54,217
Total Louisiana	594,853	674,318

[1] Breakdown for individual fields from The Oil and Gas Journal.
[2] Some fields include onshore and offshore.

See footnotes at end of table.

Table 15.—Crude petroleum production and estimated reserves in Louisiana offshore area

(Thousand barrels)

Offshore area	Number of wells		Production			Estimated reserve Dec. 31, 1966
	1965	1966	1965	1966	Cumulative total	
Bay Marchand: Block 2 [1 2]	491	453	25,298	27,211	178,614	417,002
Belle Isle [2]	63	62	1,605	1,732	15,686	19,314
Caillou Island [1 2]	693	741	23,500	26,521	289,816	210,184
East Cameron: Block 64	36	39	1,100	1,347	2,447	9,653
Eugene Island:						
Block 18	54	55	2,609	2,814	22,285	17,715
Block 32	46	38	1,233	1,504	12,742	22,258
Block 45	9	11	570	625	5,185	5,815
Block 100	25	23	962	947	5,490	14,510
Block 126 [1]	102	137	4,702	5,145	45,800	79,200
Block 128	52	71	2,837	2,647	20,643	39,357
Block 188	30	47	1,323	2,166	9,218	25,782
Block 208	16	25	427	659	6,891	28,109
Block 238	---	20	---	837	1,078	9,465
Grand Isle:						
Block 41	---	9	---	596	727	5,967
Block 16 [1]	227	214	11,743	12,963	65,924	109,076
Block 18	41	43	1,778	1,791	23,792	16,208
Block 43	74	126	3,609	6,645	14,721	18,355
Block 47 [1]	83	81	3,813	4,069	35,636	61,788
Lake Washington: [1 2]	365	354	9,661	10,203	125,053	174,947
Main Pass:						
Block 6	---	18	---	1,012	1,337	10,120
Block 41	115	197	3,438	8,486	14,126	29,874
Block 69 [1]	257	247	10,946	11,807	102,962	197,038
Rabbit Island	---	10	---	691	3,126	6,921

See footnotes at end of table.

Table 15.—Crude petroleum production and estimated reserves in Louisiana offshore area—Continued

(Thousand barrels)

Offshore area	Number of wells		Production			Estimated reserve Dec. 31, 1966
	1965	1966	1965	1966	Cumulative total	
Ship Shoal:						
Block 28	22	31	1,901	3,370	8,578	21,522
Block 107	54	55	3,857	3,853	16,923	43,077
Block 154	22	42	792	1,696	14,321	25,689
Block 176	7	18	477	1,283	9,368	15,780
Block 208	52	53	3,027	3,602	9,368	56,398
Block 113	---	30	---	692	1,640	7,003
South Marsh Island:						
Block 6	26	28	1,305	1,319	3,227	35,185
Block 23	48	42	1,839	2,002	5,919	48,063
Block 73	11	32	538	1,469	2,031	14,992
South Pass:						
Block 24 [1] [2]	625	682	21,576	22,163	256,025	493,975
Block 27 [1]	465	474	18,323	20,179	111,345	199,655
South Pelto:						
Block 23	---	12	---	517	1,629	6,123
Block 20	33	35	1,034	1,337	5,330	14,670
Tiger Shoal	20	23	854	1,027	5,439	14,561
Timbalier Bay [1] [2]	480	573	19,037	23,775	159,187	140,813
South Timbalier:						
Block 54	---	10	---	520	2,365	5,467
Block 131	63	62	2,698	3,067	12,081	37,919
Block 135	---	148	---	9,310	25,944	27,100
Block 176	---	21	---	480	928	4,802
Vermilion:						
Block 14	35	42	1,698	1,910	9,033	22,967
Block 16	5	4	523	606	1,353	5,398
West Cameron:						
Block 45	27	37	633	594	7,707	18,594
Block 192	39	34	415	460	3,435	16,565
West Delta:						
Block 24	52	125	3,437	5,948	11,890	41,110
Block 30 [1]	462	444	21,103	20,556	121,646	278,354
Block 53 [2]	16	27	729	492	8,752	13,248
Block 27	10	8	731	446	2,886	10,021
Block 41	33	55	1,984	3,519	5,567	27,481
Block 58	4	3	496	385	2,179	4,615
Block 73	---	206	---	10,689	18,580	10,000
Total	5,390	6,350	220,161	279,192	1,839,223	3,176,557

[1] Estimated ultimate recovery of 100 million barrels or more.
[2] Combined onshore and offshore.

Source: The Oil and Gas Journal, v. 65, No. 5, Jan. 30, 1967, pp. 162–164.

Shell Pipeline Corp. in 1966 proposed a 650-mile crude oil pipeline, named "Capline," from Donaldsonville to the Wood River-Patoka, Ill., area. The 40-inch pipeline, costing in excess of $100 million and requiring 2 years to construct, would have a planned initial throughput of 400,000 barrels daily. Ultimate capacity was to be in excess of 1 million barrels per day. It will be the largest crude oil pipeline built.

Refineries.—At yearend, 13 petroleum refineries were in Louisiana; all were operating. Crude oil capacity (barrels per calendar day) totaled 924,150, a gain of approximately 50,508 over that of 1965. Crude oil processed in State refineries totaled 327.6 million barrels (17.6 million barrels more than in 1965) and represented about 48.6 percent of the crude oil production in the State.

Gulf Oil Corp's. new refinery at Venice was partially onstream before yearend. This refinery, the first in the United States designed only for natural gas liquids treatment, will have a throughput of 20,000 barrels daily. Output was to be more than 80 percent gasoline. The firm's natural gas processing plant, recently completed on an adjacent site, is to furnish natural gas liquids to the refinery. No crude oil is to be used in making gasoline and other products. Gulf Oil Corp. also announced plans to build a $50 million chemical complex, including a refinery near Donaldsonville.

A construction project at the Humble Oil & Refining Co. Baton Rouge refinery, in progress during 1966, would raise plant

capacity from 380,000 barrels daily to 415,000 barrels. This expansion and modernization of the No. 10 pipe still was budgeted at a total cost of more than $7 million. The refinery was to be the first in the United States to exceed 400,000-barrel-per-day crude capacity. The plant has been the largest in the United States and, after expansion, will be one of the four largest refineries in the world.

Murphy Oil Corp. completed a new alkylation unit at the Meraux refinery on the Mississippi River near New Orleans. The new unit was scheduled to produce 1,620 barrels daily of alkylate, a high-octane material used in blending gasoline.

Texaco Inc. continued constructing a new $75 million refinery near the Sunshine Bridge in St. James Parish. Completion was scheduled in 1967. This is the company's only refinery in Louisiana although it has been the leading producer of crude oil in the State for many years.

At Norco, Shell Oil Co. was completing an expansion and modernization program to increase refinery capacity to 150,000 barrels per day.

Petrochemicals.—Louisiana's already enormous petrochemical industry continued to grow in 1966. This growth is partially due to the availability of the Mississippi River water supply, convenient economical shipping facilities, and the nearness to refineries and chemical producing plants. The supply of experienced labor in the area also contributes to the desirability of the region.

In 1966, it became apparent that traditional raw materials for petrochemical plants feedstock were becoming more scarce. Cheap feedstock, primarily LP gases and their immediate derivatives, was the basis of the rapid growth of the industry in the United States following World War II. The price of these feedstocks has been rising, and demand has grown faster than supply. Although there is plenty of potential petrochemical feedstock available in other forms, these low-priced and easily converted hydrocarbons may not remain available at economically attractive prices.

At Geismar, Borden Chemical Co. completed, at a reported cost in excess of $5 million, the world's largest acetic acid plant, capable of producing 100 tons of acid per day. Also under construction was a new ammonia facility and a new urea facility. Allied Chemical Corp. expected to complete in 1967 a plant to produce 1,000 tons per day each of ammonia and urea. Union Texas Petroleum Division was building a 500-million-pound-per-year ethylene plant. Monochem, Inc. (owned by Borden Chemical Co. and U.S. Rubber Co.), completed a 120-million-pound-per-year expansion of vinyl chloride facilities. Shell Chemical Co. was constructing plant facilities for ethylene oxide and derivatives, used in detergents, paints, and antifreeze; a plant to produce primary alcohols used in manufacturing soft detergents; and a plant to produce 100 million pounds per year of paraxylene. Wyandotte Chemicals Corp. completed expansion of an ethylene oxide, ethylene glycol facility with the annual capacity increased by 50 percent to a total of 145 million pounds. Construction of a toluene diisocyanate plant was nearing completion by Wyandotte.

In the Baton Rouge area, Copolymer Rubber and Chemical Co. was constructing a $10 million synthetic rubber plant. Enjay Chemical Co. was expanding its ethylene plant capacity by 400 million pounds per year (to more than 800 million pounds per year); its butadiene plant capacity; and planned to complete in 1967 a new 50 million gallon per year benzene plant. Allied Chemical Corp. announced construction of a large-scale chlorine caustic soda facility. Ethyl Corp. completed ethylene dichloride, vinyl chloride, trichlorethylene, and perchlorethylene producing facilities. The vinyl chloride plant capacity was doubled to 100 million pounds per year.

At Sterlington, Commercial Solvents Corp. was adding 1,000-ton-per-day ammonia capacity to its plant.

In the New Orleans area, Shell Chemical Co. completed facilities at Norco for making sulfolane, an extractive solvent used in refineries and natural gas plants, and planned to complete in 1967 a $30 million 500-million-pound-per-year ethylene plant. American Cyanamid completed a 450-ton-per-day urea plant at Avondale. A methyl methacrylate monomer expansion of 48 million pounds per year was scheduled for completion in 1967. First Nitrogen Corp. began production in November at its new

1,000 ton per day anhydrous ammonia facility at Donaldsonville. Gulf Oil Corp. was constructing a 1,000- to 1,500-ton-per-day ammonia plant also at Donaldsonville; it was planned as part of a fertilizer complex, costing about $50 million, to be completed in 1968. Union Carbide Corp. began constructing a 120 million pounds per year peracetic acid unit at Taft. Additional facilities for production of 200 million pounds per year of peracetic acid derivatives, including caprolactum used in making textile fibers, special printing inks, and electronic goods were also under construction. Included in the Taft complex were facilities for producing ethylene oxide and other ethylene-based chemicals.

In the Lake Charles area, Pittsburgh Plate Glass Co. appropriated $37 million for a chlorine-caustic-power complex at its Lake Charles plant; it will include one of the largest mercury cell chlorine circuits in the world. Stauffer Chemical Co., jointly with Continental Oil Co., expected to complete one of the world's largest vinyl chloride monomer plants in the fall of 1967. Continental Oil Co. also started construction of a new ethylene facility. In April, Continental completed facilities at Lake Charles which doubled the company's capacity to manufacture cyclohexane, an important raw material in manufacturing nylon. Calcasieu Chemical Corp. was expanding ethylene glycol plant capacity to more than 20 million gallons per year. Firestone Synthetic Rubber and Latex Co. was expanding its polybutadiene plant. National Distillers and Chemical Corp. was building a polyethylene plant. Petroleum Chemicals, Inc. (a subsidiary of Columbian Carbon Co.), was constructing a 25-million-pound-per-year cyclic chemicals plant, the first of its kind in the Western Hemisphere. The $8 million urea plant at the Olin Mathieson chemical complex began operation near yearend. Capable of producing 150,000 tons annually of high-nitrogen fertilizer, the plant was the last major project in a $45 million expansion begun last year. Earlier in 1966, the world's largest anhydrous ammonia plant began operation as part of the Olin Mathieson complex. Cities Service Petroleum Co. was constructing a paraxylene unit and a benzene plant, and was making additions to its ethylene oxide-glycol plant.

NONMETALS

Value of nonmetals (chemical and construction materials) produced in 1966 was $217 million or 6 percent of total minerals value, an increase of 18 percent over the 1965 total. Combined value of construction materials (clay, lime, cement, gypsum, sand and gravel, and stone or shell) gained 11 percent.

Barite.—Crude barite from Arkansas, Missouri, and various foreign countries was crushed and ground in three plants at New Orleans and in one at Lake Charles. Output was used mainly as a weighting agent in oil well drilling fluids. Production was somewhat higher than in 1965.

Cement.—Portland cement was produced at four Louisiana plants—one near Lake Charles, one at Baton Rouge, and two at New Orleans. Production gained slightly over that of 1965. Ready-mix concrete companies were the chief consumers, followed by highway contractors, concrete products manufacturers, and other contractors.

Table 16.—Shipments of portland cement to Louisiana consumers

Year	Thousand barrels
1957–61 (average)	8,083
1962	8,875
1963	9,112
1964	10,405
1965	11,294
1966	11,619

Clay.—A 10.6-percent gain in sales of miscellaneous clay was recorded. Seven brick companies with nine brickworks, two lightweight aggregate companies, and four cement plants used clay in 14 parishes. Output of clay used for cement gained considerably; the quantity used for brick gained slightly.

The Louisiana Geological Survey has a cooperative agreement with the Bureau of

Table 17.—Miscellaneous clay sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	739	$739
1962	638	641
1963	655	655
1964	780	797
1965	909	936
1966	1,005	983

Mines for a project surveying clay resources of the State. Much of the clay tested thus far has been found suitable for industrial use. When completed, the Louisiana Geological Survey will publish results of this study.

Gypsum.—Winn Rock, Inc., Winn Parish, mined crude gypsum for retarder in portland cement. National Gypsum Co. at Westwego and Georgia Pacific Corp. at New Orleans calcined imported crude gypsum and manufactured plaster, lath, and wallboard.

Lime.—Lime production was down slightly from 1965. Four companies produced lime—Olin Mathieson Chemical Corp. in Calcasieu Parish and Allied Chemical Co. in East Baton Rouge Parish produced lime for their use; U.S. Gypsum Co. in Orleans Parish and Pelican State Lime Co. in St. Mary Parish produced primary lime from oystershell for sale on the open market. The lime was used principally at chemical and industrial plants and for refractories. Regenerated lime for use in paper and pulp was produced by five companies at six plants as follows: Calcasieu Paper Co., Allen Parish; Olin Mathieson Chemical Corp., Ouachita Parish; Continental Can Co., Inc., Jackson Parish; International Paper Co., Morehouse and Webster Parishes; and Crown Zellerbach Corp., Washington Parish. Regenerated lime production in 1966 was 451,000 short tons, only 52 percent of 1965 production.

Salt.—Louisiana was the nation's leading salt-producing State. Output gained about 7.5 percent in 1966. Demand for all types of salt—evaporated, rock, and brine—showed moderate increases, although increased consumption of rock salt accounted for most of the overall gain. Evaporated and/or rock salt was produced by six salt companies; brine was produced by seven chemical companies.

Cargill, Inc., will boost production at its Belle Isle salt dome mine to more than 1 million tons per year, more than double its present capacity. Major additions will include new storage capacity in the mine; new crushing, screening, and grading equipment; and new barge-loading machinery.

Salt was used in tanning, food processing, manufacture of rubber, paper and chemicals, livestock feed, snow and ice removal and numerous other industrial applications.

Sand and Gravel.—Production was 18.2 million tons (7.8 million tons of sand and 10.4 million tons of gravel), about 27 percent more than in 1965. Processed sand and gravel amounted to 17.8 million tons or 98 percent of the total. Sand use was as follows: Building sand, 55 percent; paving sand, 41 percent; industrial, other construction, and fill sand, 4 percent. Gravel use was as follows: Building gravel, 51 percent; paving gravel, 46 percent; other construction and fill gravel, 3 percent. A total of 99 sand and gravel operations were reported in 21 parishes.

The Louisiana Geological Survey began a study of Louisiana sands from the standpoint of suitability for industrial use—glass manufacture, foundry sand, etc. Results will be published when the study is complete.

Stone.—Stone production, consisted primarily of shell (clam and oyster), and some anhydrite produced in Winn Parish for road surfacing and concrete. Lacking an adequate supply of stone, Louisiana relies on shell as a substitute. About 77 percent of the shell was used for concrete aggregate and road construction; cement raw material comprised 19 percent; the remainder was burned to lime. Total output of shell was about 8.5 percent higher than in 1965.

Table 18.—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
1957–61 (average)	163	$3,820	1,557	$11,094	2,525	$5,914	4,245	$20,828
1962	246	6,298	2,004	13,531	2,998	7,578	5,248	27,407
1963	250	5,988	2,294	15,227	3,655	9,235	6,199	30,450
1964	252	6,080	2,516	16,537	3,633	13,439	6,401	36,056
1965	256	6,293	3,106	17,828	4,854	17,691	8,126	41,812
1966	267	6,354	3,502	19,681	4,967	18,154	8,736	44,189

Table 19.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total sand and gravel	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	13,662	$17,052	348	$128	14,010	$17,180
1962	11,701	14,682	339	135	12,040	14,817
1963	12,125	14,551	375	150	12,500	14,701
1964	13,228	14,959	366	294	13,594	15,253
1965	14,024	16,306	274	99	14,298	16,405
1966	18,171	22,459	45	45	18,216	22,504

Table 20.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	2,717	$2,643	4,295	$4,632
Paving	1,708	1,593	3,170	3,287
Other [1]	340	302	301	514
Total	4,765	4,538	7,766	8,433
Gravel:				
Building	5,313	6,640	5,307	7,099
Paving	3,409	4,121	4,765	6,499
Other [2]	537	1,007	333	428
Total	9,259	11,768	10,405	14,026
Total sand and gravel	14,024	16,306	18,171	22,459
Government-and-contractor operations:				
Sand: Paving	1	2	-----	-----
Gravel:				
Building	168	19	-----	-----
Paving	105	78	45	45
Total	273	97	45	45
Total sand and gravel	274	99	45	45
Grand total	14,298	16,405	18,216	22,504

[1] Includes fill, other construction, and industrial sand (ground and unground).
[2] Includes fill, other construction, and miscellaneous gravel.

Sulfur.—Shipments of Frasch sulfur were at a record level, exceeding the 1965 total by 12 percent. Sulfur remained in short supply during the year and several new sulfur operations started.

During early 1966, United States Frasch producers did not increase their domestic prices but continued a program begun in 1965 of eliminating allowances and adjusting transportation and handling charges. Effective December 1, 1966, Freeport Sulphur Co. increased its domestic price by $2.50 per ton to $28.50 per ton for dark sulfur f.o.b. Port Sulphur. Late in the year, export prices for Frasch sulfur were $39.00 per ton and upward for bright sulfur f.o.b. gulf ports.

Table 21.—Sulfur produced and shipped from Frasch mines

(Thousand long tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1957–61 (average)	2,217	2,209	$52,185
1962	2,363	2,262	49,772
1963	2,469	2,445	48,905
1964	2,739	2,733	54,996
1965	3,582	3,577	r 81,372
1966	4,085	4,018	104,472

r Revised.

Freeport Sulphur Co. continued to be the world's largest producer and supplier of sulfur. Its production came from three mines in the bayou country of Louisiana—

Grande Ecaille, Lake Pelto, and Garden Island Bay—and from the Grand Isle mine 7 miles offshore from the Louisiana coast. The company installed a new production platform at the Grand Isle mine to maintain production levels while the two existing platforms were being relocated. The new addition was unique because it floats and thereby will not need to be relocated because of subsidence caused by mining sulfur. The pontoons were sunk about 50 feet below the water's surface, and it was expected the platform would be stable even in the most severe storm. In April, Freeport Sulphur Co. announced plans to construct a $25 million offshore facility to mine a sulfur deposit 6 miles seaward from Caminada Pass in the Gulf of Mexico. Development drilling at the site was completed, fabrication of mining facilities proceeded onshore, and production was scheduled to begin in 1968.

Texas Gulf Sulphur Co. mounted equipment on barges preparatory to mining the Bully Camp deposits in Lafourche Parish just above Golden Meadow. Production probably will start in 1968.

Jefferson Lake Sulphur Co., a subsidiary of Occidental Petroleum Corp., discovered enough sulfur in Lake Hermitage salt dome, Plaquemines Parish, to justify a mining operation. This, too, was to be a barge-mounted operation.

A plant to recover sulfur from crude oil was placed onstream at the Shell Oil Co. Norco refinery. Louisiana crude has low sulfur content, but the company expected to produce about 40 long tons per day.

A plant, built by Union Texas Petroleum Co. to reestablish production at the old Sulphur Mines salt dome—site of the first successful installation of the Frasch method—came onstream during the latter part of 1966 but produced only a relatively small tonnage of sulfur.

The current interest in sulfur led a number of companies to seek leases for additional prospecting and drilling on other known onshore dome structures in the gulf coast area.

METALS

Aluminum.—Kaiser Aluminum & Chemical Corp. produced alumina at its Gramercy and North Baton Rouge plants, calcined coke at Norco, and produced aluminum at its reduction plant at Chalmette. To meet increased demand, tabular and calcined alumina production was increased at the company's Baton Rouge plant. The new facilities should be adequate for the increased demand for tabular alumina—so named because it is composed of tablet-type crystals—used in making high-temperature refractory brick and electrical insulators for sparkplugs and in other wide applications.

REVIEW BY PARISHES

Minerals were produced in all but one of the State's 64 parishes. Mineral fuels were produced in 58 parishes; other minerals were produced in 39 parishes. Nine parishes reported mineral production valued at over $100 million (eight in 1965). Mineral production in these nine parishes totaled $2,556 million or 75 percent of the total value for the State. Three parishes reported between $100 million and $50 million, and 39 other parishes reported mineral production valued at over $1 million. Parishes with significant mineral production or mineral industry activity are reviewed separately. (See table 22 for additional details.)

Acadia.—Twenty-eight exploratory holes were drilled, but no discoveries were made in 1966. The parish ranked first in recovering natural gas liquids, valued at $37 million. Seven gasoline plants and one fractionator recovered the liquids.

Allen.—Eleven exploratory wells were drilled; two oilfields, W. LeBlanc and E. LeBlanc, and one gasfield, N. E. Fontenot, were discovered.

Ascension.—This parish had tax exemption applications for $63 million of chemical and petroleum construction, the highest in the State, as the Geismar chemical complex continues to expand. Shell Pipeline Corp. proposed a 650-mile crude oil pipeline, "Capline," frfom Donaldsonville to Wood River, Ill. Capline will be the biggest crude oil pipeline ever built. Gulf Oil Corp. announced plans to build a $50 million chemical complex, including a refinery near Donaldsonville, in the near future.

Table 22.—Value of mineral production in Louisiana, by parishes [1]

Parish	1965	1966	Minerals produced in 1966 in order of value
Acadia	$110,659,704	$121,816,941	Natural gas, natural gas liquids, petroleum.
Allen	9,744,441	9,670,524	Petroleum, natural gas, natural gas liquids.
Ascension	4,831,547	5,455,913	Petroleum, salt, natural gas.
Assumption	19,940,938	22,514,927	Natural gas, petroleum.
Avoyelles	3,660,447	4,122,753	Petroleum, natural gas, natural gas liquids.
Beauregard	8,998,340	10,047,596	Petroleum, natural gas, natural gas liquids, sand and gravel.
Bienville	9,072,233	10,185,393	Natural gas, petroleum.
Bossier	34,714,994	36,692,474	Natural gas, petroleum, natural gas liquids.
Caddo	33,498,076	37,198,454	Petroleum, natural gas, natural gas liquids, clays.
Calcasieu	41,514,907	46,654,238	Petroleum, natural gas, natural gas liquids, cement, lime, salt, clays.
Caldwell	2,560,937	2,871,208	Natural gas, petroleum.
Cameron	153,745,670	177,177,409	Natural gas, petroleum, natural gas liquids, salt, shell.
Catahoula	10,377,000	11,751,196	Petroleum, sand and gravel, natural gas.
Claiborne	25,682,140	27,965,028	Petroleum, natural gas, natural gas liquids.
Concordia	18,972,201	21,367,246	Petroleum, natural gas.
De Soto	11,159,099	11,986,411	Natural gas, petroleum.
East Baton Rouge	16,830,602	17,970,526	Cement, petroleum, lime, sand and gravel, natural gas, clays.
East Feliciana	1,068,000	W	Sand and gravel.
Evangeline	10,634,252	11,835,645	Petroleum, natural gas, natural gas liquids, sand and gravel.
Franklin	1,978,104	2,249,370	Petroleum, natural gas.
Grant	862,082	517,801	Petroleum, sand and gravel, natural gas.
Iberia	92,224,859	103,242,582	Petroleum, natural gas, salt, natural gas liquids, clays.
Iberville	44,193,599	49,256,501	Petroleum, salt, natural gas, natural gas liquids.
Jackson	330,272	371,169	Natural gas, petroleum.
Jefferson	r 137,238,905	161,149,572	Petroleum, sulfur, natural gas, sand and gravel, salt, natural gas liquids, shell.
Jefferson Davis	52,118,465	57,909,016	Natural gas, petroleum, natural gas liquids.
Lafayette	14,034,723	15,843,364	Natural gas, petroleum, clays.
Lafourche	309,069,232	350,723,699	Petroleum, natural gas, natural gas liquids.
La Salle	18,531,842	21,071,503	Petroleum, natural gas, sand and gravel.
Lincoln	22,204,665	25,525,726	Natural gas liquids, natural gas, petroleum, clays.
Livingston	306,054	201,459	Petroleum, natural gas.
Madison	1,598,662	1,793,802	Petroleum, sand and gravel, natural gas.
Morehouse	1,872,566	2,182,724	Natural gas, natural gas liquids, petroleum.
Natchitoches	212,935	240,131	Petroleum, natural gas, clays.
Orleans	13,487,675	15,004,223	Cement, lime, shell, natural gas.
Ouachita	9,417,485	11,357,642	Natural gas, natural gas liquids, petroleum, sand and gravel, clays.
Plaquemines	r 673,429,716	783,913,858	Petroleum, natural gas, sulfur, natural gas liquids, salt.
Pointe Coupee	11,422,011	12,704,906	Petroleum, natural gas, natural gas liquids, clays.
Rapides	5,111,374	5,595,025	Petroleum, sand and gravel, natural gas, clays.
Red River	961,137	1,458,162	Petroleum, sand and gravel, natural gas.
Richland	15,069,511	16,871,372	Petroleum, natural gas, natural gas liquids.
Sabine	20,427,484	23,283,443	Do.
St. Bernard	16,560,800	17,285,915	Natural gas liquids, petroleum, natural gas, clays.
St. Charles	44,676,567	48,449,530	Petroleum, natural gas, natural gas liquids.
St. Helena	280,000	592,000	Sand and gravel.
St. James	5,353,749	6,066,614	Petroleum, natural gas, natural gas liquids.
St. John the Baptist	3,729,536	4,972,351	Petroleum, shell, natural gas.
St. Landry	47,433,163	56,850,857	Petroleum, natural gas, natural gas liquids.
St. Martin	64,502,426	72,741,769	Petroleum, natural gas, salt, natural gas liquids.
St. Mary	234,936,040	267,250,412	Petroleum, natural gas, natural gas liquids, salt, shell, lime.
St. Tammany	3,445,532	2,947,336	Shell, sand and gravel, natural gas, petroleum, clays.
Tangipahoa	790,064	384,365	Sand and gravel, petroleum, clays.
Tensas	17,405,067	19,476,105	Petroleum, natural gas, natural gas liquids.
Terrebonne	r 366,582,522	420,200,599	Petroleum, natural gas, sulfur, natural gas liquids, salt.
Union	13,480,705	15,118,160	Natural gas, petroleum.
Vermilion	149,061,774	170,756,350	Natural gas, petroleum, natural gas liquids, sand and gravel.
Vernon	3,000	8,000	Sand and gravel.
Washington	869,000	790,000	Do.
Webster	28,500,894	33,189,435	Petroleum, natural gas, natural gas liquids, sand and gravel.
West Baton Rouge	651,679	703,910	Petroleum, natural gas, clays.
West Carroll	210,618	236,121	Natural gas.
West Feliciana	W	W	Sand and gravel.
Winn	3,826,302	3,610,941	Petroleum, stone, gypsum, natural gas, sand and gravel.
Undistributed	r 12,192,676	38,758,298	
Total	2,988,261,000	3,430,140,000	

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] East Carroll not listed because no production was reported.

Assumption.—During the year, 13 exploratory holes were drilled, proving two gasfields, Northwest Oakley and Ratcliff, and one oilfield, Bayou Grosbec.

Avoyelles.—Drilling of 16 exploratory wells proved one oilfield, Vick.

Bienville.—The Danville gasfield was discovered. United Gas Pipeline Co. continued constructing a gas storage reservoir in the old Bistineau gasfield.

Caddo.—The parish ranked third in total number of wells drilled—227 wells in 1966 (716 in 1965). All but six were development wells, many in the Pine Island area. One oilfield, Walnut Bayou was opened.

Calcasieu.—Exploratory drilling of 18 wells proved one oilfield, Newton. The Lake Charles industrial area remained one of the important industrial concentrations in the State, and it continued to expand. The sulfur plant, built to reestablish production at Sulphur Mines salt dome, produced a relatively small tonnage of sulfur. The parish ranked fourth in mineral industry investment, according to tax exemption records, with $43 million.

Cameron.—The parish ranked fifth in total value of mineral production; sixth in value of petroleum, fourth in value of natural gas, and seventh in value of natural gas liquids. Two gasfields were discovered onshore—South Lake Misere, and Twin Island. Exploratory drilling of 56 wells offshore proved five gasfields: E. Cameron —Block 118, —Block 139, —Block 189, —Block 224; and West Cameron—Block 456. A 1964 gas discovery offshore was named in 1966 (E. Cameron Block 49). Natural gas liquids were recovered at 12 gas processing plants. Continental Oil Co. completed a 500-million-cubic-foot-per-day gas processing plant at Grand Chenier. It will replace their old 350-million-cubic-foot-per-day plant.

Catahoula.—Exploratory drilling of 55 wells resulted in two productive oilfields: Bayou Louis, probably the most important Wilcox discovery in Louisiana this year, and Serena.

Claiborne.—The Forest Grove School oilfield was opened. Natural gas liquids were recovered at four gas processing plants. Bedded siderite and limonite deposits exposed in hillsides have been investigated by the Louisiana Geological Survey and are reportedly similar to deposits in East Texas.

Concordia.—The parish ranked first in exploratory drilling (77 wells) and second in total drilling (228 wells). Natchez Ferry oilfield was opened.

De Soto.—Ten exploratory wells were drilled. Mansfield gasfield was opened. South Louisiana Production Co. operated its underground gas storage system in the Holly field reservoir. Working capacity of the storage was 1 billion cubic feet.

East Baton Rouge.—Construction of petroleum and petrochemical facilities and expansion of existing facilities was widespread in the Baton Rouge area. Clay for brick manufacture was mined by Acme Brick Co. Ideal Cement Co. produced portland and masonry cements from shell which was barged up the Mississippi by a New Orleans supplier. Kaiser Aluminum & Chemical Corp. processed bauxite into alumina at its North Baton Rouge plant. According to tax exemption records of the Louisiana Department of Commerce and Industry, the parish ranked third in mineral industry investment with $45 million.

Franklin.—Drilling of 17 exploratory wells proved Longview gasfield.

Iberia.—The parish ranked first in value of salt output. Natural gas liquids were recovered at three plants. West Lake Ferme gasfield was discovered onshore. South Marsh Island Block 27 oilfield and South Marsh Island Block 142 gasfield were discovered offshore.

Iberville.—Gulf States Utilities Co. began a $41.7 million expansion of its generating plant in Iberville Parish. In addition, mineral industry investment for 1966, according to tax exemption records, ranked fifth in the State with $25 million. Willow Glen oilfield was discovered.

Jefferson.—Freeport Sulphur Co. produced sulfur at its Grand Isle offshore platform. The company began development work on another offshore sulfur mine about 5 miles west of the Grand Isle mine. Production is scheduled to begin in 1968.

The parish ranked fifth in petroleum production, valued at $112 million. In April, Humble Oil and Refining Co. completed a 100-million-cubic-foot-per-day natural gas processing plant at Grand Isle. This again put Jefferson Parish in the ranks of natural gas liquids producers.

Two gasfields were discovered offshore in the Grand Isle area (Block 33 and Block 72).

Lafourche.—The parish ranked third in exploratory drilling with 48 wells and seventh in total drilling with 141 wells. Only one gasfield, Plum Point, was discovered onshore. South Timbalier Block 190 gasfield was discovered offshore. The total mineral production value was $351 million, third in the State. Texas Gulf Sulphur Co. was preparing to mine the Bully Camp sulfur deposit. Production will probably start in 1968.

La Salle.—Mosquito Bend oilfield was discovered.

Natchitoches.—Placid Oil Co. was constructing its Black Lake natural gas processing plant. It will have a capacity of 130 million cubic feet per day and was expected to be completed in March 1967. Initial yield from the field was gas, but subsequent drilling discovered a big reserve of crude oil.

Ouachita.—Acme Brick mined clay at Monroe for brick and tile. Drew gasfield was opened. Natural gas liquids were recovered at the Calhoun plant of Arkla Chemical Corp., and the Calhoun plant of Southwest Gas Producing Co., Inc. Work continued on the anhydrous ammonia plant of Commercial Solvents Corp. at Sterlington with completion scheduled for mid-1967.

Plaquemines.—Total value of mineral production, highest in the State, increased from $673 million in 1965 to $784 million in 1966, a gain of 16 percent. The parish ranked first in total drilling, fifth in exploratory drilling, first in petroleum and sulfur production, second in natural gas production, and third in natural gas liquids production. Lake Lery gasfield was opened. Three new offshore oilfields, West Delta Block 133 and Breton Sound Block 31 and Block 37, were opened. West Delta Block 35 gasfield was opened. Gulf Oil Corp. was completing its new 20,000-barrel-per-day refinery at Venice. The company completed a new 800-million-cubic-foot-per-day natural gas processing plant at the same location.

Humble Oil and Refining Co. early in 1966 completed its Delta gas processing plant at Venice with a capacity of 310 million cubic feet per day.

Jefferson Lake Sulphur Co. discovered enough sulfur in Lake Hermitage salt dome to justify a mining operation.

Red River.—The East Hope gasfield was opened.

Sabine.—The East Sardis and Columbus oilfields were discovered by 16 exploratory wells. The Toledo Bend Dam was partially closed and began collecting water that will eventually back up 65 miles. This joint Texas-Louisiana built reservoir and hydroelectric project was about 70 percent complete, and the target date for completion of the $65 million project was May 1968.

St. Bernard.—Chandeleur Sound Block 54 gasfield and Breton Sound Block 12 oilfield were discovered offshore. Tenneco Oil Co. planned to expand its refinery at Chalmette in the near future, and Murphy Corp. completed a new alkylation unit at the Meraux refinery. Kaiser Aluminum & Chemical Corp. operated its Chalmette aluminum reduction plant.

St. James.—The Kaiser Aluminum & Chemical Corp. plant at Gramercy operated during the year to produce aluminum fluoride, isocyanates, hydrogen fluoride, and fluorcarbons. St. Amelia gasfield was discovered. Texaco Inc. continued construction of its new $75 million refinery near the Sunshine Bridge. Completion was scheduled in 1967.

St. John the Baptist.—The Edgard gasfield was discovered.

St. Mary.—The parish ranked fourth in total value of minerals, petroleum, and natural gas liquids production. It was fifth in natural gas production. The West Bayou Carlin oilfield and the East Franklin gasfield were discovered. Offshore, a gasfield —Eugene Island Block 231—was discovered. The Humble Oil & Refining Co. let a $4.8 million contract to expand its Garden City gas processing plant. Already the State's largest, capacity will be increased 350 million cubic feet per day to 1.25 billion cubic feet per day.

Terrebonne.—The parish ranked second in total value of minerals produced, first in natural gas production, third in petroleum production, and fourth in exploratory drilling for petroleum and natural gas. East Lake Decade, a 1965 discovery, was named in 1966. North Kent Bayou gasfield was discovered onshore. Offshore in the

Ship Shoal area three gasfields (Block 40, Block 58, and Block 224) and one oilfield (Block 299) were discovered. South Timbalier, Block 245 gasfield was discovered.

Union.—Shiloh gasfield was discovered.

Vermilion.—The parish ranked third in natural gas production and second in natural gas liquids production. Vermilion area Block 193 gasfield offshore was discovered in 1964 but named in 1966. Vermilion area Block 171 gasfield and South Marsh Island Block 16 oilfield were discovered in 1966. Natural gas liquids were recovered at six gas processing plants.

The Mineral Industry of Maine

By Robert E. Ela [1]

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.

Value of Maine mineral production totaled $16.7 million, a 6-percent decrease from the record high established in 1965. The decline was attributed principally to lower demand for sand and gravel in highway construction and to the lower volume of shipments of portland cement. Decreases in value were also reported for clay and feldspar.

Exploration for and development of metallic mineral deposits, including gold, silver, copper, lead, zinc, and nickel, continued. Spooner Mines and Oils Ltd., operating through North American Exploration; Northern Canada Mines, Ltd.; and Noranda Mines, Ltd., were active south of Jackman in Somerset County.

According to the new Federal Highway Act, passed by Congress in 1966, a minimum standard of four-lane divided highways must now be provided on the interstate system. This new standard will affect 108 miles of highway between Old Town and Houlton. Substantial quantities of sand and gravel, stone, and cement will be required for the highway work that will have to be done before Maine's interstate system is completed.

[1] Statistical assistant, Bureau of Mines, Pittsburgh, Pa.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Dragon Cement Co., Inc., Division of Martin Marietta Corp., the sole cement producer in Maine, manufactured cement using the wet process. Two types of finished portland cement were produced: Types I and II (general use) and type III (high-early-strength). Stocks of finished portland cement at yearend rose to their

Table 1.—Mineral production in Maine [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays----thousand short tons--	49	$63	45	$58
Gem stones	NA	35	NA	35
Peat----short tons--	1,275	56	1,600	60
Sand and gravel----thousand short tons--	17,294	7,831	15,036	7,027
Stone----do----	1,100	3,409	1,092	3,622
Value of items that cannot be disclosed: Cement (portland and masonry) and feldspar	XX	6,347	XX	5,932
Total	XX	17,741	XX	16,734

NA Not available. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1957	r $12,842	1962	r $14,598
1958	r 12,651	1963	r 13,894
1959	r 13,529	1964	r 17,256
1960	r 13,692	1965	r 17,631
1961	r 15,282	1966	p 16,451

r Revised.
p Preliminary.

Table 3.—Employment 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
1965:								
Metal and nonmetal	195	212	41	330	1	22	69.73	18,844
Sand and gravel	1,652	235	389	3,128	----	56	17.90	378
Stone	466	248	115	960	----	12	12.50	222
Peat	20	110	2	17	----	----	----	----
Total	2,333	234	547	4,435	1	90	20.52	1,716
1966: p								
Metal and nonmetal	120	189	23	181	1	7	44.20	34,569
Sand and gravel	1,620	233	378	2,499	----	50	20.01	530
Stone	445	248	110	913	----	28	30.67	697
Peat	21	136	3	23	----	----	----	----
Total	2,206	233	514	3,616	1	85	23.78	2,272

p Preliminary.

highest level since 1962 as shipments failed to keep pace with production. Cement rock, the principal raw material consumed in the two rotary-kiln plant, was quarried by the company. Purchased sand, gypsum, and iron-bearing materials were also used as raw materials. In order of size, the principal consumers of finished portland cement were ready-mixed concrete companies, concrete product manufacturers, and building material dealers. Total apparent consumption of portland cement in Maine during 1966 was 997,000 barrels. Eighty percent of the portland cement was shipped in bulk to consumers in Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.

Clays.—Clay production, predominantly miscellaneous clay, was 8 percent less than in 1965. Miscellaneous clay mines, two in Androscoggin County and three in Cumberland County, supplied local brick-manufacturing plants. A small quantity of fire clay, used in pottery manufacture, was recovered from property in Hancock County. Cumberland County continued to be the principal clay producing area. Clay mining on property near Eliot, York County, by Morin and Sons, Inc., was not economical and was terminated in mid-July.

Feldspar.—Production of marketable crude ore was limited to Oxford County. Output which had increased for 3 successive years was 7 percent lower than in 1965. Feldspar from mines in Oxford County together with a substantial quantity of high potash feldspar mined in New Hampshire was processed at a grinding plant at West Paris. Ground feldspar production was about the same as the previous year and was used chiefly for ceramic materials, although a limited quantity was consumed for soaps and abrasives. Ceramic uses included electrical porcelain, tile, sanitary ware, and other pottery products. Most of the ground feldspar was consumed at plants located in Pennsylvania, Ohio, and New Jersey.

Gem Stones.—Oxford County continued to be the chief area for collecting gem-quality stones and mineral specimens in Maine. Other counties in which the recovery of mineral specimens has been reported were Franklin, Sagadahoc, Washington, and York. Minerals collected included agate, autunite, beryl, gem-quality aquamarine, lithium minerals, and amethyst.

Lime.—Regenerated high calcium lime produced by Oxford Paper Co. at Rumford, Oxford County, was used for manufacturing paper. The quantity of lime lost was relatively small, and was supplemented with purchased material.

Nitrogen Compounds.—Anhydrous ammonia, used as a fertilizer component, was produced by Northern Chemical Industries, Searsport, Waldo County.

Peat.—Despite a 25-percent increase in the tonnage of peat sold, the value rose only 7 percent. Lower unit prices were reportedly due to increased competition from Canadian producers. All peat sold during the year was the sphagnum variety and was used principally as a soil conditioner.

Sand and Gravel.—Production of sand and gravel, which had set new records in the 4 previous years, dropped to 15 million tons; 13 percent below the record high established in 1965. The Maine Highway Commission, the State's largest single user of sand and gravel, reported a substantial decrease in consumption. Completion of Interstate Highway 95, in the central part of the State, and a reduction of highway size from four to two lanes in the northern section were the chief reasons for the decrease in demand. Construction on the last remaining gap on Interstate 95, extending for 41 miles between Medway and Oakfield, is currently underway and is scheduled for completion in 1967.

Commercial production was only 14 percent of the State total and was reported from all counties except Lincoln and Piscataquis. Shipments to consumers were predominantly by truck.

Combined production of both commercial and Government-and-contractor operations exceeded 1 million tons in only four counties. The counties of Aroostook, Penobscot, Cumberland, and York, in order of decreasing contribution, accounted for more than half of the State production. Government-and-contractor operations in Penobscot produced 2.2 million tons less than in 1965.

Shifts in use patterns reflected the various phases in highway construction. Sand and gravel for paving accounted for 91 percent of total production, compared with 63 percent in 1965. Fill, principally sand, dropped 4.9 million tons and represented only 3 percent of the total production, compared with 31 percent in 1965. Eighty-three percent of the sand and gravel was beneficiated by washing, screening, or other methods; commercial producers processed 54 percent of their output, while Government-and-contractor operations processed more than 87 percent of their total output.

Stone.—In terms of value, dimension granite and crushed limestone continued to be the principal types of stone quarried in the State. Stone production totaled 1,092,000 tons and remained near the record high established in 1965. Value of stone rose $213,000 due largely to the higher unit value of crushed limestone. Output of dimension granite, in order of decreasing value, included dressed architectural, dressed monumental, curbing, flagging, dressed construction, and rough construction stone. Crushed granite was marketed as riprap, concrete aggregate, and roadstone. Crushed and broken limestone was used principally in the manufacture of cement with sizable quantities being used for concrete, roadstone, and agricultural purposes. Slate, the only other dimension stone produced, was marketed as electrical slate and flagging. Miscellaneous stone was crushed or broken and used primarily for concrete aggregate and roadstone. The principal limestone-producing area was Knox County followed by Aroostook and Kennebec. Dimension granite was produced in Hancock, Knox, and York Counties; crushed granite was produced in Cumberland, Knox, and York Counties. Slate production was exclusive to Piscataquis County; crushed miscellaneous stone was produced in Cumberland County.

METALS

Development of the Black Hawk Mining Corp., Blue Hill property, was virtually at a standstill. Shortage of experienced personnel was the main reason for the delay. Black Hawk Mining Corp., a subsidiary of Denison Mines Ltd., Toronto, Ontario, started exploration at the site in 1961.

Table 4.—Sand and gravel sold by producers, by classes of operations and uses

(Thousand short tons and thousand dollars)

Class of operation and use	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Structural	331	$254	280	$166
Paving	255	193	300	270
Fill	277	121	279	105
Engine	4	6	4	6
Other	51	40	72	47
Total	918	614	935	594
Gravel:				
Structural	195	202	199	184
Paving	667	695	680	726
Railroad ballast	31	10	26	9
Fill	257	111	199	79
Other	142	62	[1] 126	[1] 52
Total	1,292	1,080	1,230	1,050
Total sand and gravel	2,210	1,694	2,165	1,644
Government-and-contractor operations:				
Sand:				
Structural	3	2	----	----
Paving	792	600	3,065	1,400
Fill	4,629	1,622	----	----
Other	227	178	238	183
Total	5,651	2,402	3,303	1,583
Gravel:				
Paving	9,199	3,639	9,566	3,799
Fill	231	95	2	1
Other	3	1	----	----
Total	9,433	3,735	9,568	3,800
Total sand and gravel	15,084	6,137	12,871	5,383
All operations:				
Sand	6,569	3,016	4,238	2,177
Gravel	10,725	4,815	10,798	4,850
Total	17,294	7,831	15,036	7,027

[1] Includes miscellaneous and other gravel.

Passage of legislation by a special session of the Maine Legislature, permitted Callahan Mining Corp. to proceed with the development of its open pit copper-zinc mine in Hancock County. Construction of a dam to block the ocean and a retaining wall around the pit area to deflect local drainage has been completed. The company planned to have the mine in production by mid-1967.

Knox Mining Company, with Office of Mineral Exploration assistance, completed half of its current nickel exploration project near Union, Knox County.

REVIEW BY COUNTIES

The Maine State Highway Commission produced paving sand and gravel in each of the State's 16 counties; output was obtained by its own crews and by workers under contract. A small quantity of gravel for fill was also mined. In addition, five municipalities in Androscoggin County, two in Hancock, one each in Cumberland and Penobscot recovered sand and gravel for local roads and street maintenance. Production of Government-and-contractor sand and gravel was over 2 million tons in Aroostook and in Penobscot Counties, the principal producing areas.

Androscoggin.—Eleven commercial sand and gravel operations reported output in 1966 compared with 12 in 1965. Fifty-six

Table 5.—Value of mineral production in Maine, by counties

County	1965	1966	Minerals produced in 1966 in order of value
Androscoggin	$577,050	$502,040	Sand and gravel, clays.
Aroostook	1,590,848	1,555,576	Sand and gravel, stone.
Cumberland	1,088,795	1,125,971	Sand and gravel, stone, clays.
Franklin	177,000	168,000	Sand and gravel.
Hancock	571,949	1,247,087	Stone, sand and gravel, clays.
Kennebec	474,961	400,000	Sand and gravel, stone.
Knox	W	W	Cement, stone, sand and gravel.
Lincoln	130,000	98,000	Sand and gravel.
Oxford	236,110	287,084	Sand and gravel, feldspar.
Penobscot	2,038,000	1,110,000	Sand and gravel.
Piscataquis	W	W	Stone, sand and gravel.
Sagadahoc	161,000	W	Sand and gravel.
Somerset	294,000	315,000	Do.
Waldo	W	278,000	Do.
Washington	351,900	W	Sand and gravel, peat.
York	W	W	Sand and gravel, stone.
Undistributed [1]	10,049,632	9,647,650	
Total	17,741,000	16,734,000	

W Withheld to avoid disclosing individual company confidential data.
[1] Includes value of sand and gravel and gem stones that cannot be assigned to specific counties and values indicated by symbol W.

percent of the sand and gravel was prepared and used chiefly as building and paving material; smaller quantities of sand were prepared for ice control and for fill. Principal producers were Lewiston Crushed Stone Co., Inc., Lewiston; Blue Rock Sand & Gravel, Leeds; and G. A. Peterson, Co., Auburn. The Morin Brick Co. and the Dennis Brick Co., Inc., produced miscellaneous clay from open pits near Auburn for use in brick manufacture.

Aroostook.—Although total output of sand and gravel decreased 13 percent below that of 1965, production exceeded 3 million tons for the second consecutive year. The decline was attributed to completion of Interstate Highway 95 between Oakfield and Houlton. Commercial sand and gravel, only 2 percent of the total output, was used as paving, railroad ballast, and miscellaneous gravel. McKay Rock Products, Inc., quarried limestone near Presque Isle; the output was used mainly for concrete aggregate and railroad ballast.

Cumberland.—Output of commercial sand and gravel increased 12 percent and totaled 533,000 short tons. Cumberland County continued to lead in commercial tonnage but ranked second in value. Fifty-seven percent of the material produced was processed, and the entire output was transported by truck. The leading producers were Harry C. Crooker & Sons, Inc., Cumberland Sand & Gravel Co., Inc., Maynard W. Robinson & Sons, Leroy S. Prout Sand & Gravel, and Hamlin Sand & Gravel Co., Inc. Granite quarried near Portland by Cook & Co., Inc., was used as riprap, concrete aggregate, and roadstone. Miscellaneous crushed stone produced by Blue Rock Quarry at Westbrook was sold for the same uses. Cumberland County led in clay output and value. Miscellaneous clay used for manufacturing brick was produced by Lachance Bros. Brick Co., Gorham; Fred S. Liberty & Sons, Inc., North Yarmouth; and Royal River Brick Co., Inc., Gray.

Franklin.—Commercial sand and gravel used for building and paving was recovered from pits near Wilton and Weld. Brown Co., a paper manufacturer at Berlin, N.H., produced gravel on company-owned property for use in maintaining their access roads.

Hancock.—Deer Island Granite Corp. completed its contract to supply granite for the John F. Kennedy grave site at Arlington National Cemetery, Virginia. The company produced dimension granite from the Deer Island quarry, located on an island off the coast near Stonington, and the Settlement quarry at Buckmaster Neck, also near Stonington. Dimension granite was also produced by Joseph Musetti from Joe's quarry at Mt. Desert. Grenci & Ellis, Inc., ceased all operations at their Hall quarry at the end of December 1965. Harold MacQuinn, Inc., Bar Harbor, the principal commercial producer,

used two portable plants and one stationary plant to process sand and gravel for use in construction of highways and parking areas and for ice control. Commercial sand and gravel production was also reported from pits near Gouldsboro, Ellsworth, Blue Hill, and Winter Harbor. Stoneware clay recovered from a pit near East Blue Hill was used for making art pottery and dinnerware.

Black Hawk Mining Ltd., temporarily discontinued development of its Blue Hill property. A shortage of experienced miners delayed development of the mine and curtailed plans to construct a 600-ton-per-day mill.

Kennebec.—Output of commercial sand and gravel increased slightly over the previous year. Production was reported by V. E. Dunn & Son, Augusta; Calvin Rundstrom, Pittston; and Lee Brothers, South China. Blue Rock Quarry, Sidney, produced limestone for concrete aggregate and roadstone.

Knox.—Portland and masonry cements were produced at Thomaston by Dragon Cement Co., Division of Martin Marietta Corp. Cement rock quarried nearby was the principal raw material utilized by the company. The Dragon Cement Co. Division was awarded a Certificate of Achievement in Safety for its outstanding safety record in 1966. A total of 30,280 man-hours were worked without a disabling work injury.

Limestone quarried by Rockland-Rockport Lime Co., Rockland, and Lime Products Corp., Union, was used principally for agricultural purposes. Limited quantities were marketed for concrete and roadstone, poultry grit, and for use at papermills.

Hocking Granite Industries, Inc., Clark Island, quarried dimension granite mainly for use as dressed construction, architectural, and curbing stone. Limited quantities of fill material and stone sand were also produced.

As in 1965, C. R. Wallace & Sons, Inc., Warren, continued as the county's only source of commercial sand and gravel.

Oxford.—Brown Co. of Berlin, N. H., recovered bank run gravel on company-owned property in the county for use in maintaining access roads. Commercial sand and gravel was also produced by Donald E. Wood from a pit near Norway. Eight producers recovered crude feldspar from mines near West Paris, Sumner, Hebron, Albany, and Bethel. All of the crude material was ground at Bell Mineral Co.'s mill at West Paris. Feldspar was ground for ceramic uses, including electrical porcelain, sanitary tile, and pottery, and for soaps, abrasives, and metal polishes. Oxford County continued to be the gem collectors' main source of gem materials and mineral specimens.

Penobscot.—Completion of Interstate Highway 95, between Howland and Medway seriously affected the sand and gravel industry in the area. Combined production of commercial and Government-and-contractor operations totaled 2.4 million tons, a drop of 2.2 million tons from the previous year. Decreases of 44 and 49 percent were recorded for commercial and Government-and-contractor production, respectively.

Piscataquis.—Portland-Monson Slate Co. mined slate by the block-caving method at its No. 2 and 4 underground slate mines. The slate was fabricated at the local finishing mill, for use as heavy switch gear panels, flagging, and floor tile.

Sagadahoc.—Production of commercial sand and gravel remained virtually the same as in 1965. Most of the output was used as construction material; a limited quantity was used as fill. The principal supplier was Jack's Pit located near Topsham.

Somerset.—Commercial sand and gravel mainly for building and paving uses was recovered from pits near Fairfield, Pittsfield, and Smithfield.

Exploration for base metals on properties south of Jackman increased. Northern Canada Mines, Ltd., was granted prospecting and exploration rights covering 10,000 acres. Spooner Mines & Oils, Ltd., of Toronto has taken out options on 200.2 square miles of land. The region is near the 12,000 acres where Noranda Mines, Ltd., has been doing exploratory work.

Waldo.—McKay Rock Products, Inc., processed sand and gravel with a high granite silicate content for use in concrete and as a roadstone. Grenci & Ellis, Inc., terminated all operations at its Waldo Quarry near Frankfort.

Washington.—Commercial gravel for railroad ballast and other miscellaneous uses

was recovered from pits near East Machias. Eric W. Kelley Peat Moss Co., Inc., Centerville, and New England Peat Industries, Inc., Jonesport, accounted for the State's peat production. All of the peat was packaged and marketed for general soil improvement.

York.—John Swenson Granite Co., Inc., of Concord, N. H., quarried dimension granite from the Swenson Pink quarry, Wells, and the Swenson Green Quarry, York, and processed at the Concord plant. Dimension granite was used in construction and architectural applications; crushed stone was used chiefly as riprap.

Sand and gravel production by commercial operations totaled 277,000 tons, compared with 281,000 tons in 1965. The out put was used mainly as building and paving material and as fill, and was recovered from operations near Biddeford, North Berwick, Saco, Sanford, and York.

Clay mining by Morin & Sons, Inc., was terminated in mid-July. The property near Eliot will be put up for sale.

The Mineral Industry of Maryland

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

By E. L. Hemingway [1]

The value of mineral production in Maryland in 1966 was $74 million, a slight decrease from the record high of $78 million in 1965. The decline was attributed to a slowup in construction which resulted in lower output of cement and crushed limestone. Stone, accounting for over one-third of the total value of State mineral output, continued to be the principal mineral product.

Baltimore County continued to rank first in value of mineral output, followed by Carroll. Mineral production was reported from every county in the State except Queen Annes and Somerset.

The Maryland Geological Survey announced the initiation of two new mineral resource studies—the first is an investigation of the mineral resources of the three Southern Maryland Counties of Charles, Calvert, and St. Mary's and the second is an investigation of the Wakefield marble belts in Frederick and Carroll Counties. Exploratory drilling in the Southern Maryland study is programmed to outline the potential areas of diatomite, greensand, sand and gravel, and clays.

Legislation and Government Programs.—The 1966 session of the General Assembly of Maryland enacted a new strip mining law which provides for the licensing of all coal strip mine operators and the reclamation of lands after stripping is completed. Noncompliance will result in revocation of the operator's license. The law also provides for the establishment of a Land Reclamation Advisory Committee.

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

Table 1.—Mineral production in Maryland [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	914	$1,088	856	$1,084
Coal (bituminous) do	1,210	4,389	1,222	4,367
Gem stones	NA	3	NA	3
Lime short tons	37,294	481	29,447	386
Natural gas million cubic feet	408	103	696	181
Sand and gravel thousand short tons	16,200	21,188	15,108	20,383
Stone do	14,553	28,432	13,868	27,229
Value of items that cannot be disclosed: Ball clay, cement (portland and masonry), greensand marl, peat, potassium salts, talc and soapstone	XX	22,311	XX	20,528
Total	XX	77,995	XX	74,161

NA Not available. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes ball clay; included with "Value of items that cannot be disclosed."

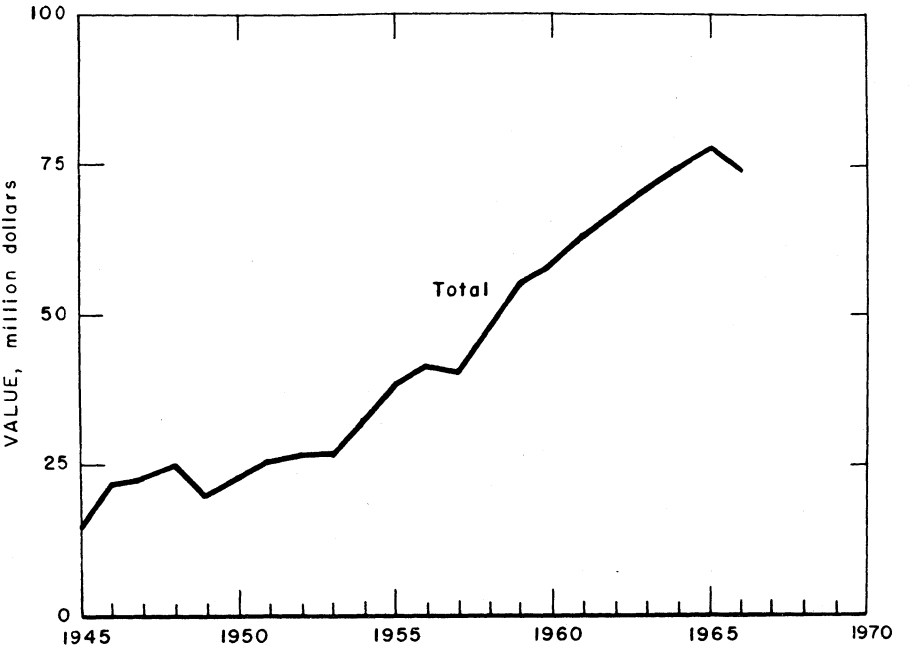

Figure 1.—Value of mineral production in Maryland.

Table 2.—Value of mineral production in constant 1957–59 dollars
(Thousands)

Year	Value [1]	Year	Value [1]
1957	$39,904	1962	$65,460
1958	46,012	1963	69,772
1959	54,512	1964	73,119
1960	56,232	1965	78,006
1961	61,800	1966	[p] 73,329

[p] Preliminary.
[1] Data for 1957–65 revised.

Table 3.—Employment 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
1965:								
Coal and peat	424	191	81	652	---	13	19.95	9,935
Nonmetal	288	271	78	617	---	38	61.55	1,160
Sand and gravel	1,024	252	258	2,150	1	56	26.52	3,919
Stone	1,266	255	323	2,809	---	46	16.38	285
Total	3,002	247	740	6,228	1	153	24.73	2,636
1966: [p]								
Coal and peat	425	191	81	668	---	18	26.95	892
Nonmetal	360	263	94	757	---	25	33.03	8,483
Sand and gravel	995	262	261	2,225	---	49	22.02	2,614
Stone	1,115	265	295	2,480	---	52	20.97	2,138
Total	2,895	253	731	6,130	---	144	23.49	2,959

[p] Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Production of cement was lower than in 1965. Portland cement accounted for 90 percent of the total output. Three plants, one each in Carroll, Frederick, and Washington Counties, produced both portland and masonry cement. In Frederick County, at another plant, only masonry cement was produced. More than one-half of the total output was used for ready-mixed concrete. Concrete product manufacturers, highway contractors, and building material dealers also consumed large quantities.

Clays.—Total output of clays remained about the same as in 1965. In 10 counties there were 17 active operations mining ball clay, fire clay, and miscellaneous clay. Ball clay was produced only in Baltimore County and was used in pottery, floor and wall tile, and fire brick and block. Fire clay products included fire brick and block and vitrified sewer pipe. Miscellaneous clay and shale were used mostly in manufacturing building brick and cement. Shale in Frederick County was used in manufacturing lightweight aggregate. Small quantities were used in other heavy clay products and as a filler for fertilizers.

Gem Stones.—A wide variety of semiprecious gem material and mineral specimens were collected by hobbyists.

Lime.—Three plants in Frederick County produced lime for agricultural purposes.

Marl, Greensand.—An open pit mine near Dunkirk, Calvert County, yielded greensand marl for use as a fertilizer and soil conditioner.

Perlite.—Expanded perlite was produced at plants in Baltimore and Prince Georges Counties from crude perlite mined in other States. The largest portion of total output was utilized as lightweight aggregate in plaster and concrete.

Pigments.—Two plants in Baltimore County produced titanium pigments by the sulfate process from ilmenite concentrate. Finished natural and manufactured iron oxide pigments were produced at a plant in Prince Georges County. All crude pigment material was shipped in from other States.

Potassium Salts.—One cement company in Washington County produced as a by-product a low-grade potassium sulfate for agricultural uses.

Sand and Gravel.—Sand and gravel ranked second in value of mineral production in 1966 however, tonnage and value declined from that of 1965. Output was reported from 17 counties, the foremost of which were Prince Georges, Cecil, Baltimore, and Anne Arundel. Commercial production amounted to 98 percent of the total State output. The chief uses were for structural use, highway construction and maintenance, and fill. A total of 73 commercial operations were active.

Stone.—In terms of value, the stone industry was the most important mineral industry in the State. Output was reported from quarry operations in 11 counties; limestone was the leading industrial stone. Crushed limestone comprised over one-half of the stone produced and was used mainly for concrete aggregate, roadstone, filler, and the manufacture of cement.

Several other varieties of stone were mined. Basalt (gabbro) and crushed granite were used for concrete aggregate, roadstone, railroad ballast, and riprap. A small tonnage of dimension granite was quarried for architectural building stone. Crushed sandstone was used in cement manufacture, and crushed quartzite was used for refractory silica brick; dimension sandstone and quartzite were used in rough construction. Crushed marble was used for terrazzo. Miscellaneous stone (serpentine and mica schist) was used for building stone, rubble, flagging, concrete aggregate, and roadstone.

Baltimore County ranked first in stone production, followed by Washington and Frederick Counties.

Talc and Soapstone.—Lava-grade talc was sawed and processed in Harford County. Ground soapstone was produced in Carroll County. Most of the ground material was sold for asphalt filler, roofing granules, and foundry facings.

Vermiculite (Exfoliated).—Crude vermiculite was processed in Prince Georges County from material originating outside the State. It was sold for insulation, concrete and plaster aggregate, and agricultural purposes.

Table 4.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Structural	4,094	$5,390	3,874	$5,256
Paving	2,157	3,277	1,860	2,758
Other [1]	2,017	1,837	2,303	2,239
Total	8,268	10,504	8,037	10,253
Gravel:				
Structural	2,848	5,361	2,907	5,438
Paving	2,207	3,017	2,524	3,311
Fill	1,649	900	549	327
Other [2]	1,075	1,347	822	966
Total	7,779	10,625	6,802	10,042
Total sand and gravel	16,047	21,129	14,839	20,295
Government-and-contractor operations:				
Sand	6	2	6	2
Gravel	147	57	263	86
Total sand and gravel	153	59	269	88
All operations:				
Sand	8,274	10,506	8,043	10,255
Gravel	7,926	10,682	7,065	10,128
Total	16,200	21,188	15,108	20,383

[1] Includes sand for glass, fill, and other uses.
[2] Includes railroad ballast (1965), miscellaneous, and other gravel.

MINERAL FUELS

Coal (Bituminous).—Coal production and value were approximately the same as in 1965.

Production was from 52 active mines; 23 underground mines (9 fewer than in 1965) produced 35 percent of the coal; 27 strip mines (8 fewer than in 1965) accounted for 63 percent of production; and the remaining 2 percent was recovered from 2 auger operations.

Production came from mines in Allegany and Garrett Counties in the mountainous western part of the State. Allegany County had 9 deep mines, 11 strip mines, and 1 auger mine. Garrett County had 14 deep mines, 16 strip mines, and 1 auger operation. Garrett County produced 79 percent of total State production.

Underground coal was valued at an average of $3.82 per short ton, compared with $3.44 for strip-mined and auger coal. The average overall value per ton of coal produced was $3.57, a decrease of $0.06 per ton from the 1965 average.

Coke and Chemicals.—Bethlehem Steel Corp. produced coke and coal chemicals from slot-type coking ovens, at its Sparrows Point Plant. Coproducts included coke breeze, coke oven gas, ammonium sulfate, soft pitch of tar, crude tar, crude chemical oil, intermediate light oil, crude light oil and derivatives (benzene, toluene, and xylene), and naphthalene.

Natural Gas and Petroleum.—Mountain Lake Park in Garrett County was the leading source of natural gas in Maryland with 17 producing wells. After the Texas Eastern Transmission Corp. established a gas storage reservoir there was only one active well in the Accident field. Five miles east of the Accident field, and separated from it by a fault, were three wells in the Negro Mountain area. A gas well discovery added Allegany County as a gas-producing area in Maryland. This well, in the Green Ridge Forest, was an extension of the Artemas field in Pennsylvania.

Chevron Asphalt and American Oil Co. processed imported crude oil at refineries near Baltimore.

Peat.—Value of Maryland peat production increased slightly over the 1965 value. Reed-sedge and humus peat was recovered at peat bogs and processed at plants in Garrett and Kent Counties. Output was sold in bulk and packaged form.

Table 5.—Value of mineral production in Maryland, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Allegany	$2,547,885	$2,663,434	Coal, sand and gravel, stone, clays.
Anne Arundel	2,492,000	3,131,000	Sand and gravel.
Baltimore	14,000,315	13,627,663	Stone, sand and gravel, clays.
Calvert	W	W	Greensand marl, sand and gravel.
Caroline	W	W	Sand and gravel.
Carroll	W	W	Cement, stone, clays, soapstone.
Cecil	3,790,552	3,894,318	Stone, sand and gravel, clays.
Charles	W	W	Sand and gravel.
Dorchester	W	W	Sand and gravel, stone.
Frederick	7,363,668	7,058,077	Cement, stone, lime, clays, sand and gravel.
Garrett	r 3,663,319	4,002,113	Coal, stone, natural gas, sand and gravel, peat.
Harford	1,767,835	1,763,079	Stone, sand and gravel, clays, talc.
Howard	W	W	Stone, sand and gravel.
Kent	W	W	Peat, clays.
Montgomery	W	W	Stone.
Prince Georges	9,471,300	8,201,700	Sand and gravel, clays.
St. Marys	W	W	Sand and gravel.
Talbot	W	W	Do.
Washington	W	W	Cement, stone, clays, potassium salts.
Wicomico	W	W	Sand and gravel, clays.
Worcester	W	W	Sand and gravel.
Undistributed [2]	r 32,897,652	29,819,740	
Total	77,995,000	74,161,000	

r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Queen Annes and Somerset Counties are not listed because no production was reported.
[2] Includes some sand and gravel that cannot be assigned to specific counties (1965), gem stones, and values indicated by symbol W.

METALS

Copper.—Two plants near Baltimore produced electrolytic copper from copper anodes shipped into the State.

Iron and Steel.—The Bethlehem Steel Corp., at its Sparrows Point plant near Baltimore, produced basic and offgrade pig iron from imported iron ores. Steel ingot as well as semifabricated products are produced at this integrated iron and steel plant.

REVIEW BY COUNTIES

Allegany.—Bituminous coal mining, representing almost 50 percent of total value of mineral production, was the largest industry in the county. Output decreased 11 percent from the 1965 tonnage, owing mainly to a reduction in the number of active mines. Total number of mines operated was 21, of which 9 were underground, 11 were strip mines, and 1 was an auger operation. Largest underground mine was the Bakerstown No. 6 of the W. & W. Coal Co. The Winner Bros. Coal Co., Inc., No. 1 was the largest strip operation.

Production of sand and gravel decreased slightly in tonnage and value. Building and glass sand was produced by the Manley Sand Division, Martin Marietta Corp. The Cumberland Cement & Supply Co. produced processed sand and gravel for building and paving. Crushed limestone for use as concrete aggregate and roadstone was produced at Corriganville by the Appalachian Stone Division, Martin Marietta Corp. This operation won an award in the National Safety Competition for 30,473 man-hours worked without a disabling work injury.

Fire clay was produced at an underground mine near Frostburg by Kaiser Refractories Division of Kaiser Aluminum & Chemical Corp.

The world's largest lime sludge reburning kiln was put in operation at Luke, Md., by the West Virginia Pulp & Paper Co. in September 1966.

At an abandoned strip mine near Frostburg, the Maryland State Department of Health will start a 3-year pilot project on waste disposal. County wastes will be compacted, placed in the mine, and covered with overburden. Pollution of surrounding ground and surface water will be carefully monitored.

Anne Arundel.—Sand and gravel was the only mineral commodity produced in the county; output increased 14 percent and value 26 percent. Leading producers were

The Arundel Corp., Chesapeake Terrace Corp., and The Belle Grove Corp., all near Baltimore; Reliable Asphalt, Inc., Millersville; and Ferndale Farms, Inc., Glen Burnie. Chief uses were for building and paving.

Baltimore and Baltimore City.—Baltimore continued to lead in terms of value among the mineral-producing counties in the State, supplying 18 percent of Maryland's mineral value in 1966. Stone was the leading mineral produced. Crushed basalt, (gabbro) and serpentine, used mostly for concrete aggregate and road base, was produced by The Arundel Corp. at its Woodberry and Blue Mount quarries. The Weaver Stone Co. near Butler quarried dimension quartzite used for dressed architectural stone, rough construction, and flagging. Crushed limestone was produced by The Arundel Corp. at its Greenspring quarry for concrete and roadstone. Harry T. Campbell Sons' Corp., a subsidiary of the Flintkote Co., produced crushed limestone at the Texas and Marriottsville quarries mainly for concrete aggregate, roadstone, filler, and agricultural purposes.

Four sand and gravel pits were active during 1966. The largest producer was Harry T. Campbell Sons' Corp. at their White Marsh operation. Other producers were Nottingham Farms, Inc., at its Joppa Road plant and Harry A. Smuck & Sons at their Lansdowne plant. Output from these pits was used for building and paving. William Spiegel & Son, Kingsville, produced sand for building use. Clay was produced by three operators. Miscellaneous clay was recovered from the pits of the Baltimore Brick Co. and the Champion Brick Co. and was used for manufacturing building brick. Ball clay was produced by the United Sierra Division, Cyprus Mines Corp. for use in whiteware pottery, floor and wall tile, and fire brick. Oyster Shell Corp. crushed and ground oystershell for poultry grit and lime at its mill in Baltimore.

Calvert.—The Kaylorite Corp., Dunkirk, produced greensand marl for use as a soil conditioner.

Carroll.—The county ranked second in the value of mineral production and led the state in output and value of cement. At the Union Bridge operation, Lehigh Portland Cement Co. manufactured cement at its three-kiln plant, producing masonry cement and general-use, moderate-heat, and high-early-strength portland cements. Shipments were to ready-mixed-concrete companies, concrete product manufactures, highway contractors, and building material dealers. Crushed limestone for concrete aggregate and roadstone was produced by Teeter Stone, Inc., subsidiary of Harry T. Campbell Sons' Corp. Both the Union Bridge quarry of Lehigh Portland Cement Co. and the Teeter Stone Inc. won awards in the National Safety Competition for man-hours worked without a disabling injury. Liberty Talc Mines, Inc., mined soapstone at its Marriottsville mine. The output was processed at the company's Sykesville plant, for use mainly as roofing, asphalt filler, and foundry facing.

Cecil.—Seven sand and gravel operations were active in the county; output and value were slightly higher than in 1965. York Building Products Co., Inc., formerly Mason-Dixon Sand and Gravel Co., was the largest producer. At its Perryville and North East operations, sand and gravel was produced for use in ready-mixed concrete. Maryland Sand, Gravel, & Stone Co., Elkton, produced and processed building sand. Stone production decreased slightly in value, but production remained nearly static. D. M. Stoltzfus & Son, Inc., quarried granite gneiss at Elk Mills for riprap and concrete aggregate. Crushed granite for riprap and dimension granite for rough architectural stone was produced by the Port Deposit Granite Co., at its Port Deposit quarry. Maryland Materials, Inc., produced crushed granite near North East; crushed quartzite for use as silica brick was quarried by Harbison-Walker Refractories Co., near Leslie. Plastic fire clay for manufacturing fire brick and block was mined by Fred S. Russell at a pit near North East.

Charles.—Building sand and building and paving gravel were produced near Waldorf by the Charles County Sand & Gravel Co., Inc. Potomac Sand & Gravel Co., Washington, D.C., subsidiary of Dravo Corp., dredged sand and gravel from the Potomac River near Washington for building and paving and concrete product dealers. Gravel was chiefly used in construction.

Dorchester.—Oystershell for poultry grit and lime was processed by J. M. Clayton Co., Cambridge. J. Edwin Rosser, Inc., Federalsburg, produced sand and gravel for construction and sand for fill.

Frederick.—Cement ranked first in value of county mineral output. At the Lime Kiln plant, portland and masonry cements were manufactured by the Alpha Portland Cement Co. At Frederick, M. J. Grove Lime Co., Division of the Flintkote Co., manufactured masonry cement. Shale was quarried and expanded into lightweight aggregate by Lehigh Portland Cement Co. at its plant near Woodsboro. Total output was sold for concrete block mix. Crushed limestone and cement rock for concrete aggregate and roadstone, cement, agricultural lime, stone sand, and railroad ballast was reported by five companies. M. J. Grove Lime Co., Division of the Flintkote Co., was the largest producer. Three operators of limekilns near Le Gore, Woodsboro, and Middletown produced quicklime and hydrated lime for agricultural uses.

Garrett.—Bituminous coal output represented 82 percent of the value of the county's mineral production. A total of 31 mines were in operation, of which 16 were strip mines, 14 underground mines, and 1 was an auger mine. Most production was from the Kittanning and Freeport coal seams. With one underground mine in the Freeport seam and one strip mine in the Kittanning seam, the Buffalo Coal Co., Inc., was the largest producer in the county.

Vetter Brothers, Inc., mined and crushed limestone near Oakland for concrete aggregate and roadstone. Near Grantsville, M & S Quarries and B & B Stone Co. operated sandstone quarries. Output was for rough construction and flagging.

Humus and reed-sedge peat was recovered from a bog near Accident by Garrett County Processing and Packaging Corp.

Harford.—Five operators produced sand and gravel, the largest producer of which was Stancill's, Inc., Edgewood, followed by Joppa Sand and Gravel Corp., Joppa. The chief uses of sand and gravel were for building, paving, and fill.

Gatch Crushed Stone Co., Inc., and D. M. Stoltzfus & Sons, Inc., produced crushed gneiss and grabbro, respectively, at quarries near Churchville and Aberdeen. Maryland Green Marble Corp., Division of General Stone & Materials Corp., produced crushed marble for terrazzo at Cardiff. Harford Talc & Quartz Co., Inc., mined talc near Dublin for foundry facings and ceramics.

Plastic fire clay was recovered by Stancill's Inc., Edgewood, and Maryland Clay Co., Aberdeen, for use in vitrified sewer pipe.

Howard.—Howard-Montgomery Crushed Stone Co., Inc., quarried and crushed limestone for concrete aggregate at Clarksville. Crushed basalt (gabbro) was produced at Savage by The Arundel Corp. for concrete aggregate and riprap.

Kent.—Maryland Peat and Humus Co. recovered reed-sedge peat from a bog near Betterton which was processed and marketed for general soil improvement use.

Chestertown Brick Co. mined miscellaneous clay from a pit near Chestertown for manufacturing building brick.

Montgomery.—Rockville Crushed Stone quarried and crushed basalt (serpentine and gabbro) for concrete aggregate. Mica schist was quarried for rough and dressed building stone, flagging, and rubble by Stoneyhurst Quarries near Bethesda.

Prince Georges.—The county ranked first in output and value of sand and gravel. Commercial sand and gravel accounted for 96 percent of the value of county mineral production. There were 17 active commercial operations with the larger producers being Contee Sand & Gravel Co. Inc., Laurel; Arundel Supply Corp., District Heights; Silver Hill Sand & Gravel Co., Silver Hill; and Buffalo Sand & Gravel Co., Inc., Washington, D.C. Sand & gravel was used chiefly for building, paving, and fill.

The Washington Brick Division of Thomas Somerville Co., Muirkirk, and West Brothers Brick Co. near Washington, D.C., mined miscellaneous clay from open pits, mainly for manufacturing building brick.

Expanded perlite for use as lightweight aggregate in plaster and concrete was produced by Atlantic Perlite Co. at its plant near Washington, D.C.

Exfoliated vermiculite from imported crude raw material was produced by the Zonolite Division, W. R. Grace & Co., at Beaver Heights. Mineral Pigments Corp. manufactured a variety of iron oxide pigments at a plant in Muirkirk.

St. Marys.—Leonardtown Sand & Gravel Co., Leonardtown, and Charlotte Hall Sand & Gravel Co., Charlotte Hall, produced sand and gravel used chiefly for building and paving. Bank-run gravel was produced

by a contractor for the Maryland State Road Commission.

Washington.—Cement, comprising 68 percent of the total value of minerals produced, was the leading commodity in the county. Portland and masonry cements were produced by the Marquette Cement Manufacturing Co. at its Hagerstown plant. Nearly all the limestone quarried and crushed at the Security quarry was utilized. Some crushed limestone was used as commercial stone. Crude potassium sulfate was recovered as a byproduct during the burning of the cement materials.

Wicomico.—Raymond A. Weisner, Salisbury, was the largest of four sand and gravel producers in the county. The output averaged 97 percent sand and was sold mainly for fill.

Salisbury Brick Co., Inc., mined miscellaneous clay for use in manufacturing building brick.

Worcester.—Processed sand and gravel for building and road construction was produced by Mervin L. Blades & Son from a dredge operation near Pocomoke City. Worcester County Roads Board at Snow Hill produced unprocessed sand and gravel for highway construction, maintenance, and repairs.

The Mineral Industry of Massachusetts

By Melvin E. Hinkle [1]

The value of mineral production in Massachusetts reached a new high of $38.5 million, a gain of 6 percent over that of 1965. The combined values of sand and gravel and stone production represented 92 percent of the State total.

Middlesex County retained its lead in terms of value as the State's chief mineral-producing county; Berkshire County was second.

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

Table 1.—Mineral production in Massachusetts [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays----------short tons--	181,100	$238	201,754	$260
Gem stones----------	NA	2	NA	2
Lime----------short tons--	169,684	2,779	181,974	2,712
Sand and gravel-----thousand short tons--	22,141	16,172	17,321	17,846
Stone----------do----	6,168	16,980	6,424	17,624
Value of items that cannot be disclosed: Nonmetals----------	-XX	27	XX	29
Total----------	XX	36,198	XX	38,473

NA Not Available. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]	Year	Value [1]
1957----------	$25,065	1962----------	29,332
1958----------	24,031	1963----------	32,177
1959----------	26,266	1964----------	35,723
1960----------	27,396	1965----------	35,981
1961----------	30,127	1966----------	[p] 37,829

[p] Preliminary.
[1] Data for 1957–65 revised.

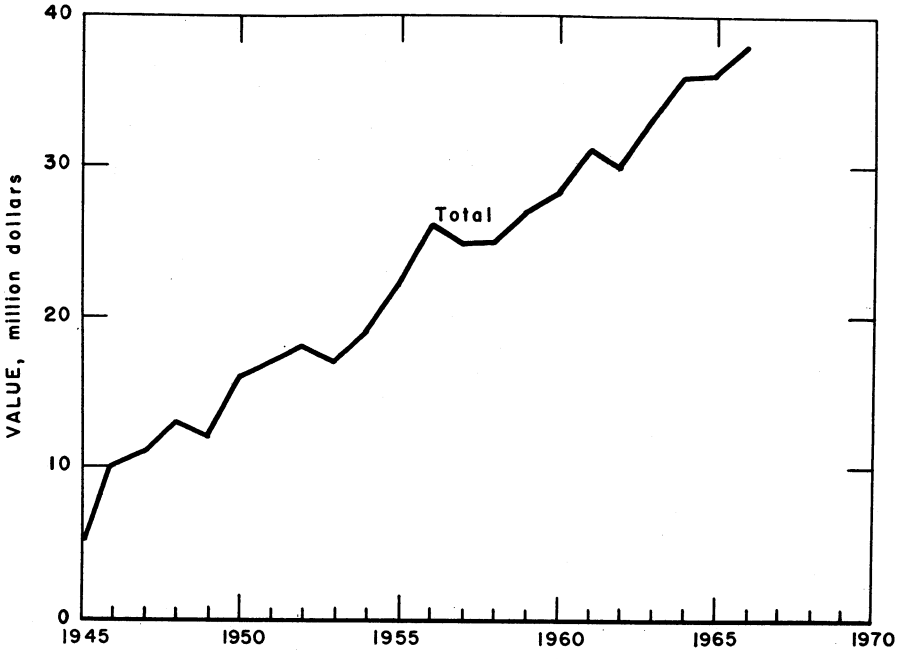

Figure 1.—Total value of mineral production in Massachusetts.

Table 3.—Employment 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
1965:								
Nonmetal and peat	91	229	21	167	---	1	6.00	102
Sand and gravel	1,332	215	287	2,506	1	47	19.16	2,762
Stone	1,025	255	261	2,105	---	45	21.38	845
Total	2,448	232	569	4,778	1	93	19.67	1,824
1966: p								
Nonmetal and peat	75	291	22	180	---	3	16.67	983
Sand and gravel	1,350	218	294	2,410	1	53	22.41	3,025
Stone	1,115	246	273	2,200	---	50	22.73	753
Total	2,540	232	589	4,790	1	106	22.34	1,905

p Preliminary.

REVIEW OF MINERAL COMMODITIES

NONMETALS

Clays.—Production of miscellaneous clay and shale increased 11 percent in tonnage and 9 percent in value over that of 1965. Norfolk County remained the leading clay producer. Miscellaneous clay also was mined in Hampden and Plymouth Counties by three companies for use in building brick. One company mined shale in Norfolk County for use in manufacturing lightweight aggregate.

Gypsum.—Crude gypsum imported from Nova Scotia was manufactured into calcined gypsum products at a plant in Charlestown, Suffolk County.

Lime.—Three producers in Berkshire County produced quicklime and hydrated lime from local limestone. Production in-

creased by 7 percent, but value declined 2 percent below that of 1965. The chemical industry consumed 76 percent of the total production, with the remainder used in the building industries and agriculture.

Peat.—Peat was produced in Essex and Worcester Counties. Production and value increased 7 and 6 percent, respectively, over that of 1965.

Perlite (Expanded).—Crude perlite mined outside the State was expanded at a Roslindale, Suffolk County, plant that marketed the product mainly for use as a lightweight aggregate and as a soil conditioner. Production and value was less than in 1965.

Sand and Gravel.—Total value of sand and gravel increased 10 percent over that of 1965, but output declined 22 percent, reflecting an increase in value per ton. Gravel accounted for 59 percent of the total production.

Building and paving markets consumed 83 percent of the sand and gravel output. Small quantities of sand were used for fill, molding, blast, filtration, and other uses.

Pits in operation increased from 193 in 1965 to 318 in 1966. Middlesex County produced 4.5 million tons of sand and gravel, to lead all counties. Other counties producing over 1 million tons were Bristol, Essex, Franklin, Hampden, Norfolk, and Worcester.

Table 4.—Lime sold or used by producers

Year	Short tons	Value
1957–61 (average)	143,691	$2,263,885
1962	148,401	2,337,027
1963	144,889	2,425,699
1964	171,398	2,703,276
1965	169,684	2,779,055
1966	181,974	2,711,920

Table 5.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Structural	2,952	$2,808	3,485	$3,586
Paving	2,024	1,877	2,197	2,070
Fill	478	193	604	213
Blast	W	W	4	45
Filtration	W	W	9	16
Undistributed [1]	553	1,013	575	1,069
Total	6,007	5,891	6,874	6,999
Gravel:				
Structural	2,741	3,646	3,170	4,534
Paving	2,247	2,364	2,968	2,904
Fill	1,172	678	1,126	680
Other	W	W	221	331
Miscellaneous	366	337	373	370
Undistributed [2]	558	536	---	---
Total	7,084	7,561	7,858	8,819
Total sand and gravel	13,091	13,452	14,732	15,818
Government-and-contractor operations:				
Sand:				
Paving	13	5	178	176
Other	21	27	22	27
Total	34	32	200	203
Gravel:				
Paving	2,224	1,080	2,295	1,761
Fill	6,777	1,579	50	22
Other	15	29	44	42
Total	9,016	2,688	2,389	1,825
Total sand and gravel	9,050	2,720	2,589	2,028
All operations:				
Sand	6,041	5,923	7,074	7,202
Gravel	16,100	10,249	10,247	10,644
Total	22,141	16,172	17,321	17,846

W Withheld to avoid disclosing individual company confidential data; included with undistributed.
[1] Includes molding and sand for other uses.
Includes railroad ballast.

Stone.—Both tonnage and value of stone increased 4 percent over that of 1965 owing to greater production of limestone and miscellaneous stone. Production of basalt, granite, and sandstone declined. Basalt, used mostly for concrete aggregate and roadstone, remained the most important stone produced in the State in both quantity and value. Production of dimension stone increased slightly over that of 1965, but value declined 4 percent. Crushed and broken stone used for concrete aggregate and roadstone accounted for 80 percent of the total stone sold in 1966.

Stone was produced in all counties except Dukes, Barnstable, and Nantucket. Limestone production, as in the past, was confined to Berkshire County in the western end of the State. Middlesex County was the leading stone-producing county.

Roofing Granules.—Roofing granules were prepared from rhyolite quarried in Norfolk County. For statistical purposes the stone was classified as miscellaneous stone. Production and value of roofing granules was less than in 1965.

Vermiculite.—Exfoliated vermiculite for use in agriculture, for insulation, and as lightweight aggregate for concrete and plaster was produced at a plant in Hampshire County. Two other vermiculite exfoliating plants in the State were idle throughout the year. Sales increased 20 percent and value 26 percent over that of 1965.

Table 6.—Stone sold or used by producers, by uses

Use	1965		1966	
	Short tons	Value	Short tons	Value
Riprap	60,905	$105,860	40,509	$63,749
Concrete aggregate and roadstone	4,901,260	8,222,542	5,148,856	8,855,099
Agricultural (limestone)	187,526	621,836	181,553	632,912
Undistributed [1]	1,018,367	8,030,148	1,053,407	8,072,119
Total	6,168,058	16,980,386	6,424,325	17,623,879

[1] Includes dimension stone, railroad ballast, furnace flux, and other uses.

REVIEW BY COUNTIES

The Commonwealth of Massachusetts, Department of Public Works, quarried basalt in Franklin, Hampden, and Hampshire Counties, and granite in Plymouth County for use as riprap. Sand and gravel was produced by this agency in all counties except Nantucket. The municipalities of Dartmouth, Fall River, Malden, North Adams, and Watertown also produced small quantities of sand and gravel. Total production of Government-and-contractor sand and gravel was about one-fourth that of 1965 and was used mainly for paving and fill.

Barnstable.—Production of sand and gravel sharply increased over that of 1965. Hyannis Sand & Gravel, Inc., Hyannis, produced and processed sand and gravel for building and paving. Whitehead Brothers Co., Provincetown, produced and processed molding sand. Frederick V. Lawrence, Inc., Falmouth, mined and processed sand and gravel for paving and fill. Falmouth Cement Works, Inc., Teaticket, was idle in 1966.

Berkshire.—This is the only county in the State to produce limestone. Five operators were active; they were the Minerals, Pigments & Metals Division, Chas. Pfizer & Co., Inc., Adams; Georgia Marble Co., Calcium Products Division, Adams; John S. Lane & Son, Inc., West Stockbridge; Lee Lime Corp., Lee and West Stockbridge; and United States Gypsum Co., Farnams. The chief uses for limestone were lime manufacture, rubber and asphalt filler, agriculture, concrete aggregate and roadstone, mineral food, and blast-funace flux.

Lime for chemical, construction, and agriculture uses, was produced by Lee Lime Corp., Lee; Minerals, Pigments & Metals Division, Chas. Pfizer & Co., Inc., Adams; and United States Gypsum Co., Farnams. In the National Safety Competition, Quarry Group, the Lee Lime Corp. was cited for its outstanding safety record in 1966—99,050 man-hours worked without a disabling work injury.

Table 7.—Value of mineral production in Massachusetts, by counties

County	1965	1966	Minerals produced in 1966, in order of value
Barnstable	$215,000	W	Sand and gravel.
Berkshire	6,565,005	6,839,133	Stone, lime, sand and gravel.
Bristol	2,390,930	3,100,229	Sand and gravel, stone.
Dukes	W	W	Sand and gravel.
Essex	2,659,453	2,820,970	Stone, sand and gravel, peat.
Franklin	1,300,467	1,241,691	Sand and gravel, stone.
Hampden	2,570,219	2,567,372	Stone, sand and gravel, clays.
Hampshire	1,809,530	942,420	Sand and gravel, stone.
Middlesex	10,043,102	11,268,960	Stone, sand and gravel.
Nantucket	16,000	W	Sand and gravel.
Norfolk	4,883,563	4,547,926	Sand and gravel, stone, clays.
Plymouth	748,903	750,215	Do.
Suffolk	486,836	397,937	Stone, sand and gravel.
Worcester	2,253,602	2,895,279	Sand and gravel, stone, peat.
Undistributed [1]	255,000	1,101,000	
Total	36,198,000	38,473,000	

W Withheld to avoid disclosing individual company confidential data. Included with "Undistributed."
[1] Includes value of gem stones and some sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

Production of commercial sand and gravel increased 21 percent over that of 1965; 12 operations were active. The largest producer was General Sand & Stone Corp., Dalton. Other large producers included Catskill Material Corp., Great Barrington; Abby & Sons, Lee; and W. E. Williams, Inc., Lenox.

Bristol.—Morse Sand & Gravel Co., Attleboro, quarried and crushed basalt and Warren Bros. Roads Co., Acushnet, quarried and crushed miscellaneous stone for concrete aggregate and roadstone.

Thirteen operations produced commercial sand and gravel; output increased 5 percent over that of 1965. The leading producer was Assonet Sand & Gravel Co., Inc., Freetown. Other large producers were Morse Sand & Gravel Co., Attleboro; River Sand & Gravel Co., Seekonk; Curtois Sand & Gravel Co., North Attleboro; and Joseph Borge & Sons, Inc., Swansea.

Dukes.—Commercial sand and gravel for paving and building was produced by two operators, Goodale Construction Co., Inc., Vineyard Haven, and Grant Brothers, Inc., Edgartown.

Essex.—The county ranked second in the State in production of stone, exclusive of limestone. Lynn Sand & Stone Co., Swampscott, quarried basalt mostly for concrete aggregate and roadstone; small quantities were used for railroad ballast, mineral stabilizer, and riprap. Basalt was also produced by Trimount Bituminous Products Corp., Saugus, and Essex Bituminous Concrete Corp., Peabody, for roadstone and concrete aggregate. Dimension granite was produced by Karl A. Persson, Rockport, for rough construction and curbing, and by Rockport Quarries Co., Inc., Rockport, for rough architectural purposes.

Commercial sand and gravel output reported from eight operations decreased 8 percent. The largest producer was Merrimack Materials, Inc., Groveland. Other large producers were Georgetown Sand & Gravel Co., Georgetown, and Miles River Sand & Gravel Inc., Ipswich.

Andover Sand & Gravel, Inc., recovered humus peat from a bog near Lawrence for general soil improvement use.

Franklin.—Warner Brothers Inc., near East Deerfield, quarried basalt for use as concrete aggregate and road-stone, railroad ballast, and riprap.

Commercial sand and gravel for paving and building was produced at five operations; production increased 24 percent over that of 1965. Gravel accounted for 72 percent of the output. The largest producer was Warner Brothers Inc., Sunderland, followed by Northfield Washed Sand & Gravel Co., Inc., Northfield, and Mackin Sand & Concrete Products, Greenfield.

Hampden.—Basalt was quarried and crushed by John S. Lane & Son, Inc., Westfield, for use as concrete aggregate and railroad ballast. McCormick Longmeadow Stone Co., Inc., East Longmeadow, produced dimension sandstone for architectural purposes.

Commercial sand and gravel produced at nine operations increased 2 percent. The largest producer was North Wilbraham Sand & Gravel & Concrete Co., Inc., North

Wilbraham. Other producers were John's Trucking Co., Agawam, and Monson Sand & Gravel Corp., Monson.

Miscellaneous clay for building brick was mined by the Hampshire Brick Mfg. Co., Inc., Chicopee, and Westfield Clay Products Co., Westfield.

Hampshire.—Total sand and gravel output was only one-seventh that of 1965 due to a sharp drop in highway construction. The largest commercial producers were Bill Willard, Inc., Northampton; Eli Quenneville, South Hadley; and D. D. Ruxton Co., Inc., North Wilbraham.

John S. Lane & Son, Inc., Amherst, quarried and crushed basalt for concrete aggregate and roadstone.

The Zonolite Division, W. R. Grace & Co., exfoliated vermiculite at Easthampton for sale mainly as insulation, lightweight aggregate, and agricultural use.

Middlesex.—Middlesex County led the State in total value of mineral output as well as in output and value of both stone and sand and gravel. Dimension granite was quarried in the Westford-Chelmsford area by six operators: Le Masurier Granite Quarry, Inc., and Guilmette Bros. Corp., both near North Chelmsford; H. E. Fletcher Co., West Chelmsford; and Oak Hill Granite Co., Inc., Morris Bros. Granite Co., Inc., and Forrest Road Granite Co., Inc., all near Westford. Dimension stone sold included curbing, architectural and monumental stone, rough and dressed construction stone, paving blocks, and rubble. Crushed granite was produced by H. E. Fletcher Co. for agricultural use, and by Le Masurier Granite Quarry, Inc., for use as riprap. Crushed basalt was produced by Rowe Contracting Co., Malden; Massachusetts Broken Stone Co., Weston; George Brox, Inc., and Essex Bituminous Concrete Corp. of Dracut (formerly John P. Condon Corp.), both of Dracut; and B & M Crushed Stone Corp., Ashland. Output was used for roadstone, concrete aggregate, riprap, and railroad ballast.

Production of commercial sand and gravel, in terms of tonnage, increased 22 percent over that of 1965. Twenty-six operations were active. The largest producers included San-Vel Contracting Co., Littleton; Lexington Sand & Gravel Co., South Acton: Stow Sand & Gravel Co., Boxborough; and Pomerleau Brothers, Inc., Westford.

The vermiculite plant of Zonolite Division, W. R. Grace & Co., North Billerica, was idle during 1966.

Nantucket.—Nantucket Construction Co., Nantucket, produced a small tonnage of processed sand for paving.

Norfolk.—Although Norfolk ranked second among Massachusetts counties in quantity and value of sand and gravel produced, output declined 27 percent from that of 1965. There were 11 active commercial operations. The largest operators were L. Romano Construction Co., Raynham; Wrentham Sand & Gravel Co., Inc., Wrentham; Tresca Brothers Sand & Gravel, Inc., Millis; and West Sand & Gravel Co., Walpole.

Dimension and crushed granite was produced at three operations. Bates Brothers Seam Face Granite Co., near Weymouth, produced dimension granite for architecture, rubble, and flagging, and crushed granite for riprap. Old Colony Crushed Stone Co., Quincy, and Simeone Stone Corp., Wrentham, produced crushed granite for concrete aggregate, roadstone, and stone dust. Simeone Stone Crop., Stoughton, also quarried and crushed basalt for concrete aggregate. S. M. Lorusso & Sons, Inc., quarried rhyolite near Wrentham and sold the crushed stone to Bird & Son, Inc., East Walpole, for roofing granule manufacture.

Masslite, Division of Blackstone Industries, Inc., Plainville, mined shale and converted it into lightweight aggregate.

The vermiculite plant of the Zonolite Division, W. R. Grace & Co., Hingham, was idle during 1966.

Plymouth.—Production of commercial sand and gravel declined 25 percent from the 1965 tonnage. The leading producers included Marshfield Sand & Gravel, Inc., Marshfield; Whitehead Brothers Co., Marion and Onset; and Bridgewater Materials, Inc., Bridgewater.

Granite was quarried by Plymouth Quarries, Inc., East Weymouth, at its Hingham quarry as rough architectural block, irregular shapes for building purpose, and rubble.

The Stiles & Hart Brick Co., Bridgewater, mined miscellaneous clay for building brick manufacture.

Suffolk.—West Roxbury Crushed Stone Co., West Roxbury, quarried and crushed basalt for concrete aggregate and roadstone.

United States Gypsum Co., Charlestown, manufactured calcined gypsum products from raw material imported from Nova Scotia.

Perlite was expanded by Whittemore Products, Inc., Roslindale, for sale as a soil conditioner, as insulating material, and as lightweight aggregate in plaster and concrete.

Worcester.—Holden Trap Rock Co., Holden, and Mario Pandolf Co., Inc., Sterling, quarried and crushed basalt for concrete aggregate and roadstone. H. E. Fletcher Co., Milford, quarried and dressed dimension granite for architectural use. Castellucci & Sons, Inc., Milford, quarried pink dimension granite for rough architectural purposes.

Output of commercial sand and gravel increased 38 percent over that of 1965. There were 20 active operations. The largest producer was the Worcester Sand & Gravel Co., Shrewsbury. Other producers were the Rosenfeld Washed Sand & Stone Co., Hopedale; F & G Sand & Gravel Co., Shrewsbury; E. L. Dauphinais, Inc., Grafton; and P. J. Keating Co., Lunenburg.

Sterling Peat Co. mined reed-sedge peat near Sterling for use in packing flowers, plants, and shrubs.

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 Conservation, for collecting information on all minerals except fuels.

By Donald F. Klyce [1]

In 1966 the value of mineral production in Michigan totaled $602.1 million, exceeding $600 million for the first time. Increased output of nearly every major mineral product, except petroleum, helped set this record.

Iron ore remained first in value, followed by cement, copper, and sand and gravel.

Nonmetals, chiefly construction materials (cement, clays, gypsum, lime, sand and gravel, and stone) and chemicals recovered from natural salines (bromine, calcium chloride, calcium-magnesium chloride, iodine, magnesium compounds, potassium salts, and salt) accounted for more than 55 percent of the State's total mineral value. Value of copper, iron ore, and silver was 35 percent of the total, and mineral fuels made up the remainder.

[1] Industry economist, Bureau of Mines, Minneapolis, Minn.

Table 1.—Mineral production in Michigan [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	27,565	$86,996	28,171	$87,413
Masonry—thousand 280-pound barrels	2,108	5,373	2,032	5,221
Clays—thousand short tons	2,402	2,580	2,450	2,620
Copper (recoverable content of ores, etc.)—short tons	71,749	50,798	73,449	53,133
Gypsum—thousand short tons	1,338	5,027	1,522	5,489
Iron ore (usable)—thousand long tons, gross weight	13,527	145,482	14,377	157,377
Lime—thousand short tons	1,095	13,057	1,701	20,016
Magnesium compounds—short tons	319,389	26,143	342,482	28,105
Natural gas—million cubic feet	34,558	8,674	34,100	8,598
Natural gas liquids:				
Natural gasoline—thousand gallons	9,054	607	15,703	1,099
LP gases—do	76,299	3,815	79,719	4,385
Peat—short tons	230,950	2,134	235,842	2,175
Petroleum (crude)—thousand 42-gallon barrels	14,728	41,091	14,273	40,913
Salt—thousand short tons	4,171	36,087	4,465	38,611
Sand and gravel—do	53,168	47,176	55,123	49,521
Silver (recoverable content of ores, etc.) thousand troy ounces	458	592	483	625
Stone—thousand short tons	34,713	36,438	37,864	40,380
Value of items that cannot be disclosed: Bromine, calcium chloride and calcium-magnesium chloride, gem stones, iodine, and potassium salts	XX	53,490	XX	56,446
Total	XX	565,560	XX	602,127

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

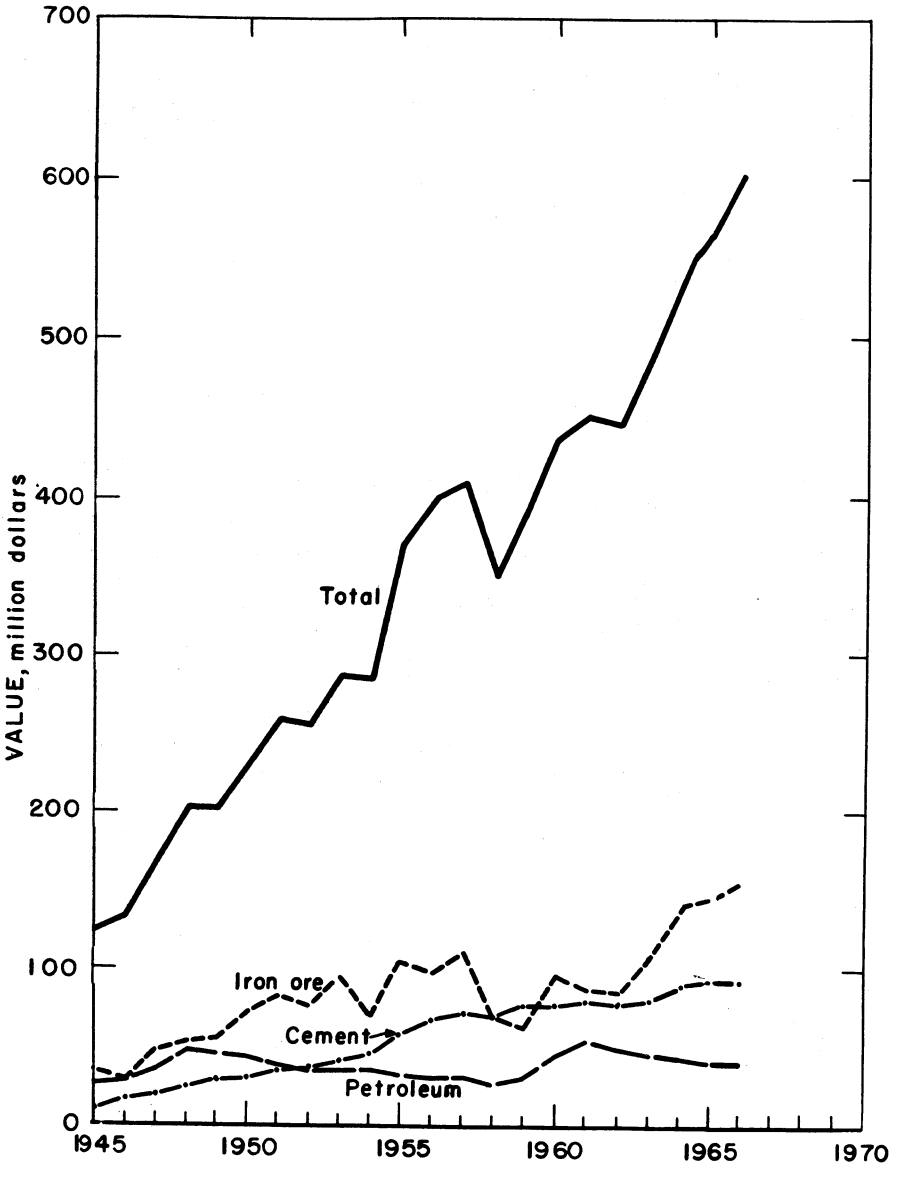

Figure 1.—Value of iron ore, petroleum, cement, and total value of all minerals produced in Michigan.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Millions)

Year	Value [1]
1955	$388
1956	397
1957	411
1958	353
1959	384
1960	427
1961	439
1962	436
1963	478
1964	528
1965	534
1966	p 562

p Preliminary.
[1] Data for 1955–64 revised.

Table 3.—Employment 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: Fatal	Number of injuries: Non-fatal	Injury rates per million man-hours: Frequency	Injury rates per million man-hours: Severity
1965:								
Metal	5,662	284	1,607	12,855	4	345	27.15	2,726
Nonmetal	1,548	265	410	3,310	---	31	9.37	1,244
Sand and gravel	2,547	222	567	4,822	2	85	18.04	3,342
Stone	3,414	292	998	7,997	---	61	7.63	457
Peat	189	159	30	270	---	3	11.11	148
Total	13,360	270	3,612	29,254	6	525	18.15	2,013
1966: p								
Metal	5,980	296	1,767	14,126	7	484	34.76	4,613
Nonmetal	1,790	272	487	3,901	---	39	10.00	847
Sand and gravel	2,505	220	551	4,659	2	83	18.24	3,656
Stone	3,490	298	1,039	8,348	1	90	10.90	1,428
Peat	162	192	31	281	---	2	7.11	747
Total	13,927	278	3,875	31,315	10	698	22.61	3,126

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Total shipments of portland and masonry cements exceeded 30 million barrels for the first time. Portland cement shipments were more than 2 percent higher than in 1965, while output of masonry cement declined slightly. Portland cement was produced at eight plants in six counties. Masonry cement was produced at seven of these plants. Total plant capacity was nearly 35.2 million barrels. Yearend stocks of portland cement at mills were nearly 3.3 million barrels, about 1.2 million barrels more than 1965. Nearly 96 percent of the portland cement shipped was of types I and II (general-use and moderate-heat); the remainder was type III (high-early-strength). More than 52 percent of the cement was shipped to consumers within the State. Ohio, Illinois, Wisconsin, Indiana, Western New York, and Minnesota received most of the remainder. Ready-mixed concrete companies purchased 60 percent of the shipments with the remainder going principally to concrete product manufacturers, highway contractors, and building-material dealers.

Raw materials used in cement manufacture included 7.2 million tons of limestone, and 2.3 million tons of clay or shale, as well as gypsum, iron ore, sand, slag, mill scale, air-entraining compounds, and grinding aids.

About 708 million kilowatt-hours of electrical energy was used. The wet process was used at seven plants and the dry process at one.

Automation of the industry continued with computer controls planned at the new

Table 4.—Finished portland cement produced, shipped, and in stock

(Thousand 376-pound barrels and thousand dollars)

Year	Active plants	Production	Shipped from mills		Stocks at mills Dec. 31
			Quantity	Value	
1957–61 (average)	8	21,010	21,056	$70,437	2,664
1962	9	23,070	22,682	73,267	3,354
1963	9	24,194	25,016	76,944	2,532
1964	9	26,802	26,745	84,316	2,737
1965	8	27,018	27,565	86,996	r 2,110
1966	8	28,848	28,171	87,413	3,264

r Revised.

Charlevoix plant of Medusa Portland Cement Co. and in operation at the Dundee Cement Co., Dundee, and at the Alpena plant of Huron Cement Co. (Division of National Gypsum Co.).

Clays.—Output of miscellaneous clay and shale from 12 pits in 10 counties was about 2 percent above that of 1965. About 89 percent of the production was used in cement manufacture. The remainder was used in manufacturing heavy clay products (sewer pipe and draintile), lightweight aggregates, and art pottery. The largest production was reported from operations in Alpena, Monroe, Saginaw, St. Clair, and Wayne Counties.

Gem Stones.—Gem stones were collected, principally in the upper peninsula, by hobbyists. Agates, thomsonite, and other semiprecious stones were found as well as specimens of native copper and hematite.

Gypsum.—Gypsum was produced from underground mines in Kent County and quarried in Iosco County. Output was 14 percent higher than 1965. Most of the ore was processed at plants in National City, Grand Rapids, and Detroit for use in wallboard, lath and plaster, and other building uses. Crude ore was also shipped to plants in other States. Uncalcined gypsum was sold as a cement retarder.

Lime.—Lime output was 55 percent higher than in 1965. Much of the increase was due to the operation of two new facilities in Wayne County, as well as the uninterrupted operation of the Wyandotte Chemicals Corp. plant, also in Wayne County, which was shut down for seven months in 1965 because of a strike. More than 58 percent of the lime manufactured was used by producers. About 94 percent of the lime was consumed in the State. Most of the lime manufactured was quicklime, and was used in chemical manufacture, metallurgical operations (particularly basic-oxygen converters), water and sewage treatment, and paper and sugar manufacture. Data for lime regenerated at paper mills, water purification plants, and acetylene processors are excluded from total State production.

Natural Salines.—Bromine, calcium chloride, calcium-magnesium chloride, iodine, magnesium compounds, and potash were extracted from natural well brines at processing plants in Gratiot, Lapeer, Mason, Manistee, Midland, and Wayne Counties. The value of chemicals produced from natural salines, excluding salt, was more than 6 percent higher than in 1965.

Perlite.—Crude ore, mined in Nevada and New Mexico, was expanded at plants in Iosco, Kent, and Wayne Counties. The output was used chiefly as lightweight aggregate and plaster.

Salt.—Salt was recovered from natural and artificial brines at processing plants in Gratiot, Manistee, Midland, Muskegon, St. Clair, and Wayne Counties. In April, American Salt Corp. began operating a new plant in Midland County. One underground salt mine was operated in Detroit by International Salt Co., Inc. Salt output was about 7 percent higher than in 1965, and was sold principally for use in chemical manufacture, meat packing, ice control, water softening, and animal feed.

Sand and Gravel.—Sand and gravel production increased 4 percent to 55.1 million tons, the second highest in the Nation (after California) and a record high for the State. Sand and gravel for building use was up 6 percent over 1965, while paving and road material was nearly 3 percent higher. Industrial sand (foundry, molding, glass, grinding and polishing, and engine, etc.) output was about 12 percent greater than in 1965. Sand and gravel production

Table 5.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	6,469	$4,726	6,350	$5,093
Paving	5,377	4,697	5,469	4,645
Fill	3,265	1,484	3,639	1,659
Molding	3,298	5,903	3,611	6,735
Other [1]	917	2,014	868	2,002
Total	19,326	18,824	19,937	20,134
Gravel:				
Building	5,436	7,406	6,385	8,329
Paving	17,696	14,969	17,533	14,849
Railroad ballast	240	264	201	212
Fill	378	199	353	205
Other	347	397	56	70
Total	24,097	23,235	24,528	23,665
Total sand and gravel	43,423	42,059	44,465	43,799
Government-and-contractor operations:				
Sand:				
Building	74	33	----	----
Paving	1,699	790	2,115	1,008
Fill	1,224	400	1,116	397
Other	102	41	114	42
Total	3,099	1,264	3,345	1,447
Gravel:				
Building	103	56	87	48
Paving	6,265	3,707	6,828	4,088
Fill	190	63	396	137
Other	88	27	2	2
Total	6,646	3,853	7,313	4,275
Total sand and gravel	9,745	5,117	10,658	5,722
All operations:				
Sand	22,425	20,088	23,282	21,581
Gravel	30,743	27,088	31,841	27,940
Total	53,168	47,176	55,123	49,521

[1] Includes sand for foundry, grinding and polishing (1965), abrasive, enamel, engine, glass, railroad ballast, other construction and industrial uses (1965–66), and fire or furnace and pottery, porcelain, and tile (1966).

was reported from all counties except Bay and Monroe. The Detroit metropolitan area (Livingston, Macomb, Oakland, Washtenaw, and Wayne Counties), produced nearly 20 million tons, more than a third of the State total. Production of more than 1 million tons was also reported from each of the following counties: Berrien, Branch, Genesee, Ingham, Kent, Mason, Ottawa, and Tuscola. More than 90 percent of the sand and gravel was processed. About 93 percent was moved by truck and the remainder by rail and water. Production was reported from 389 commercial operations and 191 Government-and-contractor operations.

Leading producers of sand and gravel, in alphabetical order, included the following:

American Aggregates Corp.
Construction Aggregates Corp.
Grand Rapids Gravel Co.
Holloway Sand & Gravel Co., Inc.
Holly Sand & Gravel Plant, J. P. Burroughs & Son, Inc.
Michigan Silica Division, (Ottawa Silica Co.)
Mickelson Corp.
The Nugent Sand Co., Inc.
Pickitt & Schreur, Inc.
Sargent Sand Co.

Stone.—Total stone production increased 9 percent over that of 1965. Limestone ac-

Table 6.—Dimension stone sold or used by producers, by kinds

Year	Basalt		Limestone		Sandstone		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1962	------	------	7,798	$51,603	15,223	$65,406	23,021	$117,009
1963	------	------	4,938	60,371	8,937	62,348	13,875	122,719
1964	150	$150	5,383	68,711	8,306	62,030	13,839	130,891
1965	------	------	5,286	76,989	6,396	42,760	11,682	119,749
1966	------	------	4,266	64,166	8,109	53,510	12,375	117,676

Table 7.—Crushed and broken stone sold or used by producers, by kinds and uses

(Thousand short tons and thousand dollars)

Kind and use	1965		1966	
	Quantity	Value	Quantity	Value
Basalt: Concrete aggregate and roadstone	------	------	5	$6
Limestone:				
Riprap	100	$151	109	173
Flux	12,550	14,447	13,391	15,789
Concrete aggregate and roadstone	5,614	6,540	6,479	7,748
Agriculture	609	1,069	669	1,040
Cement	8,999	7,303	9,443	7,786
Lime	4,514	3,814	5,560	5,125
Other [1]	2,183	2,904	2,053	2,495
Total	[2] 34,570	36,228	[2] 37,703	40,156
Marl: Agriculture	132	90	143	100
Grand total	34,702	36,318	[2] 37,852	40,262

[1] Includes limestone for dust for coal mines (1965), asphalt and miscellaneous filler, chemicals, mineral food, poultry grit, railroad ballast, stone sand, whiting or whiting substitutes, and other uses.
[2] Data do not add to total shown because of rounding.

counted for more than 99 percent of the total, and was quarried in 15 counties by 20 commercial producers and four county highway departments. Most of the output came from large quarries, in Alpena, Chippewa, Mackinac, Monroe, and Presque Isle Counties. About 78 percent of the stone was moved by water from company-operated ports on Lakes Huron and Michigan to steel mills, cement and lime plants, and other consumers.

Total crushed stone production was 9 percent greater than in 1965. Demand for fluxstone increased 7 percent, for concrete aggregate and roadstone 15 percent, for cement rock 5 percent, and for lime 23 percent. Major producers of limestone, in alphabetical order, included the following:

Drummond Dolomite, Inc.
Dundee Cement Co.
The France Stone Co.
Huron Cement Co. (Division of National Gypsum Co.)
Inland Lime & Stone Co. (Division of Inland Steel Co.)
The Michigan Stone Co.
Penn-Dixie Cement Corp.
Presque Isle Corp.
United States Steel Corp.
The Wallace Stone Co. (Division of J. P. Burroughs & Son, Inc.)

Marl production was reported from 12 counties at 29 operations. The largest production came from Allegan, Barry, Calhoun, Cass, and Kalamazoo Counties.

Sandstone, used principally for building, was quarried and milled in Baraga and Jackson Counties.

Sulfur.—Byproduct sulfur was recovered from crude petroleum at Alma by Leonard Refineries, Inc., using the hydrofining process, and at Detroit by Marathon Oil Co. using the Parsons process.

Vermiculite.—Zonolite Division, W. R. Grace & Co. exfoliated crude vermiculite, mined in southern and western States, at its plant in Dearborn. The material was used for insulation, plaster and concrete aggregates, agricultural, and miscellaneous uses.

METALS

Metals accounted for 35 percent of the total value of mineral production.

Copper.—Production of copper in terms of recoverable metal was 2 percent more than in 1965 and its value nearly 5 percent higher. The average weighted priced increased to 36.2 cents per pound compared with 35.4 cents in 1965. During the year the average weekly price for domestic refinery copper, with few exceptions, moved in a narrow range around 36 cents per pound and at yearend was 36.2 cents.

Calumet & Hecla, Inc., operated eight mines, one reclamation plant, and one smelter in Houghton and Keweenaw Counties.

Copper Range Co. operated the Champion mine and the Freda mill in Houghton County. The mill concentrated ore from the mine and from the old Atlantic mine tailings. Quincy Mining Co. operated a reclamation plant and smelter in Houghton County. White Pine Copper Co. operated a mine, mill, and smelter in Ontonagon County.

The Bear Creek Mining Co. explored for possible copper deposits near Negaunee, on the Marquette Range.

Table 8.—Mine production of copper in 1966, by months, in terms of recoverable metal

Month	Short tons
January	6,275
February	5,875
March	6,639
April	6,275
May	6,615
June	6,425
July	5,355
August	6,085
September	5,605
October	6,240
November	6,055
December	6,005
Total	73,449

Table 9.—Mine production of copper, in terms of recoverable metal

Year	Mines producing		Material treated		Copper	
	Lode	Tailing	Ore (short tons)	Tailing (short tons)	Short tons	Value
1957–61 (average)	11	3	6,054,732	1,992,236	59,667	$35,593,560
1962	9	3	7,555,357	1,812,530	74,099	45,644,984
1963	10	3	7,211,387	2,226,129	75,262	46,361,392
1964	9	3	6,717,862	2,174,478	69,040	45,014,080
1965	10	3	7,367,571	1,611,378	71,749	50,798,292
1966	10	3	7,999,770	1,850,860	73,449	53,133,006

Iron Ore.—Shipments of usable iron ore totaled 14.4 million long tons, an increase of 850,000 tons over the 1965 total. Value of shipments increased by $11.9 million. Concentrates comprised 70 percent of the shipments of usable ore compared with 63 percent in 1965. In 1966 pellets produced from low-grade ores, as well as from ore from the Mather B mine in Marquette County, increased to 60 percent of shipments from 56 percent in 1965. Shipments were made from 13 underground and 5 open pit mines. About 75 percent of the crude ore mined came from open pit operations. Average iron content of usable ore produced was 58.9 percent, natural. The average weighted mine value of Michigan iron ore, without respect to grade, was $10.95 per long ton compared with $10.76 in 1965.

Michigan iron ore was shipped to producers of pig iron and steel, except for a small quantity used in manufacturing iron oxide pigments.

About 95 percent of the ore was shipped by rail to ore docks in Escanaba and Marquette and then by water to lower lake ports. The remainder was shipped by rail to the consuming districts. The lake shipping season for Michigan iron ores opened at Escanaba on March 31 and closed at the same port on December 23, the latest closing date on record. No ore was shipped from Ashland, Wis. because the port was closed late in 1965.

The Federal Bureau of Mines sampled selective low-grade iron ore resources.[2] An experimental all-rail shipment of iron ore pellets via a unit train from the Marquette Range and Ohio steel plant was made

[2] Heising, L. F., and D. W. Frommer. Lake Superior Iron Resources. Preliminary Samples and Metallurgical Evaluation of Selected Michigan-Wisconsin Iron Formations. Bureau of Mines Rept. of Inv. 6895, 1967, 31 pp.

Table 10.—Crude iron ore data, in 1966, by counties and ranges

(Thousand long tons)

County and range	Stocks Jan. 1	Production		Shipments		Stocks Dec. 31
		Underground	Open pit	Direct to consumers	To concentrators	
County:						
Dickinson	---	---	3,578	---	3,578	---
Gogebic	441	113	---	364	---	190
Iron	776	2,980	---	2,717	189	850
Marquette	1,015	3,479	14,670	1,191	17,281	692
Total	2,232	6,572	18,248	4,272	21,048	[1] 1,731
Range:						
Gogebic	441	113		364		190
Marquette	1,015	3,479	14,670	1,191	17,281	692
Menominee	776	2,980	3,578	2,717	3,767	850
Total	2,232	6,572	18,248	4,272	21,048	[1] 1,731

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

Table 11.—Usable iron ore [1] 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 [2]
1854–1956	289,298	240,884	236,187	766,369
1957	6,557	4,201	2,868	13,626
1958	4,111	2,896	1,397	8,404
1959	2,851	2,616	1,663	7,129
1960	6,619	4,079	2,169	12,866
1961	3,205	4,097	1,062	8,364
1962	4,563	3,460	1,237	9,259
1963	5,706	3,729	902	10,336
1964	7,898	4,551	1,227	13,676
1965	8,973	4,595	753	14,322
1966	9,589	4,620	113	14,322
Total [2]	349,369	[3] 279,728	[3] 249,577	878,675

[1] Exclusive, after 1905, of iron ore containing 5 percent or more manganese.
[2] Data may not add to some totals shown because of rounding.
[3] Distribution by range partly estimated before 1906.

Table 12.—Usable iron ore shipped from mines, by ranges [1]

(Thousand long tons)

Year	Marquette range	Menominee range (Michigan part)	Gogebic range (Michigan part)	Total [2]
1957–61 (average)	4,454	3,532	1,746	9,731
1962	4,479	3,462	1,480	9,422
1963	5,809	4,168	813	10,789
1964	7,909	4,560	1,403	13,871
1965	8,303	4,451	773	13,527
1966	9,686	4,327	364	14,377

[1] Exclusive of iron ore containing 5 percent or more manganese.
[2] Data may not add to some totals shown because of rounding.

prior to the opening of the lake shipping season.

According to a study by the Michigan Department of Conservation,[3] the average mining cost per ton for underground mines was $9.15 in 1966 compared with $9.80 in 1965. Labor costs decreased to $2.70 per ton compared with $2.77 per ton in 1965, while taxes (excluding Federal income tax) decreased to $0.33 per ton from $0.41. Deferred costs per ton were $0.50 in 1966 and $0.55 in 1965. Other costs per ton in 1966 compared with 1965 were as follows: General overhead, $1.17 and $1.42; transportation, $3.02 and $3.04; royalty, $0.32 and $0.31; and marketing, $0.05 and $0.09.

Table 13.—Production of usable iron ore

(Thousand long tons)

Year	Gross weight		Iron content (percent)
	Ore	Iron content	
1957	13,626	7,108	52.16
1958	8,404	4,460	53.07
1959	7,129	3,791	53.17
1960	12,866	6,920	53.78
1961	8,364	4,589	54.87
1962	9,259	5,160	55.73
1963	10,336	5,913	57.21
1964	13,676	7,923	57.93
1965	14,322	8,343	58.25
1966	14,322	8,432	58.87

Table 14.—Iron ore [1] shipped from mines

(Thousand long tons)

Year	Direct-shipping ore [2]	Concentrates			Total usable ore	Proportion of concentrates to total usable ore (percent)
		Agglomerates	Other	Total		
1957–61 (average)	7,865	692	1,175	1,867	9,731	19.18
1962	5,557	2,222	1,644	3,865	9,422	41.03
1963	4,852	4,364	1,574	5,938	10,789	55.03
1964	5,753	6,573	1,546	8,118	13,871	58.53
1965	4,969	7,554	1,004	8,558	13,527	63.26
1966	4,272	8,690	1,415	10,106	14,377	70.28

[1] Exclusive of ore containing 5 percent or more manganese.
[2] Includes crushed, screened, and sized ore not further treated.

Pig Iron and Steel.—Pig iron and steel were manufactured in the Detroit area. Pig iron shipments and value were 6 percent and 5 percent higher, respectively, than in 1965. Basic, foundry, and low phosphorus grades were produced. According to the American Iron & Steel Institute, Michigan steel production was 10 million tons, about 3 percent larger than in 1965.

Silver.—Silver was recovered from copper ore mined at the White Pine mine. Concentrate from a silver-recovery circuit in the White Pine mill was smelted separately for delivery to electrolytic refineries where the silver was recovered. The amount of silver recovered was about 5 percent higher than in 1965. Silver contained in fire-refined copper was not recovered but was marketed as a constituent of lake copper.

MINERAL FUELS

Natural Gas and Natural Gas Products.—Natural gas production decreased in volume and value. Macomb and St. Clair Counties each supplied about a quarter of the State total while the Albion-Scipio trend fields in Calhoun, Hillsdale, and Jackson Counties accounted for nearly a third. The remainder, about 15 percent, came from fields in 20 counties.

At the end of 1966 there were 81 producible gas fields, of which 59 produced gas for commercial sale.

Total production of natural gasoline and liquid petroleum gases was about 12 percent higher than in 1965. Nearly all (99 percent) of the production came from processing plants in Hillsdale, Oscoda, St. Clair, and Washtenaw Counties. Gas processed in Washtenaw County was from out-of-State fields, delivered by interstate pipeline.

Peat.—Michigan again led the Nation in peat production with 39 percent of the U.S. output. Peat was produced in 15 counties with the largest production coming from Lapeer, Oakland, St. Clair, and

[3] Geological Survey Division, Michigan Department of Conservation. General Statistics Covering Cost and Production of Michigan Iron Mines. 1967, 6 pp.

Sanilac Counties. Peat was marketed principally as a soil conditioner. None was sold for fuel. Over three-quarters of the peat mined was reed-sedge. The remainder was moss and humus.

Petroleum.—Petroleum production again declined, about 500,000 barrels less than the 1965 figure. About half of the decrease occured in the fields of the Albion-Pulaski-Scipio trend in Calhoun, Hillsdale, and Jackson Counties, although the area still accounted for about 61 percent of the State production. Petroleum was produced in 43 counties and natural gas in 25 counties. Eleven refineries had an operating capacity of 172,200 barrels a day.

During the year production came from 193 active oilfields and two reactivated fields, while three fields were abandoned. According to data compiled by the Geological Survey Division of the Michigan Department of Conservation, oil and gas field activity was below that of 1965. The most active exploration and development areas were in St. Clair and Macomb Counties, also along the Albion-Pulaski-Scipio trend and in the general northwest quadrant of the Southern Peninsula. Most of the 11 new discoveries were made in the latter area. No large fields were found in 1966. The small areal extent of the new fields and the greater well spacing contributed to the decline in oil and gas field activity. Total drilling permits for oil and gas wells were 430 in 1966 compared with 494 in 1965. Of the 388 well completions in 1966, 186 were exploratory and 202 development wells. Of the exploratory wells, 175 were dry, eight yielded oil, and three yielded gas. Of the development wells, 111 were dry, 49 yielded oil, and 42 yielded gas.

An analysis of discovery wells by geologic system indicated that seven were in the Devonian, two in the Silurian, and one each in the Ordovician and Mississippian.

REVIEW BY COUNTIES

Mineral production was reported from all counties in Michigan. Value of output increased in 54 counties and decreased in 19 counties. More than $1 million in minerals was produced in each of 45 counties. Marquette County led in value of production, furnishing 19 percent of the State total.

Allegan.—Sand and gravel was produced at fixed plants near Allegan and Fennville. Portable plants were employed at several other sites throughout the county. Output declined to 719,000 tons from 877,000 tons in 1965 because of lower demands for paving and road materials. Marl was produced from pits near Allegan, Dorr, and Hopkins and sold for agricultural use. Moss and reed-sedge peat were dug from bogs near Middleville and Wayland and sold for soil improvement and for packing plants and shrubs.

Natural gas production declined 21 percent from 1965 to 245 million cubic feet, while petroleum output increased about 10 percent to 280,000 barrels. The largest gas production came from the Dorr and Hillards fields, while the greatest petroleum production came from the Wayland field.

Alpena.—Huron Cement Co. (Division of National Gypsum Co.) produced masonry and portland cements at Alpena. The company produced shale and limestone for its own use at sites near the plant. About 374,000 tons of sand and gravel was produced, mostly for road construction and maintenance, at several commercial operations and by and for the county road commission.

Antrim.—Shale was mined near Ellsworth by Penn-Dixie Cement Corp. for manufacturing cement at its Petoskey plant. Sand and gravel was produced for use on county and State roads.

Arenac.—Petroleum production totaled 298,000 barrels, down 5,000 barrels from the previous year's total. The largest output was reported from the Deep River and Sterling fields. Crushed limestone and sand and gravel for road construction and maintenance were produced by county highway crews. Sand and gravel for building, fill, and road use was produced at the Eastman Gravel Pit, Standish.

Baraga.—Sandstone was quarried and milled at Arnheim for building use by Superior Natural Redstone Quarry. Sand and gravel for fill and road use was produced with portable plants at several sites in the county.

Table 15.—Value of mineral production in Michigan, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Alcona	$141,000	$203,000	Sand and gravel.
Alger	25,000	28,000	Do.
Allegan	1,284,132	[2] 1,184,491	Petroleum, sand and gravel, peat, stone, natural gas.
Alpena	W	W	Cement, stone, clays, sand and gravel.
Antrim	204,696	336,034	Clays, sand and gravel.
Arenac	1,153,056	1,154,790	Petroleum, stone, sand and gravel.
Baraga	104,400	W	Sand and gravel, stone.
Barry	497,631	712,685	Sand and gravel, petroleum, stone.
Bay	10,342,073	10,355,213	Cement, petroleum, lime.
Benzie	30,000	57,000	Sand and gravel.
Berrien	1,376,055	2,064,741	Sand and gravel, stone, petroleum.
Branch	199,537	1,088,607	Sand and gravel, stone.
Calhoun	6,784,379	[2] 7,143,796	Petroleum, sand and gravel, stone, natural gas.
Cass	334,969	234,882	Sand and gravel, petroleum, stone.
Charlevoix	17,000	W	Sand and gravel.
Cheboygan	141,097	127,170	Stone, sand and gravel.
Chippewa	4,739,350	4,381,768	Do.
Clare	1,903,929	[2] 1,761,103	Petroleum, sand and gravel, natural gas.
Clinton	369,366	399,120	Sand and gravel, clays.
Crawford	269,202	[2] 331,157	Petroleum, sand and gravel, natural gas.
Delta	259,148	353,722	Sand and gravel, stone.
Dickinson	20,102,845	19,630,518	Iron ore, stone, sand and gravel.
Eaton	562,878	547,057	Stone, sand and gravel, clays, peat.
Emmet	7,285,985	6,104,336	Cement, stone, sand and gravel.
Genesee	652,164	755,485	Sand and gravel, petroleum.
Gladwin	W	W	Petroleum, sand and gravel.
Gogebic	6,587,762	3,020,680	Iron ore, sand and gravel.
Grand Traverse	W	96,000	Sand and gravel.
Gratiot	W	W	Salines, salt, sand and gravel, petroleum, natural gas.
Hillsdale	14,235,692	[2] 13,656,957	Petroleum, sand and gravel, stone, natural gas.
Houghton [3]	7,829,391	9,390,415	Copper, sand and gravel, stone.
Huron	1,295,026	1,256,104	Stone, sand and gravel, lime, petroleum.
Ingham	1,221,912	1,259,650	Sand and gravel, peat.
Ionia	274,000	354,000	Sand and gravel.
Iosco	4,555,659	4,720,390	Gypsum, sand and gravel.
Iron	21,225,886	20,101,578	Iron ore, sand and gravel.
Isabella	1,729,101	[2] 1,398,765	Petroleum, sand and gravel, stone, natural gas.
Jackson	4,753,171	[2] 5,164,714	Do.
Kalamazoo	945,341	1,091,634	Sand and gravel, stone, peat.
Kalkaska	59,281	74,357	Petroleum, sand and gravel.
Kent	3,081,727	[2] 3,124,266	Sand and gravel, gypsum, petroleum, peat, natural gas.
Keweenaw	(4)	(4)	Copper, sand and gravel.
Lake	75,816	49,661	Petroleum, sand and gravel.
Lapeer	1,642,947	[2] 1,610,956	Peat, sand and gravel, salines, petroleum, natural gas.
Leelanau	53,000	113,000	Sand and gravel.
Lenawee	708,357	635,284	Sand and gravel, peat, clays, petroleum.
Livingston	3,743,000	[2] 3,561,000	Sand and gravel, natural gas.
Luce	90,000	25,000	Sand and gravel.
Mackinac	W	W	Stone, sand and gravel.
Macomb	1,950,236	[2] 2,305,800	Sand and gravel, petroleum, natural gas.
Manistee	19,964,216	20,425,526	Salt, salines, sand and gravel.
Marquette	99,075,859	115,647,036	Iron ore, sand and gravel.
Mason	W	W	Salines, lime, sand and gravel, petroleum.
Mecosta	223,611	[2] 432,113	Petroleum, sand and gravel, peat, natural gas.
Menominee	1,063,482	889,822	Lime, sand and gravel.
Midland	W	W	Salines, salt, petroleum, sand and gravel, natural gas.
Missaukee	W	[2] 1,296,269	Petroleum, sand and gravel, natural gas.
Monroe	W	W	Cement, stone, clays, peat, petroleum.
Montcalm	968,561	[2] 950,187	Petroleum, sand and gravel, natural gas.
Montmorency	3,000	19,000	Sand and gravel.
Muskegon	2,166,691	2,271,854	Salt, sand and gravel, petroleum.
Newaygo	186,857	231,689	Sand and gravel, petroleum.
Oakland	8,083,304	8,595,441	Sand and gravel, peat, petroleum.
Oceana	660,047	522,515	Sand and gravel, petroleum.
Ogemaw	898,233	[2] 1,200,812	Petroleum, sand and gravel, natural gas.
Ontonagon	43,817,777	44,732,771	Copper, silver, sand and gravel.
Osceola	1,489,667	[2] 1,601,104	Petroleum, sand and gravel, natural gas.
Oscoda	23,688	124,667	Sand and gravel, petroleum.
Otsego	33,000	[2] 30,000	Sand and gravel, natural gas.
Ottawa	2,731,187	[2] 2,719,979	Sand and gravel, petroleum, stone, natural gas.
Presque Isle	W	W	Stone, sand and gravel.
Roscommon	675,618	[2] 697,755	Petroleum, sand and gravel, natural gas.
Saginaw	449,643	478,613	Clays, lime, petroleum, sand and gravel, natural gas.

See footnotes at end of table.

Table 15.—Value of mineral production in Michigan, by counties [1]—Continued

County	1965	1966	Minerals produced in 1966 in order of value
St. Clair	$16,487,453	[2] $16,498,116	Salt, cement, petroleum, peat, clays, sand and gravel, natural gas.
St. Joseph	269,746	261,939	Sand and gravel, peat, stone.
Sanilac	982,419	912,100	Peat, sand and gravel, lime.
Schoolcraft	2,000	W	Sand and gravel.
Shiawassee	569,152	671,837	Sand and gravel, clays, peat.
Tuscola	2,065,030	2,152,398	Sand and gravel, petroleum, lime, peat.
Van Buren	258,041	313,640	Sand and gravel, petroleum.
Washtenaw	1,564,849	[2] 1,279,249	Sand and gravel, petroleum, natural gas.
Wayne	40,047,759	[2] 50,556,371	Lime, cement, salt, sand and gravel, salines, stone, clays, petroleum, natural gas.
Wexford	106,000	[2] 147,000	Sand and gravel, natural gas.
Undistributed [5]	185,855,913	194,502,311	
Total	565,560,000	602,127,000	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Values for natural gas and natural gas liquids are not available on a county basis, but are included with "Undistributed."
[2] Excludes value of natural gas.
[3] Includes value of mineral production in Keweenaw County.
[4] Value of mineral production is included in that of Houghton County.
[5] 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.

Barry.—Sand and gravel production was up 30 percent to 757,000 tons because of increased demand for building and road materials in the area. Marl was dipped from pits near Caledonia and Nashville and sold for agricultural use. About 13,000 barrels of petroleum were produced, most of it from the Hope field.

Bay.—Masonry and portland cements were manufactured at Bay City by Etna Portland Cement Co., Division of Martin Marietta Corp. Monitor Sugar Division, Robert Gage Coal Co. produced quicklime for use in sugar refining. About 338,000 barrels of petroleum was recovered from county oilfields. Largest production came from the Kawkawlin and Essexville fields. Bay Refining, Division of The Dow Chemical Co., refined crude oil at Bay City.

Berrien.—Sand and gravel output totaled nearly 1.8 million tons, about 52 percent more than in 1965. The increase was derived from a greater demand for building, road materials, and industrial sand. In March the Sawyer plant of Manley Sand Division, Martin Marietta Corp., discontinued operation. The company reported their Bridgman plant would continue industrial sand production. Marl was produced from pits near Three Oaks and sold for agricultural use. A few barrels of petroleum was recovered from one well in the Pipestone field before it was abandoned in 1966.

Branch.—Sand and gravel output increased to nearly 1.7 million tons from 262,000 tons in 1965, due to greater demand for gravel for road construction and maintenance. Marl for agricultural use was obtained from pits near Kinderhook and Sherwood.

Calhoun.—The county held its position as second largest petroleum producer in the State. Output from fields in the Albion-Pulaski-Scipio trend was nearly 2.4 million barrels in 1966 compared with 2.3 million barrels in 1965. The output of 4 billion cubic feet of natural gas, about the same as in 1965, ranked the county fourth in the State in production of this commodity. Sand and gravel output increased to 777,000 tons from 733,000 tons in 1965. Most of the material was used for road construction and maintenance. Marl was obtained from pits near Burlington and Union City and sold for agricultural use.

Cass.—Sand and gravel output of 255,000 tons was reported from a fixed plant near Niles and portable plants operating in the Dowagiac, Edwardsburg, and Niles areas. Marl pits were operated near Cassopolis, Dowagiac, and Union and the output sold for agricultural use. A small amount (4,759 barrels) of petroleum was produced from the Jefferson field.

Charlevoix.—Construction continued on the 4-million-barrel plant of Medusa Portland Cement Co., scheduled for operation in mid-1967. The plant will have one of the industry's most advanced computer systems to control raw material blending, raw mill, kiln, cooler, and finish mills. About

127,000 tons of sand and gravel was produced for building, road use, and fill.

Cheboygan.—Limestone was quarried and crushed near Afton and sold for use in concrete aggregate, roadstone, agricultural limestone, and fluxstone. Sand and gravel output totaled 93,000 tons, down from 154,000 tons in 1965. Smaller requirements for road gravel by the State highway department caused most of the decline.

Chippewa.—Limestone was quarried and crushed on Drummond Island, in Lake Huron, by Drummond Dolomite, Inc. The output, from one of the largest quarries in the State, was shipped by water to consumers of fluxstone, concrete aggregate, roadstone, and agricultural limestone. About 355,000 tons of sand and gravel was produced, and was used mostly for roads.

Clare.—Petroleum production was 603,000 barrels, down from 651,000 barrels in 1965. Two-thirds of the petroleum came from the East Cranberry Lake and Hamilton fields. Natural gas output increased to 212 million cubic feet from 187 million in 1965, and come from the North Hamilton and Headquarters fields. Sand and gravel production for road use fell to 76,000 tons from 189,000 tons in 1965. State and county highway requirements decreased.

Clinton.—Clay was mined near Grand Ledge and used in manufacturing vitrified sewer pipe and other heavy clay products by Grand Ledge Clay Product Co. In the same area, operations of the American Vitrified Products Co. had been discontinued, and the plant was abandoned late in 1965. About 419,000 tons of sand and gravel was produced, primarily for building and road use.

Crawford.—Petroleum production increased to 87,000 barrels from 66,000 barrels in 1965. Natural gas output was 370 million cubic feet, an increase of 25 million cubic feet over the 1965 total. The Beaver Creek field yielded all the petroleum and gas production. Sand and gravel production, used mostly for road construction and maintenance, increased 23 percent to 113,000 tons.

Delta.—Limestone was quarried and crushed near Escanaba for use as roadstone and in concrete aggregate. Sand and gravel output increased to 511,000 tons from 372,000 tons in 1965, because of road building requirements. Delta Terminal Co. refined crude oil at Rapid River.

Dickinson.—The Hanna Mining Co. operated the Groveland open pit iron mine, concentrator, and pelletizing plant near Randville. The traveling grate pelletizing furnace at the operation was extensively remodeled. Limestone, quarried near Randville and Felch, was used principally for terrazzo, ornamental concrete, and roofing granules. About 80,000 tons of sand and gravel was produced, mostly in the Iron Mountain area, for building and road use.

Eaton.—Clay, used in manufacturing vitrified sewer pipe and other heavy clay products, was mined by the Grand Ledge Clay Product Co. Limestone was quarried by Cheney Limestone Co. near Bellevue for use in concrete aggregate, roadstone, agricultural limestone, and rubble. About 353,000 tons of sand and gravel was produced, mostly with portable plants at several sites in the county; principal use was for road construction and maintenance. Humus peat was produced near Charlotte and sold for soil conditioning.

Emmet.—Penn-Dixie Cement Corp. produced portland and masonry cements at Petoskey and, in the same area, quarried and crushed limestone for its own use. About 92,000 tons of sand and gravel for road use was produced under contract for the State highway department and by the county road commission.

Genesee.—Sand and gravel output was nearly 1.1 million tons, compared with 732,000 tons in 1965. Most of the increase was in gravel for road use. Five, fixed plants and several portable plants were operated. About 3,000 barrels of petroleum was produced from the Otisville field.

Gladwin.—About 386,000 barrels of petroleum was produced, over half of which came from the Beverton, Bentley, and Buckeye fields. Road gravel was produced near Oberlin.

Gogebic.—Pickands Mather & Co. shipped iron ore from stockpiles at the Geneva and Peterson mines, as well as ore mined at the Peterson mine in January. The mine was closed January 29. The hoist was purchased by the White Pine Copper Co. and moved to the White Pine mine.

The Geneva mine was shut down in January 1965. These were the last operating iron mines on the Gogebic range. About 107,000 tons of sand and gravel was produced in the county, mostly for road use.

Gratiot.—Michigan Chemical Corp., at St. Louis, produced bromine, calcium chloride, calcium-magnesium chloride, and magnesium compounds from natural well brines. Also at St. Louis, Michigan Salt Co. produced salt from natural well brines. About 35,000 barrels of petroleum from the Sumner field and 2 million cubic feet of natural gas from the North Star field were produced. About 399,000 tons of sand and gravel was produced with stationary plants and dredges at Alma and Ithaca and with portable plants at several sites in the county. Leonard Refineries, Inc., operated a crude oil refinery at Alma, where byproduct sulfur was also recovered using the hydrofining process.

Hillsdale.—Petroleum production totaled nearly 4.6 million barrels, the largest in the State. About 4.5 billion cubic feet of natural gas was produced. The county ranked second in the production of natural gas liquids. Sand and gravel output was 559,000 tons compared with 339,000 tons in 1965. Production came from two fixed plants and several portable plants. Most of the increase was due to larger demand for road gravel. Marl was produced from pits near Allen and Mosherville for agricultural use.

Houghton.—Copper was produced by Calumet & Hecla, Inc., Copper Range Co., and Quincy Mining Co. Calumet & Hecla operated the Ahmeek group of mines in Houghton and Keweenaw Counties and the Tamarack reclamation plant and a smelter near Hubbell. The Seneca No. 2 mine was closed in July. In its annual report the company indicated that the Hills Creek copper deposit would require further geological work to determine the extent of the ore body before adopting a mining plan. The Copper Range Co. operated the Champion mine and Freda mill, where Champion ore as well as tailings from the old Atlantic mine were treated. Quincy Mining Co. operated a reclamation plant at Hubbell and a smelter at Hancock. The Limestone Mountain Co. quarried and crushed limestone for agricultural use near Pelkie. About 128,000 tons of sand and gravel for building and road construction was produced by two companies and the county road commission. Portable plants were operated near Hancock and South Range.

Huron.—Michigan Sugar Co. produced lime for its own use in sugar refining at Sebewaing. The Wallace Stone Co. Division J. P. Burroughs & Son, Inc., quarried limestone for stone veneer, rubble, riprap, roadstone, concrete aggregate, railroad ballast, and agricultural use. About 216,000 tons of sand and gravel was produced compared with 738,000 tons in 1965. The decrease was due to smaller demand for State and county highway needs. Approximately 3,000 barrels of petroleum was produced from the Dwight and Grant fields.

Ingham.—Sand and gravel production totaled 1.6 million tons, up from 1.5 million tons in 1965. Most of the material was used for road construction and maintenance. Humus peat was dug from a bog near Lansing and sold for soil improvement. The Lansing Board of Power & Light recovered quicklime from calcium carbonate precipitated at the city water purification plant.

Iosco.—The county had the largest gypsum production in the State, all from open quarries. National Gypsum Co. operated a quarry and board plant at National City and port facility at Tawas City. At the plant, crude perlite, mined in the Southwest, was expanded for use in plaster. United States Gypsum Co. operated a quarry, processing plant, and port facility at Alabaster. Michigan Gypsum Co. opened a quarry about a mile southeast of their processing and crushing plant at Whittemore. About 120,000 tons of sand and gravel for road use was produced by and for the county road commission.

Iron.—The Hanna Mining Co. mined and shipped iron ore from the Hiawatha No. 2, Homer, and Wauseca underground mines. The Hiawatha No. 2 mine, opened in 1892, was closed the latter part of December because of depletion of ore reserves. A second screening unit to serve both the Homer and Wauseca mines began operation April 1. Inland Steel Co. operated the Bristol and Sherwood underground mines, and North Range Mining Co. operated the Book underground iron mine.

About 86,000 tons of sand and gravel for road use was produced.

Isabella.—About 280,000 barrels of petroleum, mostly from the Coldwater and Mount Pleasant fields, and nearly 5 million cubic feet of natural gas from the Fremont field were produced. Leonard Refineries, Inc., operated a refinery at Mount Pleasant. Sand and gravel output totaled 703,000 tons and was sold for building and road use. Marl for agricultural use was produced near Weidman.

Jackson.—Nearly 1.7 million barrels of petroleum and 2.1 billion cubic feet of natural gas were produced, slightly more than in 1965. Limestone was quarried and crushed at Parma for use as roadstone, concrete aggregate, and agricultural limestone. Sandstone was quarried and milled for building use in the Napoleon area. Sand and gravel production was 308,000 tons, and was used for building and road construction. Marl was obtained from pits near Horton and sold for agricultural use.

Kalamazoo.—The sand and gravel output of 917,000 tons was about the same as in 1965. Reed-sedge peat for soil conditioning was produced near Kalamazoo. Marl was dug from pits near Vicksburg and Paw Paw Lake and sold for agricultural use. Lakeside Refining Co. operated an oil refinery at Kalamazoo.

Kalkaska.—About 17,000 barrels of petroleum was produced, nearly all from the Beaver Creek field. The county road commission produced 68,000 tons of sand and gravel for road use and other purposes.

Kent.—Gypsum was produced from underground mines by Bestwall Gypsum Division of Georgia-Pacific Corp. and Grand Rapids Gypsum Co. The material was processed and manufactured into building products at company-owned plants in the Grand Rapids area. Perlite, mined in the Western States, was expanded for use in plaster at the Bestwall plant. Over 1.8 million tons of sand and gravel was produced compared with 2 million tons in 1965. Most of the decline was caused by lower demand for road materials. Humus, moss, and reed-sedge peat were dug from several bogs in the county and sold for soil improvement. About 101,000 barrels of petroleum and 15.5 million cubic feet of gas were produced. Most of the petroleum and all of the gas came from the Walker field.

Lake.—Nearly 15,000 barrels of petroleum was produced from five fields, with the major portion coming from the Luther field. The county road commission produced 16,000 tons of sand and gravel for road use and other purposes.

Lapeer.—Calcium-magnesium chloride was produced from natural well brines at Mayville by Wilkinson Chemical Corp. Nearly half of the State peat production came from bogs near Imlay City. The reed-sedge peat was sold both in bulk and packaged form for soil improvement and potting materials. About 457,000 tons of sand and gravel was produced for building and road use at sites throughout the county. The Rich field yielded about 33,000 barrels of petroleum and 25 million cubic feet of natural gas.

Lenawee.—Clay for manufacturing drain-tile was mined near Tecumseh. Reed-sedge peat was dug from a bog near Adrian and sold in packaged form for general soil conditioning. About 626,000 tons of sand and gravel was produced near Adrian and Tecumseh and used chiefly for building, road purposes, and railroad ballast. The Macon Creek and Medina fields yielded a small amount of petroleum (less than 1,000 barrels).

Livingston.—About 16.7 million cubic feet of natural gas was produced. Sand and gravel output totaled more than 3.3 million tons, most of it from the Brighton, Fenton, and Howell areas. Output was used for building, road purposes, railroad ballast, and fill. At the American Aggregates Corp. operation near Brighton, alterations were made to increase capacity and improve product quality. Included were an enlarged railroad dump hopper, raw material surge pile, reclamation system, and hydraulic separation facility.

Mackinac.—Large limestone quarries were operated by Inland Lime & Stone Co., Division of Inland Steel Co., near Port Inland and United States Steel Corp. near Cedarville. The Inland Lime & Stone Co. processing plant and port were located at Port Inland in adjacent Schoolcraft County. The crushed material was shipped from company-owned ports to consumers of fluxstone, roadstone, agricultural limestone, railroad ballast, and riprap, and cement, lime, and chemical manufacturers.

About 133,000 tons of sand and gravel was produced, mostly for road use.

Macomb.—About 2.9 million tons of sand and gravel was produced, compared with 2.4 million tons in 1965. Much of the material came from the Armada, Romeo, and Utica areas. Principal uses were for building and road construction.

Natural gas production was about 9 billion cubic feet, mostly from the Ray field. More than 3,000 barrels of petroleum was recovered from the Chesterfield and Ray fields.

Manistee.—Natural well brines were processed at several plants to recover bromine, calcium-magnesium chloride, and magnesium compounds. Salt was recovered from artificial brines. Chemical plants were operated in the Manistee area by Great Lakes Chemical Corp., Manistee Salt Works, Michigan Chemical Corp., Morton Chemical Co., Division of Morton International, Inc., Morton Salt Co., and Standard Lime & Refractories Co., Division of Martin Marietta Corp. At Filer City, Packaging Corp. of America produced quicklime for its own use in paper manufacturing by calcining carbonate sludge. Gravel for road use was produced at several sites, and molding sand was produced at Manistee.

Marquette.—Value of mineral production was nearly $116 million, the highest in the State. Iron ore shipments were up nearly 17 percent. Open pit mines accounted for 62 percent of the total iron ore shipments.

Cleveland-Cliffs Iron Co. operated four underground and four open pit iron mines. The company operated the Pioneer pellet plant near Negaunee at full capacity during the year. The plant treats natural ore from the Mather underground mine. The company also operated the Empire mine complex near Palmer, which expanded its pellet capacity to 3.2 million tons per year.

Jones & Laughlin Steel Corp. operated the Tracy underground mine, and North Range Mining Co. operated the Champion underground mine.

About 880,000 tons of sand and gravel was produced, up from 787,000 tons in 1965. Most of the material was used for building, road construction, and fill.

Mason.—Bromine, calcium chloride, calcium-magnesium chloride, and magnesium compounds were recovered from natural well brines at Ludington by The Dow Chemical Co. The company also produced quicklime. Harbison-Walker Refractories Co. produced refractory magnesia from purchased magnesium hydroxide.

Molding and glass sand was produced near Ludington, and road gravel was mined at several sites with portable plants.

About 127,000 barrels of petroleum was recovered from six fields. The Eden, Scottville, and Wiley fields yielded the major portion of county output.

Mecosta.—About 90,000 barrels of petroleum and 92 million cubic feet of natural gas were produced. The Hardy Dam and Paris fields accounted for most of the petroleum output. Natural gas was produced from seven fields.

About 303,000 tons of sand and gravel was produced, mostly for road use.

Reed-sedge peat was produced near Lakeview and sold in bulk and packaged form for soil improvement. Two marl pits which were operated near Mecosta in 1965 were idle during the year.

Menominee.—Quicklime and hydrated lime were produced at Menominee by Limestone Products Division of The C. Reiss Coal Co. The lime was sold for use in insecticides, paper and pulp manufacture, tanning, steelmaking (in basic-oxygen converters), water purification, and other purposes.

About 698,000 tons of sand and gravel was produced and used principally for road construction and maintenance.

Midland.—The Dow Chemical Co., at Midland, processed natural well brines and recovered bromine, calcium chloride, calcium-magnesium chloride, iodine, magnesium compounds and potash. The company also extracted salt from artificial brines. In April, the American Salt Corp. began production of salt in its new plant at Midland. Kaiser Aluminum & Chemical Corp. produced refractory magnesia from purchased magnesium hydroxide. Sand and gravel for building, road use, and fill was produced near Midland.

About 225,000 barrels of petroleum and a small quantity of natural gas were produced from six fields. The Porter field had the largest petroleum output.

Missaukee.—About 444,000 barrels of petroleum and 673 million cubic feet of natural gas were produced from eight fields.

The largest petroleum production was from the Enterprise and McBain fields and natural gas from the East Norwich and Falmouth fields.

The county road commission contracted for 36,000 tons of road gravel.

Monroe.—Portland and masonry cements were produced by Dundee Cement Co. at Dundee. Clay and limestone were mined near the plant site for use in manufacturing cement. The company's large rotary kiln is now controlled by a digital computer, installed during the year.

Limestone was quarried and crushed at Monroe by The France Stone Co., and by The Michigan Stone Co. at Maybee and Ottawa Lake. The material was used for flux, roadstone, railroad ballast, and for agricultural use.

F. W. Ritter Sons Co. mined miscellaneous clay at South Rockwood for use in making art pottery and other clay products.

Reed-sedge and humus peat were dug from pits near Ida and Petersburg and used for potting soils and general soil improvement.

About 7,000 barrels of petroleum was produced from the Deerfield field.

Montcalm.—About 202,000 barrels of petroleum and 5.9 million cubic feet of natural gas were produced from 12 fields. Crystal Refining Co. refined crude oil at Carson City.

Sand and gravel output was about 790,000 tons compared with 733,000 tons in 1965. Most of the material was used for road construction and maintenance.

Muskegon.—Salt was extracted from artificial brines at Montague by Hooker Chemical Corp.

Union Carbide Corp., Olefins Division, produced hydrated lime as a byproduct of their acetylene-producing operations. Output was sold for mason's lime and treatment of sewage and industrial wastes. About 35,000 barrels of petroleum was produced from five fields. Naph-Sol Refining Co. refined crude oil at Muskegon. The Marathon Oil Co. refinery at Muskegon was abandoned.

About 528,000 tons of sand and gravel was produced for molding sand, building, road use, and fill.

Newago.—About 298,000 tons of sand and gravel was produced, mostly for road use. About 24,000 barrels of petroleum was produced from several small fields. No natural gas production was reported in 1966.

Oakland.—Sand and gravel output, the largest in the State totaled 8.8 million tons, compared with 8.7 million tons in 1965. The material was used for building, railroad ballast, road construction, and fill.

Moss and humus peat were produced near New Hudson and Novi and sold in bulk for soil improvement.

About 1,000 barrels of petroleum was recovered from the Northville field.

Oceana.—About 82,000 barrels of petroleum was recovered from eight fields, with the largest production reported from the Pentwater, Stony Lake, and Elbridge fields.

About 464,000 tons of sand and gravel was produced, principally for building and road use.

Ogemaw.—About 278,000 barrels of petroleum and 627 million cubic feet of natural gas were produced. Most of the petroleum came from the West Branch and Rose City fields, and the gas came from the Rose City and Logan fields. Osceola Refining Co. refined crude oil at West Branch.

About 671,000 tons of sand and gravel was produced, compared with 222,000 tons in 1965. Demand for road material accounted for the increase.

Ontonagon.—White Pine Copper Co. a subsidiary of Copper Range Co., operated a mine, mill, and smelter at White Pine. In December, the new reverberatory furnace at the smelter was completed. Construction continued on the new 1,600 foot shaft, 5 miles from the original mine portals. The shaft had reached the ore horizon, and hoisting and surface facilities were near completion at yearend.

Sand and gravel output increased to 318,000 tons from 140,000 tons in 1965, because of demand for road materials.

Osceola.—Petroleum production totaled about 435,000 barrels, with the largest amount coming from the Reed City field, which lies in both Lake and Osceola Counties. About 291 million cubic feet of natural gas was produced, principally from the Middle Branch and Reed City fields.

Sand and gravel for fill, railroad ballast, building, and road construction was produced.

Oscoda.—Approximately 222,000 tons of sand and gravel was produced for county and State highway use.

Nearly 2,000 barrels of petroleum was recovered from the Mio field. About 12 million gallons of natural gas liquids were recovered at the Reed City plant.

Ottawa.—Sand and gravel output totaled 2.6 million tons, about the same as in 1965. Industrial sand (glass, molding, and engine) was produced, as well as large quantities of building and road materials.

A small quantity of marl was extracted from pits near Hudsonville and Jenison and sold for agricultural use.

About 133,000 barrels of petroleum and 151 million cubic feet of natural gas were recovered, principally from the Dennison, Fillmore, and Walker fields.

Presque Isle.—Limestone was produced at Rogers City by United States Steel Corp., and near Presque Isle by Presque Isle Corp. The crushed stone was shipped by water to steel mills, cement and lime plants, as well as users of concrete aggregate, roadstone, and agricultural limestone. Onaway Stone Co. produced limestone for building use at Onaway.

Sand and gravel production was 413,000 tons, down from 569,000 tons in 1965, because of smaller demand for building and road materials.

Roscommon.—About 177,000 barrels of petroleum and 714 million cubic feet of natural gas were produced from the East Norwich, Enterprise, Headquarters, and St. Helen fields.

About 296,000 tons of sand and gravel was produced, chiefly for road use.

Saginaw.—Clay was mined near Saginaw by Etna Portland Cement Co. Division, Martin Marietta Corp., for use in manufacturing cement at its plant in Bay City. Michigan Sugar Co. produced lime at Carrollton for sugar refining. About 132,000 tons of sand and gravel was produced by and for the county road commission for road use, fill, and other purposes.

About 26,000 barrels of petroleum was recovered from five fields. Birch Run field had the largest production.

St. Clair.—Portland and masonry cements were produced at Port Huron by Peerless Cement Co., Division of American Cement Corp. The company mined clay for its own use at Smiths Creek.

Salt was recovered from artificial brines by Diamond Crystal Salt Co. at St. Clair and Morton Salt Co. at Marysville.

Reed-sedge peat was produced near Capac and sold in bulk and packaged form for general soil improvement. Sand and gravel was produced, mostly for road use.

About 710,000 barrels of petroleum and 9.3 billion cubic feet of nautral gas were produced. Major oilfields were Big, Boyd, and Peters. The largest gas production came from the Capac, Columbus, Boyd, and Peters fields. Gas production was the largest in the State. More than 34 million gallons of natural gas liquids were produced at the Boyd plant.

St. Joseph.—Marl and reed-sedge peat were produced near Three Rivers and Nottawa.

About 346,000 tons of sand and gravel was produced, mostly in the Three Rivers and White Pigeon areas. The material was used principally for building, road construction, and fill.

Sanilac.—Lime was produced at Croswell by Michigan Sugar Co. for its own use. Moss and reed-sedge peat were dug from bogs near Minden City and Sandusky and sold chiefly for potting use and soil improvement. About 602,000 tons of sand and gravel was produced for building, road use, and fill.

Shiawassee.—Shale was mined at Corruna by Michigan Vitrified Tile Co. for use in manufacturing vitrified sewer pipe. Humus and reed-sedge peat were produced near Perry and Ovid, respectively, and sold for soil improvement and packing material for shrubs and plants. About 794,000 tons of sand and gravel was produced, compared with 684,000 tons in 1965. Output was used for building, road construction, and railroad ballast.

Tuscola.—About 80,000 barrels of petroleum was recovered from four fields, with the largest production reported from the Akron field. Moss peat was produced near Juniata and sold in bulk and packaged form for general soil improvement.

Sand and gravel output totaled 1.7 million tons, up from 1.5 million tons in 1965, and was used for building, road construction, and molding sand.

Lime was produced at Caro by Michigan Sugar Co. for sugar refining.

Van Buren.—About 330,000 tons of sand and gravel for road use, molding, and engine sand was produced. Petroleum output totaled about 11,000 barrels mostly from the Bloomingdale field.

Washtenaw.—Nearly 1.5 million tons of sand and gravel was produced, slightly less than in 1965. The material was used for building, road construction, and fill. About 28,000 barrels of petroleum and 177 million cubic feet of natural gas were recovered from the Lyndon and Northville fields.

Wayne.—In the Detroit metropolitan area lime was produced by Detroit Lime Co., a subsidiary of Edward C. Levy Co.; Industrial Chemicals Division, Allied Chemical Corp.; Marblehead Lime Co.; and Wyandotte Chemicals Corp. Portland and masonry cements were produced by Peerless Cement Co., Division of American Cement Corp., at two plants in Detroit; and by Wyandotte Chemicals Corp. at Wyandotte.

Salt was mined by International Salt Co., Inc., at Detroit, and recovered from artificial brines at Wyandotte by Pennsalt Chemicals Corp. and Wyandotte Chemicals Corp. The latter company also produced calcium chloride. Sand and gravel output declined to about 3.2 million tons from nearly 4.4 million in 1965, reflecting a decline in building and road construction. In addition to building and road materials, industrial sand for a variety of uses was produced. Limestone for riprap and road use was quarried from the Sibley quarry at Trenton by Michigan Foundation Quarry Co., Inc. Clay was mined at Livonia by Light Weight Aggregate Corp. and at Allen Park by Peerless Cement Co. for their own use. Flat Rock Clay Products Co. did not operate its pit or plant in 1966.

About 1.2 billion cubic feet of natural gas and 18,000 barrels of petroleum were recovered from the Northville field. Socony Mobil Oil Co. refined crude oil at Trenton. Marathon Oil Co. recovered byproduct sulfur from crude oil at its Detroit refinery.

United States Gypsum Co. operated a calcining and board plant at Detroit. The crude ore was shipped by water from the company-owned port and quarries at Alabaster in Iosco County. The company also expanded perlite at the Detroit plant. Zonolite Division, W. R. Grace & Co. exfoliated vermiculite at a plant in Dearborn.

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 Keith S. Olson [1]

Value of Minnesota mineral production increased 8 percent to $550.3 million. The State continued to lead the Nation in production of iron ore, contributing 61 percent of the total usable ore shipped from mines in the United States. Ironbearing ores (including manganiferous ores) represented 91 percent of the total value of the State mineral production.

Shipments of taconite concentrates increased by 14 percent, establishing a new record of 21.4 million long tons. Quantity and value increases were recorded for the production of portland cement, miscellaneous clay, iron ore, peat, sand and gravel, stone, and tube-mill liners. Production of masonry cement, fire clay, grinding pebbles, lime, and manganiferous ore decreased both in quantity and value.

[1] Industry economist, Bureau of Mines, Minneapolis, Minn.

Table 1.—Mineral production in Minnesota [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	207	$311	224	$336
Iron ore (usable) thousand long tons, gross weight	50,873	459,290	55,133	499,388
Manganiferous ore (5 to 35 percent Mn) short tons, gross weight	280,705	W	275,581	W
Peat short tons	7,346	123	11,366	197
Sand and gravel thousand short tons	37,545	27,296	39,331	28,972
Stone do	4,371	11,680	4,901	11,688
Value of items that cannot be disclosed: Abrasive stones, cement, fire clay, gem stones, lime, and values indicated by symbol W	XX	9,060	XX	9,696
Total	XX	507,760	XX	550,277

W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed."
XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes fire clay included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in constant 1957–59 dollars
(Millions)

Year	Value [1]	Year	Value [1]
1957	$594	1962	$410
1958	395	1963	420
1959	340	1964	448
1960	502	1965	452
1961	428	1966	p485

p Preliminary.
[1] Data for 1957–64 revised.

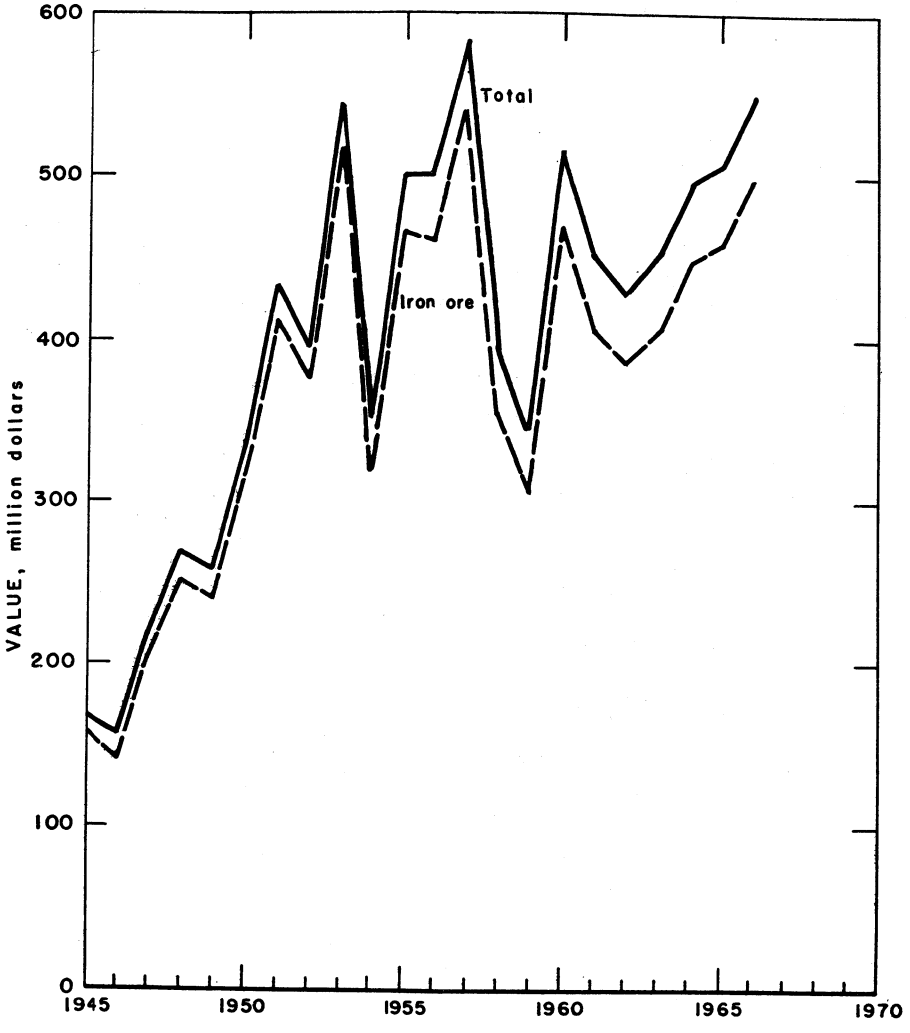

Figure 1.—Value of iron-ore shipments and total value of mineral production in Minnesota.

Table 3.—Employment 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
1965:								
Metal	9,801	285	2,793	22,382	---	92	4.11	253
Nonmetal	225	269	60	484	1	33	70.27	13,876
Sand and gravel	2,334	160	374	3,187	---	57	17.89	416
Stone	1,601	240	384	3,170	---	57	17.98	376
Peat	38	60	2	16	---	---	---	---
Total	13,999	258	3,613	29,239	1	239	8.21	509
1966: p								
Metal	10,065	293	2,944	23,575	4	99	4.37	1,283
Nonmetal	220	269	60	482	1	29	62.24	14,822
Sand and gravel	2,330	167	390	3,367	2	60	18.41	4,021
Stone	1,615	240	387	3,203	---	73	22.79	599
Peat	25	112	3	19	---	---	---	---
Total	14,255	265	3,784	30,646	7	261	8.75	1,725

p Preliminary.

REVIEW BY MINERAL COMMODITIES

METALS

Copper-Nickel.—Stimulated by high demand, extensive exploration activities for copper-nickel were conducted along the Duluth Gabbro in Cook, Lake, and St. Louis Counties. Indications are that the low-grade sulfide ores contain about one percent combined copper-nickel in the ratio of three parts copper to one of nickel. It was estimated that nearly all mining would be by underground methods. Major mining companies holding leases in the area and/or conducting exploration activities included: American Metal Climax, Inc., Bear Creek Mining Co. (the exploration arm of Kennecott Copper Corp.), Cleveland-Cliffs Iron Co., Duval Corp., The International Nickel Co., Inc. (Inco), Newmont Exploration Ltd., New Jersey Zinc Co., United States Steel Corp., Phelps Dodge Corp., and The Hanna Mining Co.

In June, Inco acquired leases on approximately 5,000 acres of Federal lands in the South Kawishiwi River area near Ely. A 1,300-ton bulk sample was transported to Inco's Copper Cliff laboratory near Sudbury, Ontario, Canada, for metallurgical testing. Inco also announced tentative plans for a mining and milling operation capable of producing 125 million pounds of copper and nickel per year. After revising rules and regulations covering mining permits and leases for copper, nickel, and associated minerals on State-owned lands, the State of Minnesota granted 50-year leases totaling about 86,500 acres to 11 companies.

The University of Minnesota Mines Experiment Station conducted tests on copper-nickel ores from northeastern Minnesota utilizing bacterial leaching and sulfide flotation methods.

Iron Ore.—Shipments of usable iron ore from Minnesota mines (excluding ore containing 5 percent or more manganese) were 55.1 million long tons, 8 percent greater than in 1965. Mine value of shipments totaled $499.4 million, an increase of $40.1 million. About 77 percent of the ore shipped during the year was beneficiated.

Greater demand by the Nation's blast furnace operators for a high quality feed was evidenced by shipments of taconite concentrates increasing to 21.4 million long tons, compared with 18.9 million tons in 1965. Taconite concentrates comprised nearly 39 percent of all iron-ore shipments in 1966. Average natural iron content of usable iron ore produced was 56.4 percent. Fourteen companies operated mines in four counties. Nearly 95 percent of the ore produced was from the Mesabi Range in Itasca and St. Louis Counties. Mines on the Cuyuna Range in Crow Wing County, the Vermilion Range in St. Louis County, and the Spring Valley district in Fillmore County produced the remainder. No production was recorded in Olmsted County.

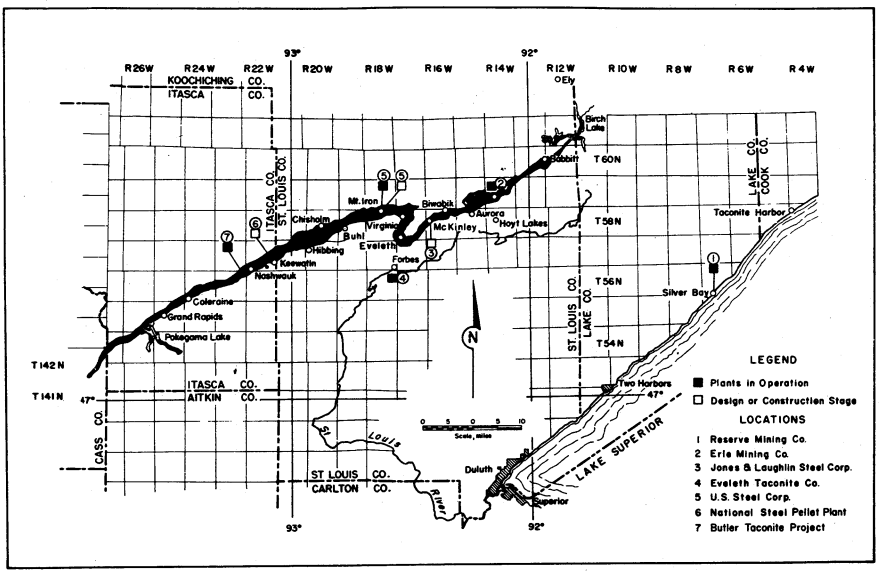

Figure 2.—Locations of currently operating and proposed Mesabi Range taconite-processing plants.

Growth of Minnesota's taconite industry continued during 1966 with three plants under construction and a fourth in design stage. In addition, expansion programs were taking place at two existing plants. The Hanna Mining Co. was nearing completion of two new pellet plants with a combined capacity of 4.4 million tons per year. At yearend, the company was conducting preoperational testing at the Butler Taconite Project near Nashwauk. The company was also slated to begin production in 1967 at the National Steel Pellet Plant near Keewatin. Development work was conducted at the Kevin pit, which will supply crude taconite to the Butler Project. Crude material for the National Steel Plant will be mined from the Section 18 pit, an exhausted natural ore mine.

Near Mountain Iron, United States Steel Corp. was building the largest of the new pelletizing plants, the 4.5 million-ton-per-year Minntac operation. Production was scheduled to begin in 1967. Jones & Laughlin Steel Corp.'s proposed 2-million-ton-per-year pellet plant near Biwabik was in preliminary design stage. Reserve Mining Co. completed an expansion program at its Silver Bay pellet plant, increasing annual capacity to 10.7 million tons. At Hoyt Lakes, Erie Mining Co. was engaged in a $50 million expansion project designed to increase its annual pellet-making capacity to 10.3 million tons.

Combining existing plants with facilities under construction, Minnesota will have an annual taconite concentrate capacity of 32 million tons in 1967.

The two remaining underground iron mines in the State were scheduled to be closed in 1967. Inland Steel Co. announced plans to cease mining operations at its Armour No. 2 mine on the Cuyuna Range, Crow Wing County. United States Steel Corp. plans to close its Pioneer mine, at Ely, the sole producer on the Vermilion Range, St. Louis County.

The navigation season for ports shipping Minnesota iron ores began at Duluth on March 30, the earliest opening for a Lake Superior port since 1953. On December 13 the final shipment left Silver Bay. The Duluth, Missabe & Iron Range Railroad reopened its Two Harbors ore docks which had been inactive since 1962.

Lake Erie base prices for iron ore were unchanged from 1965. Increasing shipments of taconite concentrates resulted in a gain

Table 4.—Crude iron ore[1] data, in 1966, by counties and ranges
(Thousand long tons)

County and range	Stocks Jan. 1	Production		Shipments		Stocks Dec. 31
		Underground	Open pit	Direct to consumers	To concentrators	
County:						
Crow Wing	73	438	1,217	443	1,209	76
Fillmore	---	---	1,404	---	1,404	---
Itasca	---	---	23,056	51	23,005	---
St. Louis	983	789	89,173	12,369	78,176	401
Total[2]	1,056	1,227	114,851	12,863	103,794	477
Range:						
Cuyuna	73	438	1,217	443	1,209	76
Mesabi	983	---	112,229	12,420	100,391	401
Vermilion	---	789	---	---	789	---
Spring Valley district	---	---	1,404	---	1,404	---
Total[2]	1,056	1,227	114,851	12,863	103,794	477

[1] Exclusive of ore containing 5 percent or more manganese.
[2] Data may not add to some totals shown because of rounding.

Table 5.—Usable iron ore[1] data, in 1966, by counties and ranges
(Thousand long tons)

County and range	Stocks Jan. 1	Production	Iron content of production	Shipments	Stocks Dec. 31
County:					
Crow Wing	73	1,299	657	1,296	76
Fillmore	98	772	361	575	295
Itasca	2,722	8,084	4,488	9,247	1,560
St. Louis	2,619	44,125	25,118	44,015	2,729
Total[2]	5,512	54,280	30,625	55,133	4,659
Range:					
Cuyuna	73	1,299	657	1,296	76
Mesabi	5,245	51,506	29,186	52,549	4,202
Vermilion	96	704	421	713	87
Spring Valley district	98	772	361	575	295
Total[2]	5,512	54,280	30,625	55,133	4,659

[1] Exclusive of ore containing 5 percent or more manganese.
[2] Data may not add to some totals shown because of rounding.

Table 6.—Usable iron ore[1] produced (direct-shipping and all forms of concentrate), by ranges
(Thousand long tons)

Year	Cuyuna	Mesabi	Vermilion	Spring Valley district	Total[2]
1884–1956	58,842	2,095,500	93,566	3,142	2,251,050
1957	2,018	64,537	1,349	382	68,286
1958	1,119	39,833	1,027	241	42,221
1959	745	33,747	809	576	35,877
1960	1,166	54,442	1,361	473	57,442
1961	1,095	41,199	930	491	43,714
1962	655	43,041	1,158	362	45,216
1963	515	43,570	774	524	45,383
1964	513	47,256	865	420	49,054
1965	367	50,279	782	625	52,053
1966	1,299	51,506	704	772	54,280
Total[2]	68,334	2,564,909	103,325	8,008	2,744,576

[1] Exclusive, after 1905, of iron ore containing 5 percent or more manganese.
[2] Data may not add to some totals shown because of rounding.

in the average weighted mine value of Minnesota iron ore to $9.06 per ton, compared with $9.03 in 1965.

Nearly all iron ore shipped from Minnesota was for use in manufacturing pig iron and steel. Small quantities were sold for cement manufacture and foundry purposes.

Research on the beneficiation of nonmagnetic taconites and semitaconites was continued by the Federal Bureau of Mines at its Twin Cities Research Center. The Bureau of Mines $4.5 million plant designed to demonstate commercial feasibility of magnetically roasting nonmagnetic taconites, semitaconites, and off-grade iron ores using scrap iron as a reductant, was in design stage. Construction was to begin in 1967, and the plant was slated to be in production in 1968. Approximately 250,000 tons of crude ore and 25,000 tons of automobile and other ferrous scrap will be consumed annually to produce 100,000 tons of prereduced pellets containing about 82 percent iron.

Table 7.—Production of usable iron ore

(Thousand long tons)

Year	Gross weight		Iron content (percent)
	Ore	Iron content	
1957	68,286	35,842	52.49
1958	42,221	22,793	53.99
1959	35,877	19,412	54.11
1960	57,442	31,147	54.22
1961	43,714	24,215	55.39
1962	45,216	25,242	55.83
1963	45,383	25,576	56.36
1964	49,054	27,660	56.39
1965	52,053	29,510	56.69
1966	54,280	30,625	56.42

Table 8.—Iron ore [1] shipped from mines

(Thousand long tons)

Year	Direct shipping ore [2]	Concentrates			Total usable ore [3]	Proportion of concentrates to total usable ore (percent)
		Agglomerates	Other	Total		
1957–61 (average)	21,373	9,984	17,781	27,765	49,138	56.50
1962	11,466	14,085	18,744	32,829	44,295	74.11
1963	7,468	16,857	21,110	37,967	45,435	83.56
1964	10,441	19,267	19,917	39,184	49,626	78.96
1965	11,579	19,039	20,255	39,294	50,873	77.24
1966	12,863	21,580	20,690	42,270	55,133	76.67

[1] Exclusive of ore containing 5 percent or more manganese.
[2] Includes crushed, screened, and sized ore not further treated.
[3] Data may not add to some totals shown because of rounding.

Table 9.—Dates of first and final cargoes of iron ore at U.S. upper Great Lakes ports

Port and dock	1965		1966	
	First	Final	First	Final
Ashland, Wis.:				
C&NW	May 3	[1] Oct. 30	---	---
Soo Line	May 3	[1] Oct. 30	---	---
Duluth, Minn.: DM&IR	Apr. 19	Nov. 20	Mar. 30	Nov. 27
Escanaba, Mich.: C&NW	Apr. 7	Dec. 19	Mar. 31	Dec. 23
Marquette, Mich.:				
Soo Line	Apr. 26	Dec. 5	Apr. 26	Nov. 20
LS&I	Apr. 17	Dec. 12	Apr. 4	Dec. 13
Silver Bay, Minn.: Reserve	Apr. 23	Dec. 14	Apr. 8	Dec. 13
Superior, Wis.:				
GN	Apr. 24	Dec. 9	Apr. 11	Dec. 1
NP–Soo Line	Apr. 29	Oct. 25	Apr. 22	Oct. 24
Taconite Harbor, Minn.: Erie	Apr. 21	Dec. 9	Apr. 8	Dec. 10
Two Harbors, Minn.: DM&IR	---	---	May 20	Nov. 20

[1] Dock closed August 16 but reopened for October shipment making October 30 shipment figure final for 1965 season. Docks not utilized in 1966.

Source: Skillings' Mining Review.

The University of Minnesota Mines Experiment Station, the University's School of Mineral & Metallurgical Engineering, and the Minnesota Geological Survey began a drilling project south of the Mesabi Range to investigate and explore the deep-lying taconite formation. Plans were to drill 10 holes on State-owned lands in the area, at intervals of about 10 miles. Drilling began

December 21 at a site about 1½ miles south of Keewatin in Itasca County. The initial phase of the project was financed by a $100,000 grant from the Iron Range Resources & Rehabilitation Commission.

Manganiferous Ore.—Manganiferous ore shipments (containing 5 to 35 percent manganese, natural) decreased 2 percent from those of 1965. Shipments totaled 246,055 long tons consisting of 39,202 tons of direct-shipping ore and 206,853 tons of concentrates. Ninety-eight percent of the shipments were classified as ferruginous manganese ore (containing 10 to 35 percent manganese, natural), compared with 87 percent in 1965. Average natural iron and manganese contents of shipments were 34 and 13 percent, respectively.

Manganiferous ore was shipped from seven Cuyuna Range mines in Crow Wing County. Operating companies were The Hanna Mining Co. and Pittsburgh Pacific Co.

A method for recovering a high-grade manganese product from Cuyuna Range tailings by the R–N direct reduction process was developed by the University of Minnesota, Mines Experiment Station in a 2-year project sponsored by the Economic Development Administration and the Iron Range Resources & Rehabilitation Commission. The Mines Experiment Station also continued testing programs involving high intensity wet magnetic separation and flotation recovery processes.

At its Twin City Research Center, the Federal Bureau of Mines continued research in developing methods of utilizing Cuyuna Range low-grade manganese ores.

NONMETALS

Abrasive Stone.—Grinding pebbles and tube-mill liners were produced by Jasper Stone Co. from a quartzite deposit in Rock County. Quantity and value of grinding pebbles decreased from that of 1965. The quantity of tube-mill liners sold during the year increased significantly.

Cement.—Portland and masonry cements were manufactured at Duluth by Universal Atlas Cement Division of United States Steel Corp., the sole producer in the State. Production of portland cement increased over that of 1965 chiefly because of increased sales for highway construction. Sales of masonry cement reflected the decrease in residential construction with a decline in both quantity and value. Output of portland cement consisted of types I and II (general use and moderate heat) and portland-slag cement. Raw materials used in the manufacturing process were limestone from Michigan, sand, slag from the nearby blast-furnace operations, bauxite, gypsum, grinding aids, and air-entraining compounds. One 100-foot and two 200-foot rotary kilns were operated, using bituminous coal and natural gas for fuel. Shipments of portland and masonry cement were primarily to Minnesota consumers with lesser amounts shipped to Michigan, North Dakota, South Dakota, and Wisconsin.

Dundee Cement Co. began construction of a $1 million service and distribution center on the Upper Harbor of the Mississippi River at Minneapolis.

Clays.—Production of miscellaneous clay and shale was reported from Brown, Carlton, Goodhue, Hennepin, Ramsey, and

Table 10.—Shipments of usable[1] 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)	
1957–61 (average)	284,877	39.34	6.66	92,777	34.52	12.19	377,654
1962	129,979	40.40	6.19	131,431	33.28	12.60	261,410
1963	---	---	---	310,121	33.39	12.18	310,121
1964	27,725	36.59	9.68	140,562	32.61	12.38	168,287
1965	32,935	33.99	7.27	217,695	35.47	12.75	250,630
1966	4,035	33.55	8.61	242,020	33.87	14.12	246,055

[1] Direct-shipping and beneficiated ore.

Redwood Counties. Output increased 8 percent in both quantity and value over that of 1965. Chief reason for the increase was greater demand for raw material used in the manufacture of building brick and lightweight aggregate. A small quantity was also used in producing floor and wall tile.

Fire clay production, all of which was used in the manufacture of vitrified sewer pipe, decreased substantially from that of 1965. Red Wing Potteries, Inc., produced dinnerware and art pottery at Red Wing, chiefly from raw materials produced in other States.

The Minnesota Geological Survey continued investigating kaolin and other clay resources at numerous locations throughout the State to obtain information useful to individuals and industries interested in developing the State's clay potential.

The Federal Bureau of Mines conducted a sampling program near Cook, St. Louis County, to test the suitability of local clays as a binding agent for iron-ore pellets. Pelletizing tests were run at the Bureau's Twin Cities Metallurgical Research Center.

Gem Stones.—Minor quantities of semiprecious gem stones, principally agates, were collected by hobbyists. Gem materials were found chiefly along the north shore of Lake Superior, along the Mississippi River, and in gravel pits in the southeastern part of the State.

Lime.—Total shipments of quicklime and hydrated lime decreased about 4 percent in quantity and 1 percent in value from 1965.

American Crystal Sugar Co. produced quicklime for sugar refining at its plants at Chaska, Carver County; at Moorhead, Clay County; and at Crookston and East Grand Forks, Polk County, Minnesota's only commercial producer, Cutler-Magner Co., manufactured both quicklime and hydrated lime at its Duluth plant, using limestone transported by lake vessel from Michigan. Approximately 92 percent of the company's output was sold for chemical and industrial purposes, including paper manufacture, water purification, and metallurgical uses. Construction and agricultural uses made up the remainder. Most of the commercial production was consumed within the State, with lesser amounts shipped to Iowa, Michigan, North Dakota, and Wisconsin.

Perlite.—Crude perlite mined outside the State was expanded my Minnesota Perlite Corp. at Bloomington and by Zonolite Division, W. R. Grace & Co. (formerly Western Mineral Products Co.) at Minneapolis. Expanded perlite was used for lightweight aggregate in concrete and building plaster, filler, and soil conditioning. Production was less, both in quantity and value, than in 1965.

Sand and Gravel.—A record high was established for sand and gravel production. The 1966 output, 39.3 million tons, exceeded the previous record established in 1965 by 5 percent. Chief reason for the gain was a 3.7-million-ton increase in production of paving material. Sales of industrial sands increased 19 percent in quantity and 16 percent in value. Sand and gravel used for building declined 12 percent in quantity and 5 percent in value. Average value of all sand and gravel produced in Minnesota was $0.74 per ton, compared with $0.73 per ton in 1965. Production was reported from each of the 87 counties in the State. Counties producing over 1 million tons in descending order of production were Hennepin, Washington, Dakota, St. Louis, Carlton, and Clay. Collectively, these six counties comprised 38 percent of the State total. Ninety-two percent of the total commercial production was hauled by truck, 5 percent by river barge, and 3 percent by rail.

Stone.—Total stone output increased to a record 4.9 million tons, exceeding the previous record set in 1965 by 12 percent. A 16-percent increase in the value of crushed and broken stone production and a decrease of 15 percent in the value of dimension stone output resulted in an increase of less than 1 percent in total value. Greater demand for material used as roadstone and concrete aggregate was the major reason for the increase in crushed stone production.

Limestone was quarried from deposits in 15 southcentral and southeastern counties. Major producing counties in descending order of value were Blue Earth, Scott, Dakota, Washington, and Winona, collectively representing 60 percent of the State limestone value. Crushed and broken limestone production increased more than 20 percent in both quantity and value. The largest increases occurred in limestone used for concrete aggregate and roadstone, agricultural limestone, and railroad ballast. Eighty-seven percent of the commercial

Table 11.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	4,454	$3,461	3,702	$3,131
Paving	1,670	1,111	2,481	1,406
Fill	855	317	846	319
Railroad ballast	5	5	W	W
Other [1]	380	1,027	461	1,185
Total	7,364	5,921	7,490	6,041
Gravel:				
Building	3,319	4,896	3,123	4,342
Paving	13,786	8,962	15,920	10,562
Railroad ballast	357	165	405	249
Fill	1,951	951	1,010	382
Other	39	24	29	33
Total	19,452	14,998	20,487	16,068
Total sand and gravel	26,816	20,919	27,977	22,109
Government-and-contractor operations:				
Sand:				
Building	7	4	1	[2]
Paving	2,036	1,083	2,310	1,247
Fill	123	42	118	56
Other	36	12	14	6
Total	2,202	1,141	2,443	1,309
Gravel:				
Building	7	4	3	2
Paving	8,202	5,165	8,703	5,482
Fill	298	60	165	57
Other	20	7	40	13
Total	8,527	5,236	8,911	5,554
Total sand and gravel	10,729	6,377	11,354	6,863
All operations:				
Sand	9,566	7,062	9,933	7,350
Gravel	27,979	20,234	29,398	21,622
Total	37,545	27,296	39,331	28,972

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes blast, engine, filler, foundry, glass, molding, oil (hydrafrac), pottery, porcelain, tile, and other construction and industrial sand (1965–66), and railroad ballast (1966).
[2] Less than ½ unit.

crushed and broken limestone production was trucked, 12 percent was transported by water, and the remainder was shipped by rail. Dimension limestone production declined due to a decrease of more than 50 percent in the sales of house stone veneer. Cut stone represented 82 percent, in value, of all dimension limestone produced in the State.

Granite was produced in seven westcentral and central counties. The three largest producing counties in descending order of value were Stearns, Big Stone, and Lac qui Parle. Finishing plants were operated at Delano, Cold Spring, and St. Cloud. Operations of the North Star Granite Corp. were acquired by Cold Spring Granite Co. Sales of both crushed and broken and dimension granite declined substantially from that of 1965. Dimension granite production declined due to a lesser output of rough and dressed monumental stone. Crushed and broken granite production declined 44 percent in quantity and 20 percent in value. Decreases were reported in virtually all use patterns.

New Ulm Quartzite Quarries, Inc., produced crushed and broken quartzite from a deposit in Nicollet County for concrete aggregate and roadstone, filter uses, furnace and converter linings, poultry grit, railroad ballast, and riprap.

Crushed and broken basalt for use in concrete aggregate and roadstone was pro-

Table 12.—Granite sold or used by producers, by uses

Use	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough monumental—thousand cubic feet	W	W	21	$73
Dressed architectural—do	W	W	150	2,102
Dressed monumental—do	84	$1,217	74	1,089
Other—do	[1] 226	[1] 2,837	---	---
Total—approximate thousand short tons [2]	26	4,054	20	3,264
Crushed and broken:				
Concrete aggregate and roadstone thousand short tons	W	W	86	166
Railroad ballast—do	W	W	233	346
Other [3]—do	617	857	26	170
Total—do	617	857	345	682
Grand total—do	643	4,911	365	3,946

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes granite for dressed architectural and rough monumental use.
[2] Average weight of 166 pounds per cubic foot used to convert cubic feet to short tons.
[3] Includes granite for concrete aggregate and roadstone, railroad ballast, and fill (1965); and grit, stone sand, and riprap.

Table 13.—Limestone sold or used by producers, by uses

Use	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough construction—thousand short tons	W	W	(1)	$3
Rubble—do	W	W	---	---
Rough architectural—thousand cubic feet	W	W	9	40
Sawed—do	21	$96	32	157
House stone veneer—do	95	254	45	114
Cut—do	134	1,416	97	1,425
Flagging—do	W	W	13	1
Total—approximate thousand short tons [2]	24	1,847	16	1,740
Crushed and broken:				
Riprap—thousand short tons	159	100	151	198
Concrete aggregate and roadstone—do	3,043	3,713	3,706	4,377
Agriculture—do	293	466	324	518
Railroad ballast—do	7	10	44	60
Other [3]—do	57	343	99	433
Total [4]—do	3,560	4,631	4,323	5,585
Grand total [4]—do	3,583	6,478	4,339	7,324

W Withheld to avoid disclosing individual company confidential data; included with "Total."
[1] Less than ½ unit.
[2] Average weight of 160 pounds per cubic foot used to convert cubic feet to short tons.
[3] Includes limestone for fertilizer and other uses (1965), asphalt, flux, poultry grit (1965–66), and filter beds (1966).
[4] Data may not add to total shown because of rounding.

duced in St. Louis County by Arrowhead Blacktop Co. (formerly Zenith Dredge Co.).

A small quantity of marl was produced in Wadena County for agricultural purposes.

Sulfur.—At its Pine Bend refinery in Dakota County, Great Northern Oil Co. recovered elemental sulfur, as a byproduct, utilizing the Claus process. Shipments increased both in quantity and value compared with those of 1965.

Vermiculite.—Crude vermiculite mined outside the State was exfoliated by three firms in Minneapolis and St. Paul. Sales increased both in quantity and value, with the latter showing a larger increase. Material sold for lightweight concrete and plaster aggregate increased significantly, whereas that sold for insulation decreased. Sales

of exfoliated vermiculite for other uses, including masonry fill, litter, and acoustical purposes, remained approximately the same as in 1965.

MINERAL FUELS

Peat.—Seven companies in Aitkin, Carlton, Itasca, Otter Tail, Pine, and St. Louis Counties reported production. Moss and reed-sedge comprised over 99 percent of the State total with humus peat representing the remainder. Sales increased 55 percent in quantity and 60 percent in value, chiefly because of more favorable weather conditions than in 1965. Material was sold in bulk and packaged form for soil improvement and other horticultural purposes.

REVIEW BY COUNTIES

Mineral production was recorded from every county in the State. Due to its large-scale iron-ore operations, St. Louis County produced 77 percent of the State total mineral value. Itasca County ranked second, contributing 13 percent of the State total. Mineral values in 13 counties exceeded $1 million. Mineral value increased in 47 counties, decreased in 39, and in 1 county remained the same, compared with 1965. Nearly all increases and decreases, excluding the three major iron ore producing counties, were attributed to changes in demand for road construction materials.

Sand and gravel production was recorded in each of the 87 counties. In all but 3 (Goodhue, Ramsey, and Scott) of the 35 counties discussed in this section there was some sand and gravel production by and/or contracted for the State, county, and municipal highway departments. References to this output is not included in the individual county sections; discussion being limited to commercial operations only.

Aitkin.—Sand and gravel production for highway purposes totaled 145,000 tons, a 25-percent decrease from the previous year. Portable plants were operated by Dropps Bros. Construction, Inc., near Hill City; Megarry Bros., Inc., near Aitkin; and Ulland Bros., Inc., near McGrath.

Colby Pioneer Peat Co. and Jake McKodonski produced peat from bogs near Wawina and Hill City, respectively. Approximately 1,500 tons were produced, all of which was used for soil improvement. The peat operation of Kimball & Sons Co. near Hill City was inactive in 1966.

Big Stone.—Decreased output of dimension granite was the chief reason for the 15-percent drop in value of mineral production from 1965. Granite was quarried by Cold Spring Granite Co. at the Agate quarry near Ortonville, and by Delano Granite, Inc., at the Odessa quarry near Odessa. Processing plants were operated by the former at Cold Spring and St. Cloud and by the latter at Delano, producing finished stone for architectural and monumental purposes.

Approximately 311,000 tons of sand and gravel was produced for building and road construction. Hallett Construction Co. and Mark Sand & Gravel Co. operated pits near Odessa.

Blue Earth.—Value of mineral production increased 8 percent over that of 1965, chiefly because of greater output of sand and gravel. Dimension limestone was quarried near Mankato by Mankato Stone Co. and Vetter Stone Co., principally for architectural purposes. The latter company also produced broken limestone for riprap. Lundin Construction Co. and Mankato Ag Lime & Rock Co. produced crushed and broken limestone near Mankato for concrete aggregate and roadstone, agricultural limestone (aglime), and riprap.

About 673,000 tons of sand and gravel was produced for building and road construction purposes. Stationary plants were operated near Mankato by Guaranteed Gravel & Sand Co., Hiniker Sand & Gravel Co., and North Star Concrete Co. H. R. Loveall produced paving gravel at a portable plant near Beauford.

Brown.—Approximately 163,000 tons of sand and gravel was produced for building and road construction, less than half the 1965 output. As a result, value of mineral production decreased 35 percent compared with 1965. Fixed sand and gravel plants were operated by Roberts Bros. and Wallner Sand & Gravel near Sleepy Eye and New Ulm, respectively. Portable plants were operated by Carlson Bros., Inc., near Essig and New Ulm.

Table 14.—Value of mineral production in Minnesota, by counties

County	1965	1966	Minerals produced in 1966 in order of value
Aitkin	$170,800	$89,500	Sand and gravel, peat.
Anoka	W	251,000	Sand and gravel.
Becker	468,000	W	Do.
Beltrami	157,000	370,000	Do.
Benton	64,000	172,000	Do.
Big Stone	W	744,992	Stone, sand and gravel.
Blue Earth	1,528,448	1,654,522	Do.
Brown	319,593	206,306	Sand and gravel, clays.
Carlton	292,000	656,500	Sand and gravel, peat, clays.
Carver	419,926	505,690	Sand and gravel, lime.
Cass	169,331	94,000	Sand and gravel.
Chippewa	191,000	227,000	Do.
Chisago	115,000	W	Do.
Clay	1,540,827	1,764,093	Sand and gravel, lime.
Clearwater	129,000	64,000	Sand and gravel.
Cook	270,000	302,000	Do.
Cottonwood	117,000	155,000	Do.
Crow Wing	4,460,550	11,022,327	Iron ore, manganiferous ore, sand and gravel.
Dakota	2,145,585	2,941,187	Sand and gravel, stone.
Dodge	W	W	Stone, sand and gravel.
Douglas	74,000	551,000	Sand and gravel.
Faribault	410,000	205,000	Do.
Fillmore	W	W	Iron ore, stone, sand and gravel.
Freeborn	314,000	W	Sand and gravel.
Goodhue	385,781	476,206	Stone, sand and gravel, clays.
Grant	137,000	W	Sand and gravel.
Hennepin	4,299,500	3,707,000	Sand and gravel, clays.
Houston	96,696	W	Stone, sand and gravel.
Hubbard	35,000	13,000	Sand and gravel.
Isanti	41,000	35,000	Do.
Itasca	71,644,513	72,242,887	Iron ore, sand and gravel, peat.
Jackson	107,000	60,000	Sand and gravel.
Kanabec	619,700	136,000	Do.
Kandiyohi	369,000	438,000	Do.
Kittson	49,000	31,000	Do.
Koochiching	87,000	74,000	Do.
Lac qui Parle	520,852	539,878	Stone, sand and gravel.
Lake	115,000	115,000	Sand and gravel.
Lake of the Woods	108,000	89,000	Do.
Le Sueur	1,868,972	1,703,979	Sand and gravel, stone.
Lincoln	173,000	118,000	Sand and gravel.
Lyon	213,000	273,000	Do.
McLeod	143,000	177,000	Do.
Mahnomen	W	W	Do.
Marshall	195,000	W	Do.
Martin	254,000	158,000	Do.
Meeker	W	146,000	Do.
Mille Lacs	283,100	305,500	Stone, sand and gravel.
Morrison	193,000	224,000	Sand and gravel.
Mower	577,683	511,217	Stone, sand and gravel.
Murray	79,000	82,000	Sand and gravel.
Nicollet	569,095	606,434	Sand and gravel, stone.
Nobles	119,000	173,000	Sand and gravel.
Norman	146,000	123,000	Do.
Olmsted	646,685	743,573	Stone, sand and gravel.
Otter Tail	752,000	479,500	Sand and gravel, peat.
Pennington	183,000	W	Sand and gravel.
Pine	79,975	281,543	Sand and gravel, peat.
Pipestone	W	212,000	Sand and gravel.
Polk	1,002,014	874,264	Lime, sand and gravel.
Pope	88,000	119,000	Sand and gravel.
Ramsey	706,500	W	Sand and gravel, clays.
Red Lake	61,000	44,000	Sand and gravel.
Redwood	373,350	532,472	Sand and gravel, stone, clays.
Renville	531,600	524,300	Stone, sand and gravel.
Rice	344,154	406,512	Sand and gravel, stone.
Rock	588,410	452,163	Sand and gravel, abrasives.
Roseau	129,000	85,000	Sand and gravel.
St. Louis	389,850,510	423,257,480	Iron ore, cement, sand and gravel, lime, stone, peat.
Scott	1,270,998	1,255,058	Stone, sand and gravel.
Sherburne	143,000	377,000	Sand and gravel.
Sibley	157,000	W	Do.
Stearns	3,049,741	2,689,587	Stone, sand and gravel.
Steele	436,414	494,158	Sand and gravel, stone.
Stevens	W	W	Sand and gravel.
Swift	113,000	139,000	Do.
Todd	119,000	W	Do.
Traverse	21,000	36,000	Do.
Wabash	160,646	310,315	Sand and gravel, stone.
Wadena	61,280	66,040	Do.

See footnotes at end of table.

Table 14.—Value of mineral production in Minnesota, by counties—Continued

County	1965	1966	Minerals produced in 1966 in order of value
Waseca	$20,000	$49,000	Sand and gravel.
Washington	2,506,529	3,380,736	Sand and gravel, stone.
Watonwan	W	75,000	Sand and gravel.
Wilkin	42,000	29,000	Do.
Winona	896,943	1,104,197	Stone, sand and gravel.
Wright	33,000	207,000	Sand and gravel.
Yellow Medicine	399,000	314,886	Stone, sand and gravel.
Undistributed [1]	6,209,299	7,263,998	
Total	507,760,000	550,277,000	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes some sand and gravel and stone that cannot be assigned to specific counties, and values indicated by symbol W.

Ochs Brick & Tile Co. produced shale from a pit near Springfield. Material was used in the manufacture of building brick and lightweight aggregate.

Carlton.—Due to a greater demand for road construction materials, sand and gravel production increased to 1,076,000 tons. Seven companies operated pits near Barnum, Carlton, Cloquet, Cromwell, Moose Lake, and Scanlon and produced sand and gravel for road construction, building, fill, and railroad ballast.

At Moose Lake, Nemadji Tile & Pottery Co. produced clay used in manufacturing floor and wall tile. Moss (sphagnum) peat for soil improvement was produced by Red Wing Peat Corp. from a bog near Cromwell. All sales were in packaged form.

Carver.—About 460,000 tons of sand and gravel was produced, an increase of 29 percent over that of 1965. Production was used for road construction, building, and fill. Stationary plants were operated by Wm. Mueller & Sons near Hamburg and Rosenwinkel Sand & Gravel Co. near Chaska. Fairway Construction Co. operated a portable plant near New Germany. Hallett Aggregates, Inc., produced pit-run material near Chaska. American Crystal Sugar Co. produced quicklime for use in its sugar refining plant at Chaska.

Clay.—About 1,074,000 tons of sand and gravel was produced for building, highway purposes, and fill. Rollo & George Lewis operated a dredge near Sabin, producing 60,000 tons of paving gravel. Other producers were Ames Sand & Gravel, Inc., near Glyndon; Clay County Sand & Gravel Co., near Felton; Kost Bros., Inc., and Hubert Oye Construction Co., near Moorhead; Northern Improvement Co., near Felton and Sabin; and Ulven Gravel Co., near Hawley.

At Moorhead, American Crystal Sugar Co. produced quicklime for sugar refining.

Cook.—Approximately 8.6 million tons of taconite pellets were shipped by Erie Mining Co. from Taconite Harbor. Pellets were produced at the company's Hoyt Lakes plant, St. Louis County. The 1966 shipping season began at Taconite Harbor on April 8 and concluded on December 10.

Sand and gravel production increased to about 512,000 tons, a 13-percent increase from 1965. Edwin E. Thoreson, Inc., produced building sand and gravel near Taconite Harbor. Ulland Bros., Inc., produced material for road construction near Brule River, Grand Portage, and Hovland. The State and county highway departments produced and/or contracted for paving and fill material.

Crow Wing.—Value of mineral production in the county was more than 2½ times that of 1965. Iron-ore shipments were at the highest level since 1957, although shipments of manganiferous ore decreased 2 percent in both quantity and value.

Operating companies and mines from which iron and/or manganiferous ores were shipped were as follows:

Company:	*Mines*
The Hanna Mining Co	Algoma, Merritt No. 2, Rabbit Lake, and Robert.
Inland Steel Co	Armour No. 2.
Pittsburgh Pacific Co	Hopkins, Mangan No. 1, Mangan East, Sagamore, Sultana, Trojan, and Virginia Extension.

The Hanna Mining Co. constructed a washing plant at its Rabbit Lake mine near Cuyuna and dismantled the washing and sintering plant near its Portsmouth open-pit mine. Pittsburgh Pacific Co. be-

gan production from the Virginia Extension mine and reopened the Trojan Mine. Ores from these two operations were beneficiated at the Virginia plant, a central ore-treating facility for Cuyuna Range mines operated by Pittsburgh Pacific Co.

Inland Steel Co. announced plans to close the Armour No. 2 mine near Crosby, the remaining underground producer on the Cuyuna Range.

Approximately 309,000 tons of sand and gravel was produced for building, paving, fill, and other purposes. Commercial plants were operated near Garrison by Jay W. Craig Co., near Fort Ripley by Ripley Sand & Gravel, Inc., and near Brainerd by C. L. Stodolka Co., Inc., and Les Roberts Sand & Gravel.

Dakota.—Sand and gravel production increased to 2.9 million tons, a 28-percent increase over 1965. Output was used for building, road construction, fill, and other uses. Portable plants were operated by Alexander Construction Co., Inc., near Rosemount and South St. Paul; B-Tu-Mix Co., near Inver Grove Heights; Fischer Construction Co., Inc., near Rosemount; Kimmes Bartelma Construction Co., Inc., near Burnsville, Hastings, and Lakeville; Edward Kraemer & Sons, Inc., near Savage; and Solberg Construction Co. near South St. Paul. Fixed plants were operated by Fischer Sand & Aggregate, Inc., near Rosemount; Northwestern Gravel Co., Inc., near Savage; and Standard Building Material Co. near South St. Paul.

Crushed and broken limestone was produced by Chicago, Milwaukee, St. Paul & Pacific Railroad Co. and Mann Construction Co., both near Hastings, and Edward Kraemer & Sons, Inc., at its Burnsville quarry. Sulfur was recovered as a byproduct at the Great Northern Oil Co. Pine Bend refinery.

Fillmore.—Iron-ore shipments from Fillmore County mines totaled 575,223 long tons, an increase of 3 percent from 1965. Virtually the entire output was shipped all-rail to consuming furnaces at Granite City, Ill. Shipments totaling 524,758 tons were made by The Hanna Mining Co. from its Spring Valley mine group. The remainder was shipped by Schroeder Mining Co. from the Mathison mine.

Seven companies, operating stationary and portable plants near Chatfield, Fountain, Hamony, Lanesboro, Ostrander, Preston, and Spring Valley, produced approximately 381,000 tons of crushed and broken limestone for concrete aggregate and roadstone, aglime, and riprap.

About 49,000 tons of sand and gravel was produced by Bothun & Tongerson Sand & Gravel near Lanesboro, Thompson Sand & Gravel near Rushford, and by the State highway department. Output was used for building, highway construction, and fill.

Goodhue.—Output of crushed and broken limestone increased 64 percent to approximately 349,000 tons, resulting in a 23-percent increase in value of county mineral production over 1965. The material was used for concrete aggregate and roadstone, aglime, and riprap. Portable plants were operated by Kielmeyer Construction Co. near Kenyon; Mann Construction Co. near Cannon Falls, Goodhue, Red Wing, Wanamingo, and Zumbrota; and Quarve & Anderson Co. near Aspelund, Cannon Falls, Roscoe, Wanamingo, and Zumbrota. Valley Limestone Co. operated a stationary plant near Zumbrota.

Sand and gravel production, about 79,000 tons, was approximately half the 1965 output. Material was used for building, road construction, and fill. Stationary plants were operated by six companies near Cannon Falls, Frontenac, Lake City, Pine Island, Red Wing, and Zumbrota. Mann Construction Co. produced paving gravel with a portable plant near Red Wing.

Plastic fire clay was produced near Goodhue by Red Wing Sewer Pipe Corp. at its Bellchester and North Star pits. Material was used in the manufacture of vitrified sewer pipe at the company's Red Wing plant.

Hennepin.—Despite an 11-percent decrease in quantity, the county continued to rank first in production of sand and gravel with 4.5 million tons. Decreases in production were recorded for building, road construction, fill, and other purposes. Nearly all production was centered in Minneapolis suburban areas. Commercial producers included Alexander Construction Co., Inc.; Anderson Aggregate Inc., Commercial Aggregate, Inc.; Consolidated Materials Co. (Hedberg & Sons Co.); J. A. Danens & Son, Inc.; Dunkley Surfacing Co.; Chas. M. Friedheim Co.; Glacier Sand & Gravel Co.; J. V. Gleason Co., Inc.; F. W. Hedberg & Sons Co.; Mapco Sand & Gravel Co.; and R. J. Potter Inc.

North Central Lightweight Aggregate Co., Inc., produced clay for lightweight aggregate at its Minneapolis plant.

Minnesota Perlite Corp. and Zonolite Division, W. R. Grace & Co. (formerly Western Mineral Products Co.) operated plants at Bloomington and Minneapolis, respectively, and expanded perlite from crude material mined outside the State. The expanded product was used for building plaster, concrete aggregate, soil conditioning, and filler. B. F. Nelson Manufacturing Co. and Zonolite Division, W. R. Grace & Co. produced exfoliated vermiculite from crude material mined outside the State. Sales of the exfoliated product were for aggregate in concrete and plaster, loose-fill insulation, fireproofing, pet litter, acoustical purposes, and miscellaneous uses.

Dundee Cement Co. began construction of a $1 million distribution center on the Upper Harbor in Minneapolis. The center will be one of several supplied by the company's plant now under construction at Clarksville, Mo.

Itasca.—Itasca County ranked second in total value of mineral production, comprising 13 percent of the State total. Iron-ore shipments, representing 17 precent of the State total tonnage, increased 2 percent over 1965. Approximately 99 percent of the iron-ore shipments were concentrates. All opreating mines were open pits. Operating companies and mines from which iron ore was shipped were as follows:

Company:	*Mines*
Cleveland-Cliffs Iron Co	Canisteo, Hill-Trumbull, Holman-Cliffs, and Sally.
The Hanna Mining Co	Harrison group, Hunner, Mississippi group, and Patrick group.
Jessie H. Mining Co	Jessie No. 2.
Jones & Laughlin Steel Corp	Hill Annex and Lind-Greenway.
Pickands Mather & Co	Danube and West Hill.
United States Steel Corp. Minnesota Ore Operations	Plummer group.

The two taconite plants of The Hanna Mining Co. near Nashwauk and Keewatin with a combined initial capacity of 4.4 million tons of pellets neared completion. At the yearend, preoperational equipment testing was being conducted at Butler Taconite Project near Nashwauk. Participating in the project with The Hanna Mining Co. were Inland Steel Corp. and Wheeling Steel Corp. Production was to be shared on a percentage basis. The plant will produce oxide pellets using the Allis-Chalmers grate-kiln process. Construction continued at the National Steel Pellet Plant near Keewatin. This plant, with an annual capacity of 2.4 million tons of pellets, was scheduled for operation in 1967. National Steel Corp. has an 85-percent interest and The Hanna Mining Co. has a 15-percent interest in the venture. The plant will be capable of producing either oxide or prereduced pellets using a Midland-Ross designed rotary hearth furnace. Autogenous grinding methods will be employed at both operations. Stripping operations were conducted by the company at the Kevin mine which will supply crude ore to the Butler Taconite Project. Crude taconite will be mined at the Section 18 mine, a depleted natural ore operation, to supply the National Steel Taconite Plant. The company has installed 60-inch gyratory primary crushers at each of the above mines. The Hanna Mining Co. made stockpile shipments of concentrates from the Harrison, Mississippi, and Patrick groups.

Cleveland-Cliffs Iron Co. reopened the Morrison mine—last operated in 1953 by Oliver Iron Mining Division of United States Steel Corp. The Morrison was operated in conjunction with the adjacent Canisteo mine near Coleraine. Jones & Laughlin Steel Corp. reactivated its Hill-Annex semitaconite plant at Calumet, which had been closed in 1964. Mining operations were discontinued by Jessie H. Mining Co. at its Jessie No. 2 mine. Stocks of concentrate remain at the property. United States Steel Corp. conducted only stripping operations at its Arcturus mine near Taconite.

A total of 607,000 tons of sand and gravel was produced for building, highway construction, and fill. Plants were operated by Brink Sand & Gravel Co., and Megarry Bros., Inc., both near Grand Rapids; and Hawkinson Construction Co., Inc., near Cohasset, Coleraine, Grand Rapids, Marble, and Taconite.

Arrowhead Peat Co. produced moss peat for horticultural purposes from a bog near Wawina.

Lac qui Parle.—Bellingham Granite Co. and Northern Quarry Corp. quarried granite for monument use near Bellingham and

Louisburg, respectively. Near Odessa, Cold Spring Granite Co. produced granite at its Red quarry. The company operated finishing plants at Cold Spring and St. Cloud, both in Stearns County, producing stone for architectural and monumental purposes. The Cold Spring Granite Co. acquired the North Star Granite Corp. and operated the former North Star Medallion Quarry No. 9 Production from this quarry was placed in stockpile. Dakota Granite Corp. quarried granite from a quarry near Bellingham and shipped the rough stone to its Milbank, S. Dak. plant for finishing.

Due to an increase in contract production for the county highway department, sand and gravel output was about 285,000 tons, more than double that of 1965. Johnson Road Co., Inc., and Mahnomen Construction Co. operated portable plants and produced paving gravel. W. J. Stolpman produced 15,000 tons of sand and gravel near Rosen, for building, paving, and fill.

Lake.—Reserve Mining Co. completed an expansion program at its Silver Bay pellet plant, increasing annual capacity to 10.7 million tons. The company shipped 31 million tons of crude taconite from the Peter Mitchell mine near Babbitt, St. Louis County, to its Silver Bay plant and produced a record 10.8 million tons of iron ore pellets. Output exceeded the previous record set in 1965 by 8 percent. The Duluth, Missabe, & Iron Range Railroad Co. reactivated its Two Harbors iron ore docks which were idle since 1962.

Sand and gravel production totaled 186,000 tons, about the same as in 1965. Paving gravel was produced by Ulland Bros., Inc., who operated portable plants near Finland, Isabella, and Little Marais. Two Harbors Aggregate Co. (North Shore Investment Co.) operated a stationary plant near Two Harbors and produced sand and gravel for building purposes and fill.

Extensive exploration activity for copper-nickel was conducted in the Duluth gabbro area by several major mining companies. The International Nickel Co., Inc., announced that it was studying the feasibility of constructing a mining and milling operation, about 8 miles southeast of Ely, capable of producing 125 million pounds of copper-nickel each year. The company shipped a 1,300-ton bulk ore sample to its Copper Cliff Laboratory, near Sudbury, Ontario, Canada, for metallurgical research.

Le Sueur.—Value of mineral output declined 9 percent from that of 1965. Near Kasota, The Babcock Co. quarried dimension limestone for architectural purposes. Some of the output was marketed as marble for interior trim and facings. Ed Swartout, Inc., produced roadstone and riprap at a limestone quarry near Kasota.

Approximately 776,000 tons of sand and gravel was produced. Silica sand was produced by Gopher State Silica, Inc., from the Jordan Sandstone formation. Material was used for glass manufacture, molding, engine sand, oil-field fracturing, filler, foundry uses, and other purposes. Glander Washed Sand & Gravel Co. operated a fixed plant near Le Sueur and produced material for building, paving, fill, and other purposes. Portable plants were operated by Ed Swartout, Inc., near Kasota; H. R. Loveall, near Waterville; and Lundin Construction Co., Inc., near Kasota. Material produced was used for building, paving, and fill.

Mille Lacs.—Cold Spring Granite Co. operated the Diamond Grey quarry near Isle. The company operated finishing plants at Cold Spring and St. Cloud, both in Stearns County, producing finished stone for architectural and monumental purposes.

Production of sand and gravel was approximately 186,000 tons. Carlson Bros., Inc., produced paving gravel, operating portable plants at four pits near Milaca and Princeton. Mille Lacs Sand & Gravel Co. operated a stationary plant near Milaca and produced building and road construction material. Paving material was produced and/or contracted for by the State and county highway departments.

Mower.—Value of mineral output decreased 12 percent, mainly because of a decline in production of crushed and broken limestone. Hickok Calcium White Rock Co. produced limestone for flux and poultry grit with a stationary plant near Le Roy. Martin Bustad & Son operated a stationary plant near Austin, and Osmundson Bros. operated a portable plant near Grand Meadow. Both companies produced crushed limestone for road use and aglime.

About 255,000 tons of sand and gravel was produced for road construction, fill, and other uses. Producers included Os-

mundson Bros. near Adams; and Martin Bustad & Son, Lea Sand & Gravel, and Ulland Bros., Inc., all near Austin.

Nicollet.—About 549,000 tons of sand and gravel was produced for building, paving, and fill. Portable plants were operated near St. Peter by Duininck Bros. & Gilchrist, and near Cambria and Courtland by H. R. Loveall. Courtland Ready Mix, Hallett Construction Co., and North Star Concrete Co. operated fixed plants near Courtland, St. Peter, and Judson, respectively.

Crushed and broken quartzite was produced near New Ulm by New Ulm Quartzite Quarries, Inc., for refractory purposes, concrete aggregate and roadstone, railroad ballast, filter use, riprap, and other purposes.

Olmsted.—Value of mineral production increased 15 percent over 1965, mainly because of a greater demand for crushed and broken limestone. Quarve & Anderson Co. operated eight quarries near Byron, Rochester, and Rockdell. Patterson Quarries, Inc., operated its quarry near Eyota. Both companies operated portable plants producing crushed and broken limestone for roadstone and aglime.

Sand and gravel production totaled 355,000 tons, a 3-percent decrease compared with 1965. Stationary plants were operated by Quarve & Anderson Co., Riverside Sand & Gravel Co., and Rochester Sand & Gravel Co., all near Rochester. Output was used for building, road construction, fill, and other uses.

The Baker property, from which Schroeder Mining Co. produced iron ore in 1965, was inactive.

Otter Tail.—Sand and gravel production decreased 50 percent to about 666,000 tons. Major reason for the decrease was a smaller output of road construction material. Plants were operated near Battle Lake, Bluffton, Dalton, Fergus Falls, Foxhome, Henning, New York Mills, Pelican Rapids, Underwood, and Vergas. Producers included J. D. Nelson Excavating Co.; John Dieseth Co.; Thomas Leo Horstman; K. & G Aggregates, Inc.; Mark Sand & Gravel Co.; the Soo Line Railroad Co.; and the State and county highway departments. Output was for building and road construction, railroad ballast, fill, and other uses.

Northland Products Co., Inc., produced moss peat for soil improvement from a bog near Underwood.

Polk.—Sand and gravel production decreased 43 percent to 431,000 tons, and resulted in a 13-percent decline in value of mineral output in the county. Plants were operated by five companies near Crookston, Euclid, Fertile, and Trail, and by the county highway department. Output was for building, road construction, railroad ballast, fill, and other uses.

American Crystal Sugar Co. produced quicklime at Crookston and East Grand Forks for use in supar refining. All production was from shaft kilns, utilizing coke as fuel.

Ramsey.—Value of county mineral production declined substantially from that of 1965, chiefly because of a 24-percent decrease in value of sand and gravel output. Arsenal Sand & Gravel Co. operated a fixed plant at New Brighton. Portable plants were operated by Alexander Construction Co., Inc., near North St. Paul and St. Paul; and Duininck Bros. & Gilchrist near Little Canada. Output was used for building, road construction, and fill.

Twin City Brick Co. produced 25,000 tons of shale for the manufacture of building brick. Exfoliated vermiculite was produced by MacArthur Co. in St. Paul from crude material mined outside the State. Output was used for aggregate in concrete and plaster, building insulation, and steam pipe insulation.

Redwood.—Due primarily to an increased output of sand and gravel, value of mineral production increased substantially from that of 1965. About 776,000 tons of sand and gravel was produced for building, road construction, fill, and other purposes. Chapman Sand & Gravel Co. and Walnut Washed Sand & Gravel operated fixed plants near Belview and Walnut Grove, respectively. Portable plants were operated by Carlson Bros., Inc., near Vesta and Delhi; Duininck Bros. & Gilchrist, near Redwood Falls; and Werner & Unzeitig near Lamberton.

Johnson Quarry Co. and View Quarry Co. produced granite near Belview for monument purposes. Miscellaneous clay was produced near Redwood Falls by Ochs Brick & Tile Co. for manufacturing building brick at its Springfield plant.

Renville.—Cold Spring Granite Co. quarried granite from its Rainbow quarry near Morton. The company operated finishing plants at Cold Spring and St. Cloud, both in Stearns County, producing finished stone for architectural and monument purposes.

Approximately 408,000 tons of sand and gravel was produced in the county, a 5-percent increase over 1965 output. The material was used for building and road construction. Commercial producers included Danube Washed Sand & Gravel Co., near Danube; Duininck Bros. & Gilchrist, near Renville; John Enestvedt, near Sacred Heart; Fairway Construction Co., near Hector and North Redwood; and Morton Aggregates, Inc., near Morton.

Rice.—Sand and gravel production was approximately 421,000 tons and was used principally for building, road construction, and fill. Owatonna Aggregate Corp. operated a fixed plant, whereas Charles W. Bickel and Kielmeyer Construction Co. operated portable plants. Pit run material was produced by Condon Sand & Gravel and Hallett Construction Co. Operations were located near Dundas, Faribault, and Northfield.

Nearly 102,000 tons of crushed and broken limestone was produced for roadstone, aglime, and riprap. Producers were Bryan Rock Products, Inc., B. H. Heselton Co., and Kielmeyer Construction Co. Material was produced at portable plants located near Faribault, Nerstrand, and Northfield.

Rock.—Jasper Stone Co. produced grinding pebbles and tube-mill liners from a quartzite deposit near Jasper. Finished products were sold for industrial grinding of feldspar, silica sand, paint, ceramics, and other materials that would be affected by iron contamination.

Sand and gravel production was about 413,000 tons and was used for building, road construction, and fill. Production was reported by three commercial producers with pits near Luverne and Leota.

St. Louis.—Value of mineral output in St. Louis County increased $33.4 million to $423.3 million. Iron-ore shipments—representing 98 percent of the total mineral value in the county—increased 9 percent in value over 1965. Eighty percent of the total iron-ore shipments in the State were from mines in St. Louis County. Companies shipping iron ore in 1966 were as follows:

	Mines
Mesabi Range:	
The Hanna Mining Co	Agnew No. 2-South Agnew, Douglas group, Morton-South Eddy, and Pierce group.
Inland Steel Co	Dean.
Jones & Laughlin Steel Corp	Schley group.
Oglebay Norton Co. (Eveleth Taconite Co.)	Thunderbird.
Pacific Isle Mining Co	Higgins No. 2.
Pickands Mather & Co	Erie Commercial, Mahoning, and Remer Stockpile.
Pittsburgh Pacific Co	Arne, Corsica Lean-ore Stockpile, Corsica-Douglas Lean-ore Stockpile, Embarrass Lean-ore Stockpile, Leonidas, Lincoln, Minnewas, Nelson, Stevenson Reserve, Syracuse, and Wyoming Annex.
Reserve Mining Co	Peter Mitchell.
Rhude & Fryberger	Hull-Rust and Wade.
Snyder Mining Co.	Kosmerl Lease Area, Wanless, Whiteside, and Woodbridge.
United States Steel Corp. Minnesota Ore Operations	Kosmerl, Pilotac, Rouchleau group, Sherman group, and Stephens.
Vermilion Range:	
United States Steel Corp. Minnesota Ore Operations	Pioneer.

Erie Mining Co. (Pickands Mather & Co., operating agents) mined over 24 million tons of crude taconite near Hoyt Lakes. Development work was conducted on the company's area No. 9 about 6 miles west of Hoyt Lakes, which originally was used to supply Erie Mining Co.'s preliminary plant. At the Hoyt Lakes plant, the firm produced 8.6 million tons of taconite pellets, exceeding the record set in 1965 by 7 percent. The pellets were shipped 73 miles on the company-owned railroad to the company's shipping port at Taconite Harbor. Work continued on a $50 million expansion program designed to increase annual pellet production capacity to 10.3 million tons in 1967.

At its Peter Mitchell mine near Babbitt, Reserve Mining Co. mined about 31 million tons of crude taconite, increasing its accumulative total to more than 200 million tons since initial production in 1952. Ore was crushed to about 3-inch size at the mine and transported on the 47-mile company-owned railroad to the Silver Bay

plant for further crushing, concentrating, and pelletizing.

Eveleth Taconite Co., owned by Ford Motor Co. (85 percent) and Oglebay Norton Co. (15 percent), completed the first year of operations at its Fairlane pellet plant near Forbes. Capacity of the plant was 1.6 million tons of pellets per year. Crude taconite was shipped to the plant by rail from the company's Thunderbird mine located 10 miles to the north.

United States Steel Corp. continued to operate its Pilotac mine and plant near Mountain Iron. Concentrates were shipped to the company's Extaca plant near Virginia for agglomeration. Construction continued at United States Steel Corp.'s 4.5-million-ton-per-year pellet plant on the Continental Divide north of Mountain Iron. Completion was scheduled for 1967.

Jones & Laughlin Steel Corp.'s proposed 2-million-ton-per-year pellet plant near Biwabik was in design stage.

Rhude & Fryberger leased the Gross-Nelson property from United States Steel Corp. The company conducted stripping operations at the site and began construction of a 500-ton-per-hour washing plant. At McKinley, Jones & Laughlin Steel Corp. also leased a natural ore deposit from United States Steel Corp. Plans were to develop an open-pit mine to be in operation in 1968.

Pittsburgh Pacific Co. reported cancellation of the following leases: Corsica Lean-ore Stockpile, Nelson, Stevenson Reserve, Embarrass Lean-ore Stockpile, Minnewas, Syracuse, South Stevenson, and Susquehanna Lean-ore Stockpile.

Natural ore mines producing and shipping more than 1 million long tons in decreasing order of shipments were the Sherman group, Stephens, and Rouchleau group, all operated by United States Steel Corp.; the Mahoning, operated by Pickands Mather & Co.; and the Schley group, operated by Jones & Laughlin Steel Corp.

United States Steel Corp. announced plans to close its Pioneer mine near Ely early in 1967. The Pioneer was the only operating underground mine in the county in 1966 and the sole producer on the Vermilion Range.

Hallett Minerals Co. began construction of a plant at Burnett to process crude bentonite from Montana for use as a binder for taconite pellets. Estimated initial capacity of the plant was 25 tons per hour, with provision for future expansion.

At yearend, the 175-ton-per-day oxygen plant at Babbitt of Union Carbide Corp.'s Linde Division was nearing completion. Scheduled to go on stream in January, 1967, the plant will be a central oxygen supplier for jet-piercing drills operating at various taconite operations on the Mesabi Range.

American Steel & Wire Division of United States Steel Corp. produced basic pig iron and steel at Duluth. During periods of maximum production, two blast furnaces were operated. Nine open hearths were available for steel production.

Universal Atlas Cement Division of United States Steel Corp. produced portland and masonry cements at its Duluth plant. Raw materials used included limestone shipped from Michigan and slag from the nearby blast furnaces. The company was the only producer of cement in the State.

Quicklime and hydrated lime were produced by Cutler-Magner Co., from Michigan limestone at its Duluth plant. The company operated a rotary kiln, utilizing bituminous coal as fuel. Output was used for paper manufacture, agricultural purposes, mason's lime, soil stabilization, paint, petroleum refining, steel manufacturing, and water purification and softening.

Reed-sedge peat was produced by Power-O-Peat Co. (formerly Mesabi Grow Co., Inc.) near Central Lakes. Output was sold in packaged form for general soil improvement and ingredient for potting soils.

Production of sand and gravel was 2.1 million tons, a marked decrease from that of 1965. Material was used for building, paving, railroad ballast, fill, and other purposes. Seventeen companies operated stationary and portable plants at various locations.

Arrowhead Blacktop Co. (formerly Zenith Dredge Co.) produced crushed and broken basalt for concrete aggregate and roadstone at a quarry near Duluth.

Scott.—More than 397,000 tons of crushed and broken limestone was produced for concrete aggregate and roadstone, aglime, railroad ballast, asphalt filler, and riprap. Producers were B & R Rock Products, Bryan Rock Products, Inc., both near Shakopee, and J. L. Shiely Co. near Savage.

Sand and gravel production declined to 280,000 tons. Output was used for building, road construction, sandblasting, and fill. Fixed plants were operated by Belle Plaine Sand & Gravel Co., near Belle Plaine; Haferman & Stark, Inc., and Shakopee Sand & Gravel Co., near Shakopee; and Minnesota Quartz Co., near Jordan. Wissota Sand & Gravel Co. operated a portable plant near New Market.

Stearns.—Value of mineral production decreased 12 percent, chiefly becuase of declines in output of both crushed and broken and dimension granite. Cold Spring Granite Co. operated five quarries near Cold Spring, Rockville, St. Cloud, and St. Joseph. The company operated finishing plants at Cold Spring and St. Cloud where rough stone was processed for architectural and monument purposes. Poultry grit, traction sand, and bituminous aggregate were produced as byproducts from stone finishing wastes. North Star Granite Corp. was acquired by Cold Spring Granite Co., who continued operations at the former company's St. Cloud finishing plant but did not operate the Minnesota Pink and Pioneer Gray quarries. Delano Granite, Inc., quarried granite at its Rockville quarry and processed the rough blocks at its Delano plant. Output was sold for architectural purposes. Crushed and broken granite was produced near Waite Park by Shiely-Petters Crushed Stone Co., Inc., for concrete aggregate and roadstone, railroad ballast, and stone sand.

About 451,000 tons of sand and gravel was produced, chiefly for building and road construction. A. C. Petters Co., Inc., and Richmond Sand & Gravel Co. produced sand and gravel near St. Cloud and Richmond, respectively.

Washington.—The county ranked second in the State in sand and gravel production, with output of nearly 3.5 million tons. Material was used for building, road construction, railroad ballast, and fill. Commercial producers included Alexander Construction Co., Inc.; Kimmes Bartelma Construction Co., Inc.; Cemstone Products Co.; Commercial Aggregates, Inc.; Jay W. Craig Co.; R. J. Jager Gravel Co.; Carl Olinger; and J. L. Shiely Co. Plants were operated near Forest Lake, Hugo, Lake Elmo, Lakeland, Newport, Scandia, St. Paul Park, Stillwater, and White Bear Lake.

Bryan Rock Products, Inc., Schumann Contracting Co. (who purchased the quarry formerly operated by Nienaber Contracting Co.), and J. L. Shiely Co. produced crushed and broken limestone near Marine-on-St. Croix, Lake Elmo, and St. Paul Park, respectively. Output was used for concrete aggregate and roadstone, aglime, railroad ballast, and filter beds.

Winona.—Value of mineral production increased 23 percent to $1.1 million, chiefly because of greater demand for road building materials. Biesanz Stone Co., Inc., produced dimension limestone for architectural purposes at its Winona quarry. Lloyd Debold, Fakler Road Construction, Inc., Hector Construction Co., Inc., and Patterson Quarries, Inc., produced crushed and broken limestone for road construction and aglime. Portable plants were operated near Dresbach, La Crescent, Lewiston, Rollingstone, St. Charles, Wilson, and Witoka. The Spitzer quarry, operated by Patterson Quarries, Inc., was depleted in 1966.

Biesanz Sand & Gravel Co. and Winona Aggregate Co. (Wissota Sand & Gravel Co.) operated stationary plants near Winona and produced sand and gravel for building, road construction, and fill.

Wright.—Delano Granite, Inc., operated its sawing and finishing plant at Delano, producing architectural and monument granite from rough blocks quarried in Big Stone and Stearns Counties. Approximately 356,000 tons of sand and gravel was produced for building and road construction. Rockite Gravel Co. operated a fixed plant near South Haven. Portable plants were operated by Jay W. Craig Co. near Rockford and Duininck Bros. & Gilchrist near Delano. Victor Johnson produced pit-run material near South Haven.

Yellow Medicine.—Crushed and broken granite for riprap and railroad ballast was produced near Granite Falls by The Green Co., Inc., contractor for the Great Northern Railway Co. Delano Granite, Inc., did not operate its Signet quarry in 1966. About 203,000 tons of sand and gravel was produced for building, road construction, and fill. Deutz & Crow Co., Inc., operated its fixed plant near Canby. Portable plants were operated near Clarkfield and Granite Falls by Johnson Road Co., Inc., and Duininck Bros. & Gilchrist.

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 Survey for collecting information on all minerals except fuels.

By Nicholas A. Kendall [1] and William H. Moore [2]

Value of Mississippi mineral production increased slightly to $211.4 million. Mineral fuels—petroleum, natural gas, and natural gas liquids—represented 83 percent of the total value.

Construction of the Mississippi Power and Light Co.'s 550,000-kilowatt Baxter Wilson steam-electric station near Vicksburg was completed in December. The generating plant will require an average of 110 million cubic feet of gas daily for fuel.

Comprehensive studies initiated in 1963 for overall development of water resources of the Pearl and Pascagoula River Basins continued. Area IV Mineral Resource Office of the Federal Bureau of Mines transmitted to the U.S. Army Corps of En-

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[2] Director, Mississippi Geological Survey, Jackson, Miss.

Table 1.—Mineral production in Mississippi [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Clays—thousand short tons	1,502	r $6,997	1,727	$7,489
Natural gas—million cubic feet	166,825	28,861	156,652	27,257
Natural gas liquids:				
Natural gasoline and cycle products—thousand gallons	26,582	1,606	23,765	1,483
LP gases—do	22,150	975	18,621	987
Petroleum (crude)—thousand 42-gallon barrels	56,183	148,437	55,227	146,353
Sand and gravel—thousand short tons	8,447	8,717	[2] 12,675	13,563
Stone [3] (includes shell)—do	2,357	2,358	1,532	1,641
Value of items that cannot be disclosed: Cement, iron ore, lime, magnesia, stone	XX	r 12,082	XX	12,587
Total	XX	r 210,033	XX	211,360

r Revised. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Increase in production in 1966 due mainly to expanded coverage.
[3] Excludes certain stones included in "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]	Year	Value [1]
1957	$143,932	1962	$209,622
1958	151,731	1963	216,913
1959	188,841	1964	211,493
1960	199,297	1965	208,597
1961	210,336	1966	p 205,800

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[1] Data for 1957–65 revised.

Table 3.—Wage and salaried workers in petroleum production, refining, and related industries

Year	Crude petroleum and natural gas production	Petroleum refining [1]	Pipeline transportation (except) natural gas)	Gas utilities	Retail filling stations	Chemicals manufactured as byproducts of petroleum or used in refining petroleum [2]
1962	5,232	392	202	2,376	4,850	92
1963	5,548	586	178	2,292	4,900	366
1964	5,300	700	150	2,300	5,250	300
1965	4,800	710	155	2,290	5,300	380
1966	4,700	750	100	2,300	5,300	410

[1] Employment in petroleum refineries and petrochemicals manufactured in petroleum refineries.
[2] Employment in petrochemical manufacturing facilities located outside petroleum refineries.
Source: Mississippi Employment Security Commission.

gineers a report entitled "Potential Mineral Cargo, Pearl River Waterway, Mississippi and Louisiana."

Prospective markets for lime improved during the year, as three major paper companies announced plans for, or had under construction, paper manufacturing plants costing a total of $210 million. Lime is important in the papermaking process.

Employment and Injuries.—Overall miner-

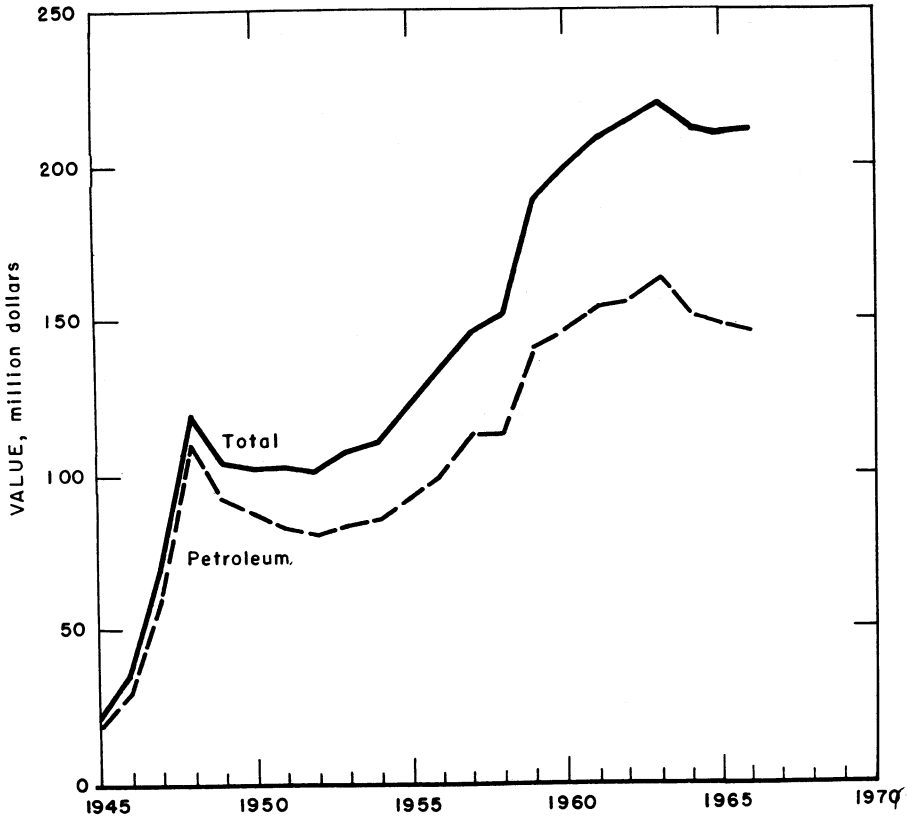

Figure 1.—Value of petroleum and total value of mineral production in Mississippi.

Table 4.—Employment 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
1965:								
Metal and nonmetal	963	257	248	2,011	--	46	22.87	1,176
Sand and gravel	540	263	142	1,223	--	22	17.99	473
Stone	304	297	90	729	--	6	8.23	156
Total	1,807	266	480	3,963	--	74	18.67	772
1966: p								
Metal and nonmetal	875	251	219	1,755	--	55	31.34	5,303
Sand and gravel	565	264	148	1,339	--	25	18.67	504
Stone	300	291	87	698	--	9	12.89	315
Total	1,740	261	454	3,792	--	89	23.47	2,690

p Preliminary.

al industry employment decreased 3.5 percent and constituted 1.1 percent of the nonagricultural labor force, according to the Mississippi Employment Security Commission. Employment in petroleum and natural gas industries dropped 6.4 percent and constituted 82 percent of the labor force in mineral industries.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Combined value of natural gas, natural gas liquids, and crude petroleum declined for the third consecutive year. It comprised 83 percent of the value of total mineral production, compared with 86 percent in 1965.

Mississippi again ranked ninth among the oil-producing States. The six leading petroleum-producing counties were Jasper, Adams, Pike, Jones, Lamar, and Franklin, in descending order.

Total drilling activity increased 2 percent, in contrast to a national decline of 11.6 percent. Average depth of all holes drilled was 7,608 feet, 223 feet less than in 1965; total footage drilled remained virtually unchanged at 5.9 million feet, according to The Oil and Gas Journal.

There were 28 new field discoveries; Mercer, Natchez Ferry, Fairchilds Creek, Painters, Greens Bayou, Cloverdale, North Cowpen Point, Cotton Valley, Pleasant Hill, and Mistletoe in Adams County; Panther Creek, South Providence, Spring Hill, and East Franklin in Franklin County; East Paulding in Jasper County; Calvits Lake (gas) and Stampley in Jefferson County; West McComb in Pike County; Pearl in Rankin County; Tallahalla Creek and Shongelo Creek in Smith County; West Clara (dual oil completion) in Wayne County; Day Creek, Hazlit Creek, North Mud Creek, Old River, and Elliston in Wilkinson County; and Satartia in Yazoo County.

The Mississippi Geological, Economic, and Topographical Survey published Bulletin 106, Sediments and Microfauna Off the Coasts of Mississippi and Adjacent States, and Bulletin 107, Claiborne County, Geology and Mineral Resources.

According to the Mississippi State Oil and Gas Bulletin, as of December 31, 1966, the State had 321 oil pools and 55 gas pools producing in 302 fields; there were 3,505 wells capable of producing, compared with 3,524 wells in 1965.

Natural Gas.—Marketed production of natural gas was 156.7 billion cubic feet, valued at $27.3 million, based on an average unit price of 17.4 cents per thousand cubic feet, compared with 17.3 cents in 1965 and 1964.

Four counties—Jefferson Davis, Marion, Forrest, and Walthall—supplied 75 percent of the State's natural gas production.

Reserves dropped 304,584 million cubic feet and represented 0.6 percent of the national reserves (0.7 percent in 1965). Ratio of reserves to yearly production was 9:1 (11:1 in 1965 and 13:1 in 1964).

Table 5.—Oil and gas well drilling and total crew-weeks spent in geophysical oil and gas prospecting in 1966, by counties

County	Drilling							Geophysical prospecting (reflection seismograph), crew-weeks
	Proved field wells			Exploratory wells			Total	
	Oil	Gas [1]	Dry	Oil	Gas [1]	Dry		
Adams	71	2	58	10	--	85	226	--
Amite	5	4	--	--	--	5	14	8
Attala	--	--	--	--	--	1	1	1
Clarke	10	--	--	--	--	1	11	31
Clay	--	--	--	--	--	--	--	1
Copiah	--	--	--	--	--	--	--	8
Covington	--	--	--	--	--	3	3	5
Forrest	3	10	10	--	--	1	24	11
Franklin	51	--	38	4	--	77	170	15
George	--	--	--	--	--	--	--	18
Greene	1	--	1	--	--	--	2	10
Hancock	--	--	2	--	--	2	4	4
Harrison	--	--	--	--	--	--	--	2
Hinds	--	--	1	--	--	4	5	4
Holmes	--	--	--	--	--	--	--	11
Issaquena	--	--	--	--	--	--	--	4
Jasper	8	--	9	1	--	8	26	68
Jefferson	3	--	4	1	1	20	29	1
Jefferson Davis	--	4	1	--	--	1	6	10
Jones	10	--	5	--	--	1	16	31
Lamar	1	2	1	--	--	2	6	8
Lauderdale	--	--	--	--	--	3	3	--
Lawrence	--	--	1	--	--	1	2	13
Lincoln	--	--	--	--	--	--	--	9
Madison	6	--	5	--	--	11	22	1
Marion	1	7	3	--	--	3	14	14
Monroe	--	--	--	--	--	3	3	--
Newton	--	--	--	--	--	2	2	4
Pearl River	--	4	2	--	--	3	9	9
Perry	--	--	--	--	--	--	--	17
Pike	9	--	4	1	--	3	17	4
Rankin	3	2	1	1	--	4	11	25
Scott	--	--	--	--	--	2	2	40
Sharkey	--	--	1	--	--	3	4	13
Simpson	6	--	2	--	--	4	12	25
Smith	1	--	2	2	--	9	14	94
Stone	--	--	--	--	--	--	--	6
Tippah	--	--	--	--	--	1	1	--
Walthall	--	2	3	--	--	3	8	4
Warren	--	--	--	--	--	--	--	4
Washington	--	--	--	--	--	--	--	1
Wayne	4	--	7	1	--	12	24	58
Wilkinson	20	--	18	5	--	61	104	3
Yazoo	8	1	2	1	--	2	14	74
Total:								
1966	221	38	181	27	1	341	809	669
1965	201	21	231	22	3	315	793	666

[1] Includes condensate.

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

	Proved reserves, Dec. 31, 1965	Changes in proved reserves, due to extensions and discoveries in 1966 [1]	Proved reserves Dec. 31, 1966 (production was deducted)	Change from 1965 (percent)
Crude oil—thousand barrels	359,756	54,950	374,102	+4
Natural gas liquids [2]—do	27,014	1,777	17,015	−37
Natural gas—million cubic feet	1,973,447	92,608	1,668,863	−15

[1] Excludes revisions.
[2] Includes condensate, natural gasoline, and LP gases.
Source: American Gas Association, American Petroleum Institute, and Canadian Petroleum Association. Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas.

Table 7.—Marketed production of natural gas [1]

Year	Million cubic feet	Value (thousands)
1957–61 (average)	167,445	$25,882
1962	170,271	32,351
1963	176,807	31,825
1964	180,428	31,385
1965	166,825	28,861
1966	156,652	27,257

[1] Comprises gas either sold or consumed by producers, including losses in transmission, amounts added to storage, and increases in gas pipelines.

One new gasfield was discovered—Calvits Lake in Jefferson County.

Mississippi Valley Gas Co. had a working storage capacity of 1,150 million cubic feet of gas in the Amory field of Monroe County; United Gas Pipe Line Co. controlled 5,816 million cubic feet of storage capacity in formations of the Jackson Dome, Rankin and Hinds Counties. At yearend, the State gas storage capacity totaled 6,966 million cubic feet, an increase of 24 percent compared with 1965 capacity.

Natural Gas Liquids.—Natural gas liquid output decreased 13 percent in volume and 4 percent in value; average price increased from 5.3 cents per gallon in 1965 to 5.8 cents per gallon in 1966.

Reserves of natural gas liquids in Mississippi dropped about 10 million barrels, according to the American Gas Association, and constituted 0.2 percent of the national reserves, compared with 0.3 percent in 1965. Ratio of reserves to yearly production dropped from 23:1 in 1965 to 17:1.

Skelly Oil Co. completed a gas processing facility in the new Bay Springs field in Jasper County. Initial input capacity was 5 million cubic feet per day; initial output was 570 barrels of LP gas mix and depropanized natural gasoline per day.

Total capacity of the State's natural gas processing and cycling plants remained 432.2 million cubic feet per day, according to The Oil and Gas Journal.

According to The Oil and Gas Journal, solution caverns in a Forrest County salt dome contained the following fuels as of October 1966: propane, 3,149,000 barrels; butane, 500,000 barrels; LP gases, 1,865,000 barrels.

Table 8.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline and cycle products		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	24,576	$1,560	10,611	$541	35,187	$2,101
1962	25,891	1,616	20,401	732	46,292	2,348
1963	28,757	1,755	24,541	956	53,298	2,711
1964	27,485	1,644	23,277	780	50,762	2,424
1965	26,582	1,606	22,150	975	48,732	2,581
1966	23,765	1,483	18,621	987	42,386	2,470

Petroleum.—Production of crude oil decreased 1.7 percent in volume and 1.4 percent in value. Average price increased slightly to $2.65 per barrel, compared with $2.64 in 1965. Jasper, Adams, Pike, Jones, Lamar, and Franklin Counties supplied about 60 percent of the State's crude oil production.

An average of 2.6 barrels of salt water was produced with each barrel of crude oil.

Discovery of 27 oilfields constituted a record high. Bay Springs field in Jasper County, discovered in January 1965, reached full development in August with completion of its 22nd well, proving up 1,760 acres. With a strong, natural waterdrive and a low gas-oil ratio, the field produced 3.5 million barrels of 48° API gravity oil from the Cotton Valley Formation at a depth of about 14,500 feet. The intensive exploration campaign set off by this successful strike led to discovery of three additional Cotton Valley oilfields with similar abundant flow characteristics. Two are in

Table 9.—Crude petroleum production

(Thousand 42-gallon barrels and thousand dollars)

Year	Production	Value
1957–61 (average)	46,883	$133,529
1962	55,713	154,882
1963	58,619	161,788
1964	56,777	151,595
1965	56,183	148,437
1966	55,227	146,353

Table 10.—Crude petroleum production, indicated demand, and stocks in 1966, by months

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Mississippi
January	4,842	4,959	2,318
February	4,133	4,220	2,231
March	4,689	4,838	2,082
April	4,538	3,997	2,623
May	4,653	4,908	2,368
June	4,520	3,995	2,893
July	4,677	4,707	2,863
August	4,732	4,949	2,646
September	4,359	4,314	2,691
October	4,669	4,635	2,725
November	4,541	4,632	2,634
December	4,874	4,732	2,776
Total:			
1966	55,227	54,886	XX
1965	56,183	56,269	XX

XX Not applicable.

Smith County west of Bay Springs, and one is in Clarke County east of Bay Springs.

The search to expand production from the Smackover Lime continued, as nineteen exploratory wells were drilled to this objective. The search extended from Yazoo County in the northwest to Wayne County in the southeast, and included Rankin, Scott, Newton, Lauderdale, Simpson, Smith, and Jasper Counties. Depth ranged from 7,850 feet in Lauderdale County to 21,052 feet in Simpson County, the latter well set a new Mississippi depth record and was still in Smackover Lime at total depth. As a result of the drilling campaign, two new oilfields produced from the Smackover Limestone (East Paulding in Jasper County and West Clara in Wayne County), and two new oilfields produced from the shallower Cotton Valley Formation (Tallahalla Creek and Shongelo Creek, both in Smith County). Cotton Valley production was also established in the Quitman field of eastern Clarke County, 35 miles east of Bay Springs and 10 miles from the Alabama border, at a depth of 11,154 feet. The field, discovered in 1945, previously produced only from the Upper Cretaceous Eutaw Formation at 3,700 feet. The singularly successful discovery of the Bay Springs

Table 11.—Crude petroleum production, by fields [1]

(Thousand 42-gallon barrels)

Field	1962	1963	1964	1965	1966
Baxterville	5,808	5,823	5,822	5,592	5,399
Bay Springs	----	----	----	970	3,487
Bolton	1,127	1,256	1,190	906	646
Brookhaven	1,498	1,545	1,456	1,299	1,073
Bryan	2,068	2,017	1,773	1,312	1,125
Dexter	(2)	(2)	1,566	1,174	796
Eucutta	1,151	1,088	1,232	1,050	814
Heidelberg	3,737	3,620	3,491	3,904	3,830
La Grange, N & S	1,322	1,234	1,236	1,245	950
Little Creek	5,384	6,107	5,589	4,137	2,841
McComb	4,383	4,482	4,379	3,837	2,797
Pool Creek	(2)	(2)	(2)	1,055	1,077
Quitman Bayou	(2)	(2)	(2)	(2)	1,392
Raleigh	1,392	1,573	1,511	1,304	1,191
Smithdale	(2)	(2)	1,019	1,155	950
Soso	2,998	2,643	2,380	2,070	1,939
Summerland	(2)	(1)	(2)	1,096	1,291
Tinsley	2,835	2,855	2,650	2,447	2,325
Yellow Creek, N & W	1,492	1,409	1,276	1,191	1,027
Other fields [3]	20,518	22,967	20,207	20,439	20,277
Total	55,713	58,619	56,777	56,183	55,227

[1] Based on The Oil and Gas Journal data adjusted to Bureau of Mines total.
[2] Included with "Other fields."
[3] Bureau of Mines data.

Cotton Valley oilfield of Jasper County provided added incentive to the deep Upper Jurassic exploration which extended into Washington and Choctaw Counties, Alabama.

Reserves of crude oil in Mississippi gained 14.3 million barrels, according to the American Petroleum Institute, and constituted 1.2 percent of the national reserves, compared with 1.1 percent in 1965. Ratio of reserves to yearly production increased slightly, from 6.4:1 in 1965 to 6.8:1 in 1966.

In 1966, the National Stripper Well Association classified 221 wells as stripper wells in 1965. These wells represented 8.8 percent of the producing oil wells and 1.4 percent of the State's 1965 reserves.

Four of the State's five plants refined 19.4 percent of the annual crude oil production; their capacity remained unchanged at 34,500 barrels per stream day. The fifth plant—the Standard Oil Co. of Kentucky refinery at Pascagoula—processed Louisiana crude oil exclusively; its capacity was 130,000 barrels per stream day.

Secondary recovery operations accounted for about 10 million barrels or 18.5 percent of the State's crude oil production. Pilot secondary recovery projects using steam and carbon dioxide were completed in Eucutta and Junction City fields; poor results were reported. Conventional waterflood operations for secondary recovery were approved for the unitized portion of the Eucutta field in Wayne County and Summerland field in Covington and Jones Counties.

Petrochemicals.—Construction of the Mississippi Chemical Corp.-Coastal Chemical Corp. 1,000-ton-per-day, single-train ammonia plant near Yazoo City was completed in June. A similar plant, but of 1,500-ton-per-day capacity, was nearing completion at the Standard Oil Co. of Kentucky refinery complex at Pascagoula. Construction continued on a $30 million plant owned by Chevron Chemical Co., a subsidiary of Standard Oil, for making paraxylene and toluene; completion was scheduled for mid-1967.

Completion in early 1967 was scheduled for the First Mississippi Corp. plant under construction at Bayou Casotte Pascagoula, adjacent to Coastal Chemical Corp.'s plant. Annual production of the new plant will be 30 million pounds of aniline and 6 million pounds of diphenylamine.

Thiokol Chemical Co. announced a $3 million expansion of its 3-year-old Moss Point plant in Jackson County near Pascagoula. The new facility will produce polytetrafluorethylene resins used in manufacturing gaskets, seals, bearings, insulators, and diverse molded goods.

NONMETALS

Bromine and Iodine.—Brine samples from three newly discovered oilfields, producing from the Upper Jurassic Smackover Limestone at a depth of approximately 14,000 feet, were analyzed and found to contain from 1,581 to 2,016 parts per million (ppm) of bromine. The concentrations are insufficient for economical exploitation but are significantly higher than the bromine concentrations in brines from the Eocene Wilcox Formation (48 to 118 ppm, 142 samples analyzed) or from the Lower Cretaceous Sligo Formation (1,232 to 1,488 ppm, two samples analyzed). These data indicate an increase in bromine content with age of formation or depth or possibly both. Iodine concentrations in the Smackover samples were insignificant.

Cement.—Production of portland cement increased 3 percent; output of masonry cement decreased 2 percent.

Clays.—Clay production was 15 percent over that of 1965, establishing a record for the seventh consecutive year. Gains were reported in quantities of miscellaneous clay, fuller's earth, and bentonite sold or used. Total tonnage of miscellaneous clay used for heavy clay products and lightweight aggregate increased 25 percent and constituted 67 percent of the State's clay production. Bentonite production rose 4 percent over that of 1965. Fire clay production decreased 15 percent. Ball clay was produced in Panola County.

In February, production of bentonite for bonding foundry sands began at the new

Table 12.—Shipments of portland cement to Mississippi consumers

Year	Thousand barrels
1957–61 (average)	2,993
1962	3,704
1963	3,999
1964	4,108
1965	4,212
1966	4,708

$250,000 plant built by Magnet Cove Barium Corp. at Vaiden. The plant has an annual capacity of 50,000 tons, an increase of 250 percent over the company's old facility at Kosciusko, and processes bentonite mined in the company's open-pit mine near West, Holmes County.

On March 3, a tornado wrecked the Jackson Tile Co. plant at Jackson.

Magnesium Compounds.—Production of magnesium compounds increased 7 percent over 1965. Magnesium-bearing lime, made from dolomite mined in Alabama, was used in the process.

Sand and Gravel.—Data on output of sand and gravel between 1965 and 1966 are not directly comparable. The reported increase in output of 50 percent in tonnage and 56 percent in value, is due mainly to increased coverage. Production was reported from 54 of the State's 82 counties; leading producers in order of value were Hinds, Copiah, Forrest, Adams, and De Soto Counties. These five counties produced 45 percent of the tonnage and 44 percent of the value.

Stone and Shell.—Offshore recovery of oyster and clam shell in Harrison County decreased 2.5 percent in tonnage but increased 33 percent in value compared with the 1965 figures. Stone production (excluding shell) dropped 40 percent in volume and value, falling back to the 1964 level, owing to a decreased use of crushed limestone as dike revetment by the U.S. Army Corps of Engineers.

Sulfur.—Recovery of sulfur from refinery and natural gases increased significantly owing to full operation of the National Sulphur Co. plant in the Loring condensate field of Madison County.

Phillips Petroleum Co. completed its Smackover discovery well of the Black Creek gas condensate field in Perry County. The well, testing 1.4 million cubic feet per day with 33 long tons of sulfur per million cubic feet, was shut-in while construction of a sulfur extraction plant was being planned.

METALS

Iron Ore.—Magnolia Mining Co., under new ownership, continued to mine iron ore from several small open pits near Porterville, Kemper County. The ore was being shipped by rail to a mill near Birmingham, Ala.

Table 13.—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 earth		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	213	$2,537	146	$1,181	453	$454	812	$4,172
1962	276	3,429	207	1,666	646	647	1,129	5,742
1963	280	3,480	230	1,761	725	727	1,235	5,968
1964	270	3,352	286	2,003	775	775	1,331	6,130
1965	280	3,477	299	r 2,570	923	950	1,502	r 6,997
1966	291	3,615	280	2,673	1,156	1,201	1,727	7,489

r Revised.

Table 14.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	5,725	$5,421	543	$539	6,268	$5,960
1962	6,394	6,336	607	926	7,001	7,262
1963	6,306	6,266	519	790	6,825	7,056
1964	7,479	7,871	346	698	7,825	8,569
1965	7,192	7,785	1,255	932	8,447	8,717
1966	[1] 12,307	12,815	368	748	12,675	13,563

[1] Increase in production in 1966 due mainly to expanded coverage.

Table 15.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	889	$783	2,629	$2,429
Paving	1,245	1,094	2,304	2,171
Other [1]	201	275	104	182
Total	2,335	2,152	5,037	4,782
Gravel:				
Building	1,272	1,456	3,195	3,689
Paving	3,130	3,721	3,783	4,051
Railroad ballast	36	13	35	13
Other [2]	419	443	257	280
Total	4,857	5,633	7,270	8,033
Total sand and gravel	7,192	7,785	12,307	12,815
Government-and-contractor operations:				
Sand:				
Building	7	7	-----	-----
Paving	35	10	4	4
Fill	999	426	142	191
Gravel:				
Paving	27	10	10	10
Fill	187	479	212	543
Total sand and gravel	1,255	932	368	748
Grand total	8,447	8,717	[3] 12,675	13,563

[1] Includes railroad ballast, fill, other, and industrial sand.
[2] Includes fill, other, and miscellaneous gravel.
[3] Increase in production in 1966 due mainly to expanded coverage.

REVIEW BY COUNTIES

Only counties with significant mineral production are discussed in the following section. Additional details are presented in table 16.

Adams.—The county again led the State in oil well drilling activity. Ten new oilfields—Mercer, Natchez Ferry, Fairchilds Creek, Painters, Greens Bayou, Cloverdale, North Cowpen Point, Cotton Valley, Pleasant Hill, and Mistletoe—were discovered as the result of 95 exploratory wells drilled. Development drilling added 73 oil wells to existing fields. The county ranked second in total value of minerals and petroleum produced and accounted for 13 percent of the State petroleum production and about three-quarters of its regenerated lime output. Production of expanded perlite was reported by Johns Manville Perlite Co.

Copiah.—The county was the second largest sand and gravel producer in the State, accounting for 13 percent of its output.

Forrest.—The county ranked third in sand and gravel and natural gas output, accounting for, respectively, 8 and 19 percent of the State's production.

Franklin.—Exploratory drilling of 81 wells resulted in discovery of four oilfields: Panther Creek, South Providence, Spring Hill, and East Franklin. The county again ranked second in oil well drilling activity, adding 51 oil wells to existing fields.

Harrison.—Jahncke Service, Inc., dredged oyster and clam shell in Mississippi Sound.

Hinds.—The county led the State in sand and gravel production and retained its lead in quantity and value of miscellaneous clay mined and used for manufacturing lightweight aggregate, face brick, and other clay products.

Itawamba.—The county ranked third in value of clay output. Bentonite was mined from open pits and processed for filtering, decolorizing, molding, and oil well drilling mud.

Table 16.—Value of mineral production in Mississippi, by counties [1]

County	1965 [r]	1966	Minerals produced in 1966 in order of value
Adams	$17,593,639	$20,328,309	Petroleum, sand and gravel, natural gas, natural gas liquids.
Alcorn	W	W	Clays, sand and gravel.
Amite	4,629,867	3,964,577	Petroleum, natural gas, sand and gravel.
Attala	286,442	W	Clays.
Bolivar	103,000	49,000	Sand and gravel.
Carroll	W	W	Sand and gravel, clays.
Chickasaw	10,328	69,297	Natural gas, sand and gravel.
Claiborne	11,094	17,704	Natural gas.
Clarke	978,626	1,106,966	Petroleum, sand and gravel, natural gas.
Clay	366,798	435,321	Natural gas, sand and gravel, petroleum, natural gas liquids.
Coahoma	----------	1,000	Sand and gravel.
Copiah	W	W	Do.
Covington	847,027	1,258,748	Sand and gravel, petroleum, natural gas.
De Soto	W	W	Sand and gravel.
Forrest	6,921,228	7,574,348	Natural gas, petroleum, sand and gravel, natural gas liquids, clays.
Franklin	8,709,094	9,704,059	Petroleum, natural gas.
Greene	273,008	235,064	Do.
Grenada	W	W	Sand and gravel.
Hancock	118,776	226,823	Natural gas, petroleum, sand and gravel.
Harrison	W	W	Shell, sand and gravel.
Hinds	3,260,369	4,269,158	Petroleum, sand and gravel, clays, natural gas.
Holmes	W	W	Sand and gravel.
Itawamba	W	1,154,889	Clays, sand and gravel, natural gas.
Jackson	W	4,691,555	Lime, magnesium compounds, sand and gravel.
Jasper	16,760,295	23,323,115	Petroleum, natural gas, natural gas liquids, sand and gravel.
Jefferson	2,999,569	2,558,734	Petroleum, natural gas, sand and gravel.
Jefferson Davis	10,956,358	5,846,931	Natural gas, petroleum.
Jones	12,828,575	12,951,620	Petroleum, natural gas, natural gas liquids, clays.
Kemper	W	W	Iron ore, sand and gravel.
Lafayette	----------	40,000	Sand and gravel.
Lamar	11,371,112	11,223,743	Petroleum, natural gas.
Lauderdale	111,953	66,041	Clays, sand and gravel.
Lawrence	1,282	2,816	Petroleum, natural gas.
Lee	W	W	Clays, sand and gravel.
Leflore	----------	156,000	Sand and gravel.
Lincoln	11,411,206	8,757,203	Petroleum, sand and gravel, natural gas liquids, natural gas, clays.
Lowndes	289,200	232,700	Sand and gravel, clays.
Madison	1,507,664	2,273,778	Petroleum, sand and gravel, natural gas liquids, natural gas.
Marion	6,796,343	7,751,693	Natural gas, petroleum, sand and gravel, natural gas liquids.
Marshall	W	369,450	Clays, sand and gravel.
Monroe	2,886,503	2,645,188	Clays, natural gas, sand and gravel, petroleum.
Noxubee	W	485,633	Sand and gravel, clays.
Oktibbeha	----------	8,000	Sand and gravel.
Panola	W	W	Clays, sand and gravel.
Pearl River	2,091,163	1,953,977	Natural gas, petroleum, sand and gravel, clays.
Perry	W	W	Sand and gravel, petroleum.
Pike	22,092,180	16,609,969	Petroleum, natural gas liquids, natural gas, sand and gravel.
Pontotoc	W	W	Sand and gravel, clays.
Prentiss	7,500	6,750	Clays.
Rankin	6,461,229	7,031,052	Cement, petroleum, stone, sand and gravel, natural gas.
Scott	90,023	136,886	Petroleum, natural gas.
Simpson	3,141,456	3,412,007	Petroleum, natural gas, sand and gravel.
Smith	8,384,212	7,609,442	Petroleum, clays, natural gas, sand and gravel, stone.
Stone	W	W	Sand and gravel.
Sunflower	W	19,200	Clays.
Tate	----------	32,000	Sand and gravel.
Tippah	W	W	Clays.
Tishomingo	W	296,500	Sand and gravel, stone.
Tunica	----------	32,000	Sand and gravel.
Union	----------	604,000	Do.
Walthall	6,032,532	5,708,886	Natural gas, petroleum.
Warren	W	W	Cement, sand and gravel, stone.
Washington	W	W	Sand and gravel.
Wayne	9,891,820	8,438,382	Petroleum, natural gas, sand and gravel.
Wilkinson	3,670,442	4,563,278	Petroleum, sand and gravel, natural gas.
Winston	----------	W	Clays.
Yalobusha	W	W	Sand and gravel.
Yazoo	7,348,999	7,144,493	Petroleum, sand and gravel, natural gas.
Undistributed	18,792,088	13,981,715	
Total	210,033,000	211,360,000	

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

[1] The following counties were not listed because no production was reported: Benton, Calhoun, Choctaw, George, Humphreys, Issaquena, Leake, Montgomery, Neshoba, Newton, Quitman, Sharkey, Tallahatchie, Webster.

[r] Revised.

Jackson.—The county led the State in value of total lime and magnesium compounds produced.

Jasper.—The Bay Springs oilfield, discovered in January 1965, produced 3.5 million barrels of oil, boosting the county to first place in the State in oil production (15 percent of State's total) and value of minerals produced. Nine exploratory wells resulted in the discovery of East Paulding oilfields, producing from the Smackover Limestone. Eight new producers were added to existing fields.

Jefferson.—Twenty-two exploratory wells resulted in the discovery of the Calvits Lake gasfield and the Stampley oilfield. Existing fields added three new producing wells.

Jefferson Davis.—The county led the State in natural gas production, accounting for 21 percent of its total output. Four new gas wells were added to existing fields.

Jones.—The county again ranked fourth in value of petroleum and total minerals produced, accounting for 9 percent of the State's petroleum production. Development drilling resulted in 10 new oil wells in existing fields.

Lamar.—Development drilling added one oil well and two gas wells to existing fields. Mississippi Gulf Refining Co.'s Black Creek refinery near Purvis furnished fluid petroleum coke to Kaiser Aluminum Co.'s adjoining calcining plant for use as electrodes in that company's alumina reduction plants.

Marion.—The county, second in natural gas production, produced 20 percent of the State total. One oil well and seven gas wells were added to existing fields.

Marshall.—Holly Springs Brick and Tile Co. and Southern Brick and Tile Co. mined fire clay from open pits to make floor and wall tile and building brick.

Monroe.—The county retained its lead in value of clay production. Bentonite was mined from open pits and processed for moldmaking, absorbing, filtering, and decolorizing.

Perry.—Phillips Petroleum Co.'s No. 1 Josephine, discovery well of the Black Creek gasfield, tested 1.4 million cubic feet of gas per day, producing from two intervals between 19,768 and 20,138 feet in the Smackover Limestone. A plant was being designed to extract the sulfur from the gas, reportedly amounting to 33 long tons per million cubic feet.

Pike.—The county ranked third in total value of minerals and petroleum produced, accounting for 10 percent of the State's total oil production. It led in production of natural gas liquids. Drilling of four exploratory wells resulted in the discovery of the West McComb oilfield. Development drilling resulted in nine new oil wells in existing fields.

Rankin.—The county led in production of crushed marl and limestone used for manufacturing cement. Marquette Cement Manufacturing Co., one of the State's two cement plants, produced portland and masonry cement at Brandon. Drilling of five exploratory wells resulted in discovery of the Pearl oilfield. Development drilling resulted in the addition of three oil wells and two gas wells in existing fields.

Smith.—Exploratory drilling of 11 wells resulted in discovery of the Tallahalla Creek and Shongelo Creek oilfields, both producing from the Cotton Valley Formation below 15,000 feet. Development drilling added one new oil well to an existing field.

Tippah.—The county was again the State's only producer of fuller's earth.

Walthall.—The county ranked fourth in the State in natural gas production. Two new gas wells were added to existing fields.

Warren.—The county ranked second in production of crushed marl and limestone used for manufacturing cement. Mississippi Valley Portland Cement Co., one of the State's two cement plants, produced portland and masonry cement.

Wayne.—Drilling of 13 exploratory wells resulted in one dual discovery—West Clara oilfield—producing from the Lower Cretaceous Rodessa Formation at 12,000 feet and the Jurassic Smackover Formation below 13,000 feet. Development drilling added four new oil wells to existing fields.

Wilkinson.—The county again ranked third in total drilling activity; drilling of 66 exploratory wells led to discovery of Day Creek, Hazlit Creek, North Mud Creek, Old River, and Elliston oilfields. Development drilling added 20 new oil wells to existing fields.

Yazoo.—Drilling of three exploratory wells led to discovery of Satartia oilfield; eight oil wells were added to existing fields.

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, Department of Business and Administration of Missouri, for collecting information on all minerals except fuels.

By Joseph C. Arundale [1] and James A. Martin [2]

Value of mineral output reached a record high of $228 million, up 1 percent from $225.6 million in 1965. Output of most minerals increased, but the quantity and value of sand and gravel and stone decreased slightly because of reductions in building and highway construction. Lead production was down slightly because the smelter at Herculaneum was closed during December in order to convert to the use of newly installed facilities. Nonmetals, with 63 percent of total value, dominated the minerals industry. Principal mineral commodities produced in order of value were stone, cement, lead, iron ore, and lime.

Development of the Nation's largest reserve of lead ore highlighted Missouri mineral activities in 1966. Discovery and exploration over the past decade of the new

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Table 1.—Mineral production in Missouri [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite—short tons	328,585	$4,219	337,076	$4,280
Cement:				
Portland—thousand 376-pound barrels	13,334	46,034	13,848	46,228
Masonry—thousand 280-pound barrels	377	1,173	382	1,075
Clays—thousand short tons	2,226	5,439	2,329	5,989
Coal (bituminous)—do	3,564	14,779	3,582	14,834
Copper (recoverable content of ores, etc.)—short tons	2,331	1,650	3,913	2,831
Iron ore (usable)—thousand long tons gross weight	1,784	24,607	1,887	26,450
Lead (recoverable content of ores, etc.)—short tons	133,521	41,659	132,255	39,981
Lime—thousand short tons	1,442	16,782	1,494	17,910
Natural gas—million cubic feet	84	21	-----	-----
Petroleum (crude)—thousand 42-gallon barrels	73	W	97	W
Sand and gravel—thousand short tons	12,068	13,735	10,702	13,540
Silver (recoverable content of ores, etc.) thousand troy ounces	300	387	-----	-----
Stone—thousand short tons	36,247	53,574	35,240	53,393
Zinc (recoverable content of ores, etc.)—short tons	4,312	1,259	3,968	1,151
Value of items that cannot be disclosed: Asphalt and tripoli (1965), and values indicated by symbol W	XX	r 250	XX	288
Total	XX	225,568	XX	227,950

r Revised.
W Withheld to avoid disclosing individual company confidential data; included in "Value of items that cannot be disclosed."
XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]	Year	Value [1]
1957	$151,660	1962	$151,132
1958	147,579	1963	157,584
1959	154,876	1964	182,733
1960	151,051	1965	214,508
1961	149,134	1966	p214,543

p Preliminary.
[1] Data for 1957–65 revised.

Table 3.—Employment 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
1965:								
Coal	408	266	108	833	-----	31	37.22	8,088
Metal	2,476	275	680	5,478	2	254	46.73	3,593
Nonmetal and native asphalt	1,035	233	242	1,962	-----	63	32.11	868
Sand and gravel	789	242	191	1,594	-----	24	15.06	4,241
Stone	4,899	260	1,272	10,359	1	200	19.40	1,049
Total	9,607	259	2,493	20,226	3	572	28.43	2,262
1966: p								
Coal	360	271	98	717	1	30	43.24	9,414
Metal	2,530	272	689	5,550	3	268	48.83	5,171
Nonmetal and native asphalt	1,075	228	245	1,974	-----	61	30.90	777
Sand and gravel	710	240	171	1,409	1	19	14.19	4,696
Stone	4,830	266	1,288	10,519	9	191	19.01	5,644
Total	9,505	262	2,491	20,169	14	569	28.91	5,105

p Preliminary.

lead belt, called the "Viburnum trend," has been one of the most significant mineral developments in the country's history. Although no official reserve figure has been released, it has been widely stated that the area has an estimated potential of 1 billion tons of ore containing 20 to 30 million tons of recoverable lead. This tonnage represents between two and three times more recoverable lead than has been produced in Missouri in recorded history (10.7 million short tons valued at $1.6 billion) and more lead than has been produced in the United States in this century. Missouri, for many years the Nation's leading lead producer, appears destined to continue this leadership for the foreseeable future.

The lead smelting capacity in the State is being increased to handle the expansion of mine-mill production. St. Joseph Lead Co. completed an expansion and modernization program at yearend at its Herculaneum, Jefferson County, smelter. Two new smelters under construction in Iron County by Missouri Lead Operating Co. at Bixby and American Smelting and Refining Co. at Glover are scheduled to begin operation in early 1968. Rated smelter capacity for the State by 1969 will be about 380,000 tons of pig lead per year.

Much of the new mineral development in southeast Missouri is in the Clark National Forest. Construction of mines and ancillary facilities has had great impact on management of the forest and to the general economy of the region. About 80 percent of the development is in national forest lands and one-fourth of the royalty receipts from minerals are to be returned to the counties included in the Clark National Forest tracts for improvement of roads and schools.

Major processing facilities were completed or under construction by the cement, refractories, and glass industries at yearend. In northeast Missouri, Universal Atlas Cement Co. began operations at its new wet-process plant south of Hannibal, and the 7-million-barrel plant of Dundee Cement Co. at Clarksville neared completion. H. K.

Porter Refractories Division completed construction of a plant at Fulton, and an expansion and modernization program began at the Kaiser Refractories Division plant at Mexico. The Pittsburgh Plate Glass Co. float-glass plant registered its first full year of production.

Peabody Coal Co. expanded production at its Bee Veer mine, Macon County, and Pittsburg and Midway Coal Mining Co. announced plans to open a strip mine in southern Barton County.

The Missouri Mining Industry Council, a newly formed organization, held its first annual meeting in Jefferson City on March 1; nine basic mineral commodity groups were represented. The meeting, believed to be the largest ever held by the mineral industry in Missouri, indicated the industry's concern with problems such as urbanization, zoning, reclamation, pollution control, and increased taxation.

Exploration.—Lead ore exploration continued in the Viburnum trend and other areas but to a lesser degree than in recent years.

Records of the Clark National Forest indicated that 85 prospecting permits, covering 100,000 acres, and 29 mineral leases, covering 30,000 acres, were in effect by yearend. This was a significant increase over the 1965 land under prospecting permits and mineral leases which totaled 82,772 and 25,661 acres, respectively.

Mining companies drilled nearly 431,000 feet in 1966. Much of the drilling was confined to delineating known deposits and for metallurgical processing data; the exploratory drilling indicated a favorable possibility of increasing reserves.

Transportation.—The St. Louis-San Francisco Railway Co. (Frisco) began constructing a new 32.3-mile railroad to serve the new mineral developments in Crawford, Washington, Reynolds, and Iron Counties.

The new rail line, estimated to cost slightly over $6 million, will extend from Keysville, Mo., through Viburnum and Bixby, and terminate at Buick. It will serve St. Joseph Lead Co.'s Viburnum mines and mill, the Cominco American, Inc.-Dresser Industries, Inc., Magmont mine and mill, and the Missouri Lead Operating Co. smelter, mine, and mill. Freight was expected to move over the new railroad in the latter half of 1967.

Table 4.—Exploratory drilling in Missouri

(Linear feet)

Year	Churn	Rotary	Diamond
1960	268,819	15,871	451,295
1961	153,555	2,791	600,641
1962–63	73,120	8,549	188,120
1964	148,098	34,136	289,225
1965	111,786	5,324	188,071
1966	133,879	4,036	292,699

Legislation.—A bill regulating oil and gas production in Missouri was passed by the 1966 Missouri Legislature. It established a State Oil and Gas Council composed of members from five State agencies (University of Missouri, Division of Commerce and Industrial Development, Public Service Commission, Water Pollution Board, and Geological Survey and Water Resources). The State Geologist acts as administrator of the council and is responsible for enforcement of the provisions of the act. The council was given power to regulate drilling, spacing, production and plugging of oil and gas wells; to require logs on all holes; and to require drilling permits.

Water.—The Missouri Geological Survey and the Missouri Water Pollution Board have a continuing program to analyze surface water in the new lead producing area. These analysis will be used as a base to determine any pollution after mining and smelting begin. Mining companies in the Viburnum trend area expressed their intention to prevent pollution of either surface water or ground water. Prospecting holes in the area have been sealed at two separate levels to guard against ground water pollution.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Significant nonmetallic minerals produced in Missouri, in order of value, were stone, cement, and lime. Higher production of barite, cement, clay, and lime was offset by declines in sand and gravel and stone compared with 1965. Decreases in output of sand and gravel and stone resulted from reduced quantities used for building and highway construction.

Barite.—Missouri was the leading barite producing State for the fifth consecutive year. Barite ores were mined mostly in Washington County with a minor amount

Table 5.—Barite sold or used by procedures

Year	Short tons	Value
1957-61 (average)	244,147	$3,233,623
1962	303,945	3,994,104
1963	286,750	3,679,764
1964	266,814	3,450,530
1965	328,585	4,219,343
1966	337,076	4,279,770

being produced in Benton County. Most of the washed crude barite was processed at crushing and grinding plants in St. Louis and Washington Counties. Processed barite was shipped mainly to out-of-State markets for use as a weighting material in oil well drilling fluids, in glass, and in chemicals.

Cement.—Two plants in St. Louis County and one each in Cape Girardeau, Jackson, Jefferson, and Ralls Counties produced portland and masonry cement. River Cement Co., Division of Stewart Concrete & Materials Co., with a new plant near Selma, Jefferson County, completed its first full year of operation. The 3-million-barrel facility, currently the Nation's largest dry-process unit, included a 560-foot, gas-fired kiln.

Construction of a 7-million-barrel, wet-process plant and barge slip at Clarksville, Pike County by Dundee Cement Co. neared completion. F. L. Smidth & Co., of New York, fabricated the world's largest (760-foot) rotary cement kiln for Dundee. Built in sections by Avondale Shipyards Co., of New Orleans, the kiln was barged up the Mississippi River to the plant site. General Electric was building the electrical system to power the kiln and ball mills. The grinding mills, also fabricated by F. L. Smidth & Co., are the world's largest and consist of one raw mill 15 feet in diameter and 54 feet long and two finish mills 15 feet in diameter and 49 feet long. Electronic transmitting and recording instruments control the mill operations. The plant was expected to be in full production by mid-1967.

Dundee announced plans to build a rail-truck distribution and service center in St. Louis. The terminal would include two 5,000-barrel storage silos and be located on a 2.5-acre tract with 400 feet of frontage on the Mississippi River. It was designed for the future addition of barge facilities and was the fifth in a series of terminals built or planned by Dundee to distribute the output of its new plant. Dravo Corp. was awarded a $4-million contract to build 34 covered-hopper barges for use on the Mississippi River and its tributaries to transport cement from Dundee's plant to the distribution centers. Each barge will be 195 by 35 by 12 feet and have a capacity of 1,500 tons or 7,500 barrels.

Universal Atlas Cement Division of United States Steel Corp. completed construction of a new, fully automated, single-kiln wet-process plant south of Hannibal, Ralls County. The 620-foot, coal-fired kiln, the second largest in the Nation, went on-stream in April. The 14-kiln, dry-process plant, constructed in 1901–05 and located on the same site, was phased out of operation and dismantled. Quality control at the new plant was maintained by automatic samplers, on-line X-ray analyzer and closed-loop computer, and TV monitors. New distribution centers were constructed at Bettendorf, Ga., and Summit, Ill., and two new barges, with unloading equipment, were placed in service.

Clays.—Output of fire clay and miscellaneous clay used in refractories, heavy clay products, and lightweight aggregate continued to increase from a low in 1963. Opening of new pits, construction of new plants, and expansion and modernization of existing facilities greatly improved the condition and outlook of the clay industry in Missouri.

Table 6.—Portland cement production and shipments

(Thousand 376-pound barrels and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1957-61 (average)	12,233	11,977	$40,234
1962	12,239	12,739	44,004
1963	12,692	12,402	41,640
1964	12,399	12,378	42,618
1965	13,975	13,334	46,034
1966	13,956	13,848	46,228

Table 7.—Shipments of portland cement to Missouri consumers

Year	Thousand 376-pound barrels
1957-61 (average)	7,812
1962	8,814
1963	8,990
1964	10,266
1965	10,414
1966	9,230

Table 8.—Clays sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Fire clay [1]		Miscellaneous clay		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	1,451	$5,603	952	$953	2,403	$6,556
1962	1,080	4,060	973	973	2,053	5,033
1963	850	3,568	896	899	1,746	4,467
1964	1,002	3,905	964	969	1,966	4,874
1965	1,128	4,313	1,098	1,126	2,226	5,439
1966	1,285	4,898	1,044	1,091	2,329	5,989

[1] Includes diaspore and burley.

Table 9.—Lime sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	1,263	$14,980
1962	1,176	13,703
1963	1,240	14,386
1964	1,219	14,328
1965	1,442	16,782
1966	1,494	17,910

Mid-America Clay Co. was completing a new plant near Oran in Scott County. Porters Creek clay will be mined, calcined, and used as absorption material, fillers, and carriers for insecticides.

Missouri Clay Products Co., a subsidiary of St. Joseph Lead Co., investigated the Porters Creek clay in Stoddard County for an iron ore pellet binder and other uses.

The Refractories Division of H. K. Porter Co., Inc., began production in November at the new Fulton plant in Callaway County. The plant was completed in December, and the Laclede plant in St. Louis was phased out.

Kaiser Refractories Division, Kaiser Aluminum & Chemical Corp., began an expansion and modernization program at its Mexico plant in Audrain County.

A new rotary calcining kiln went on stream at the Harbison-Walker Refractories Co. Fulton works, Callaway County.

Lime.—Four plants in four counties produced lime. Output has risen steadily and reached a record high in 1966. Most of the lime was for chemical, industrial, refractory, and building uses. Valley Dolomite Corp. announced plans for producing dolomitic quicklime at its Bonne Terre plant by mid-1967.

Sand and Gravel.—A decline in building and highway construction resulted in lower sand and gravel output from the record high of 1965. Silica sand production for glassmaking and other industrial uses continued the upward trend which began in 1961. Construction sand and gravel production was reported by 64 commercial operations in 40 counties. Government-and-Contractor production by State and county highway departments was reported from seven counties. Five operations in three counties produced industrial silica sand.

The new float-glass facility at the Pittsburgh Plate Glass Co. Crystal City plant, Jefferson County, was completed in late 1965 and operated continuously during 1966.

Stone.—For the fourth consecutive year, stone ranked first in value of mineral output in Missouri. Limestone, granite, marble, sandstone, and miscellaneous stone were produced. Total production declined slightly over 1 million tons from the 1965 record high, largely the result of a nearly 2 million ton decrease in the quantity of stone for concrete aggregate and roadstone.

Stone production was reported by 218 commercial producers from 79 counties. More than 99 percent of the production was marketed as crushed and broken stone for concrete and bituminous aggregate, and roadstone. Limestone and dolomite accounted for more than 90 percent of the total tonnage and value.

METALS

Metal mining and processing supplied about 30 percent of the total mineral value in 1966 or $70.4 million. Lead and iron were the principal metals produced. The average annual recovery of silver from Missouri lead ores was 234,300 ounces during the 1954–63 period. Silver-bearing residues derived from smelting lead and zinc concentrates were not processed for silver in 1966. Copper output nearly doubled and was expected to increase further as copper circuits are installed in the mills being built at the new lead mines.

Copper.—Output of copper was higher because of increased production of lead

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

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	8,686	$9,941	776	$532	9,462	$10,473
1962	9,445	10,927	859	645	10,304	11,572
1963	9,808	11,580	845	680	10,653	12,260
1964	10,761	12,762	722	618	11,483	13,380
1965	11,229	12,954	839	781	12,068	13,735
1966	10,454	13,283	248	257	10,702	13,540

Table 11.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	4,265	$3,763	3,831	$3,547
Paving	859	821	629	638
Fill	405	358	392	345
Industry glass	527	1,364	540	1,321
Other [1]	672	2,285	554	2,263
Total	6,728	8,591	5,946	8,114
Gravel:				
Building	2,749	3,094	2,274	2,770
Paving	1,001	828	1,808	2,114
Fill	W	W	209	103
Other [2]	751	441	217	182
Total	4,501	4,363	4,508	5,169
Total sand and gravel	11,229	12,954	10,454	13,283
Government-and-contractor operations:				
Sand: Paving	79	92	124	124
Gravel: Paving	760	689	124	133
Total sand and gravel	839	781	248	257
Grand total	12,068	13,735	10,702	13,540

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes railroad ballast, other construction sand, and various industrial sand (unground and ground).
[2] Includes railroad ballast, miscellaneous gravel, fill (1965), and other construction gravel.

ores containing the metal. When all facilities and arrangements are made for recovering copper from the lead ores of southeast Missouri, output will be several times the present rate.

Iron Ore.—Missouri was rapidly becoming one of the important iron ore producing States. Output of concentrates has jumped to nearly 2 million long tons in a few years. New facilities were about ready to increase this total, and large reserves hold promise for further developments.

Expansion of production at the Meramec Mining Co. Pea Ridge mine from 1.8 to 2.2 million long tons of pellets per year by the addition of pelletizing facilities for hematite ores was being considered. Previously, the company used magnetite and stockpiled hematite concentrates.

One of the oldest active iron mines in the United States, Iron Mountain mine operated by The Hanna Mining Co. in St. Francois County, was closed at mid-year. The property was recorded before 1800, and the mine has been active sporadically since 1843.

Pilot Knob Pellet Co., a joint venture of Hanna and Granite City Steel Co., began underground mine development work at its new Pilot Knob mine in Iron County. The ore, encountered at a depth of about 400 feet, extends to about 1,500 feet. Ore reserves were considered by officials to be sufficient for many years of production; the

Table 12.—Stone sold or used by producers, by uses

Use		1965		1966	
		Quantity	Value	Quantity	Value
Dimension and building:					
Rough construction	short tons	4,273	$101,804	3,386	$114,744
Dressed (cut or sawed)	do	11,236	2,011,563	12,983	2,301,704
Other [1]	do	4,569	40,773	4,250	37,900
Total	approximate short tons	20,078	2,154,140	20,619	2,454,348
Crushed and broken:					
Riprap	short tons	3,473,232	2,671,388	3,280,007	2,316,866
Concrete aggregate, roadstone, etc	do	20,887,782	28,388,518	18,908,975	25,747,986
Railroad ballast	do	356,924	252,282	435,328	210,772
Agricultural	do	3,509,192	5,572,749	3,873,175	6,491,515
Cement	do	4,068,484	4,068,484	4,248,079	4,248,079
Other [2]	do	3,931,741	10,466,505	4,473,564	11,923,767
Total	do	36,227,355	51,419,926	35,219,128	50,938,985
Grand total	do	36,247,433	53,574,066	35,239,747	53,393,333

[1] Includes flagging, rubble, and rough architectural stones.
[2] Includes stone for terrazzo, roofing granules, glass, whiting, asphalt filler, fertilizer filler, other filler, coal dust, filter beds, mineral food, poultry grit, lime, refractory, flux, and miscellaneous uses.

Table 13.—Stone sold or used by producers, by kinds

(Short tons and thousand dollars)

Year	Granite (dimension)		Limestone		Sandstone (dimension)		Other stone [1]		Total stone	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1962	4,452	$286	27,900,975	$40,889	2,943	$38	968,052	$2,793	28,876,422	$44,006
1963	2,958	317	29,776,088	42,711	3,655	55	1,101,840	3,047	30,884,541	46,130
1964	3,226	292	30,567,256	44,586	2,208	29	914,026	3,077	31,486,716	47,984
1965	3,124	234	34,952,692	49,770	2,258	52	1,289,359	3,518	36,247,433	53,574
1966	2,471	253	33,698,016	48,468	1,500	36	1,537,760	4,636	35,239,747	53,393

[1] Includes crushed granite (1965, 1966), marble, miscellaneous stone, and crushed sandstone.

Table 14.—Iron ore (usable)

(Thousand long tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	394	$3,823
1962	346	3,188
1963	345	3,085
1964	1,116	14,907
1965	1,784	24,607
1966	1,887	26,450

deposit contains a magnetite ore body that has been exceptionally well suited for concentrating and for producing high-grade iron ore pellets. Frazier-Davis Construction Co. "bottomed-out" the main production shaft at 1,356 feet. Sinking of the 15-foot-diameter ventilation shaft, 1,200 feet southwest of the main shaft, began late in 1966. Contracts were awarded for design and construction of the concentrating and pelletizing plant. Target date for beginning operations at the mine, mill, and pellet plant was early 1968. Designed annual capacity of the facility, originally 750,000 tons of iron ore pellets averaging about 64 percent iron, was increased to 1 million tons. This will supply half of the iron ore requirements for the enlarged capacity of the Granite City Steel Company's two large blast furnaces in Granite City, Ill. Increased pig iron production from the blast furnaces was to coincide with the conversion to the basic oxygen process.

Table 15.—Ferrous scrap and pig iron consumption

(Thousand short tons)

Year	Ferrous scrap	Pig iron	Total scrap and pig iron
1962	865	29	894
1963	908	33	941
1964	1,029	40	1,069
1965	1,096	42	1,138
1966	1,063	41	1,104

Lead.—The St. Joseph Lead Co. Fletcher mine and mill, with a designed capacity of 5,000 tons of ore per day, neared the production stage. One of two shafts is for men, materials, and ventilation, and the other is for automatically receiving and hoisting ore. The production shaft, the deepest in the St. Joe system, is 1,348 feet deep, and the ventilation shaft is 1,033 feet deep. Ore will be mined on two levels, at 980 feet and at 1,116 feet. The primary crusher is underground and the automated flotation mill, controlled by an X-ray analyzer and a computer, is on the surface.

A second shaft in the Indian Creek Division was begun in October. Exploration, which began in 1962, located an ore body of about 5 million tons about a mile northeast of the present plant and about 300 feet lower than the present mining operations. Another shaft, 12½ feet in diameter, was being sunk to a depth of 1,176 feet to service three separate levels of mining. Headframe, hoist, compressors, and buildings were reclaimed from Mine La Motte properties.

Missouri Lead Operating Co., a joint venture of American Metal Climax, Inc., and Homestake Mining Co., was developing a 4,000-ton-per-day mine and mill at Buick. The mine featured two 18-foot-diameter shafts almost 1,400 feet deep. Target

Table 16.—Mine production of silver, copper, lead, and zinc, in terms of recoverable metals

Year	Mines producing	Material sold or treated	Silver		Copper	
		Crude ore (short tons)	Troy ounces	Value (thousands)	Short tons	Value (thousands)
1957–61 (average)	-----	5,906,791	160,298	$145	1,333	$791
1962	6	2,991,463	490,896	533	2,752	1,695
1963	4	3,253,245	131,664	168	1,816	1,119
1964	5	4,965,814	-------	-------	2,059	1,343
1965	5	5,279,420	299,522	387	2,331	1,650
1966 [1]	7	5,387,330	-------	-------	3,913	2,831

Year	Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	
1957–61 (average)	111,073	$26,668	2,415	$570	$28,174
1962	60,982	11,221	2,792	642	14,091
1963	79,844	17,246	321	74	18,607
1964	120,148	31,479	1,501	408	33,230
1965	133,521	41,659	4,312	1,259	44,955
1966 [1]	132,255	39,981	3,968	1,151	43,963

[1] Includes Southwest Missouri.

Table 17.—Mine production of lead and zinc in Missouri, in terms of concentrates and recoverable metals [1]

Year	Lead concentrates (galena)		Zinc concentrates (sphalerite)		Recoverable metal content [2]			
					Lead		Zinc	
	Short tons	Value [3] (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1957–61 (average)	155,763	$23,610	4,701	$384	111,073	$26,668	2,415	$570
1962	83,897	10,620	5,135	492	60,982	11,221	2,792	642
1963	109,960	15,054	666	50	79,844	17,246	321	74
1964	167,630	28,125	3,115	205	120,148	31,479	1,501	408
1965	186,368	36,537	8,792	891	133,521	41,659	4,312	1,259
1966	185,410	33,816	8,525	795	132,255	39,981	3,968	1,151

[1] Based on Missouri ore "dirt" and old tailings treated at mills.
[2] In calculating metal content of ores from assays, allowance has been made for smelting losses. In comparing values of concentrate "ore" and metal, value for concentrate is that received by producer, whereas value of lead and zinc is calculated from average price for all grades.
[3] Values are arbitrary because part of lead concentrate is smelted by producer.

Table 18.—Tenor of lead and zinc ore milled and concentrates produced in Missouri

		1965	1966
Concentrate production:			
Lead	short tons	186,368	185,410
Zinc	do	8,792	8,525
Concentrate obtained from crude ore:			
Lead	percent	3.53	3.44
Zinc	do	.17	.16
Metal content of ore: [1]			
Lead	do	2.53	2.45
Zinc	do	.08	.07
Average lead content of galena concentrate	do	73.11	72.79
Average zinc content of sphalerite concentrate	do	54.49	51.71
Average value per ton:			
Galena concentrate		$196.05	$182.38
Sphalerite concentrate		$101.32	$93.27
Total material milled	short tons	5,279,420	5,387,330

[1] Figures represent metal content of crude ore only as recovered in the concentrate; data on tailing losses not available.

date for startup of the mine and mill was early 1968.

The Bunker Hill Co. was rotary drilling the main production shaft at the Higdon mine in Perry County northeast of Fredericktown. The decision to drill followed the successful drilling of the 1,500-foot, 60-inch (46-inch casing) ventilation shaft at the property. The production shaft will be 108 inches in diameter, drilled to 1,500 feet, and lined with an 84-inch casing. Ore will be hoisted with a single cage and skip with a counterbalance.

Ozark Lead Co., a wholly owned subsidiary of Kennecott Copper Corp., used an 84-inch rotary bit to drill the exploratory shaft at its new Adair Creek mine in Reynolds County in 1964 and 1965. The rotary drilling rig sank the 1,200-foot shaft in 12 months. The shaft, fitted with a steel liner, 6 feet in diameter, set in sections welded together for the total depth of 1,200 feet, was being used for underground development work. Ore recovered during mine development was being stockpiled. An $11-million contract was awarded for the firm's 6,000-ton-per-day concentrator on an 18-acre site northwest of Ellington. The lead concentrates, expected to yield about 60,000 tons per year of pig lead, will be treated in ASARCO's new lead smelter at Glover; zinc, silver, and cadmium will be recovered at out-of-State facilities.

Cominco American, Inc., operator of the Magmont project near Bixby, is developing a 4,000-ton-per-day lead mine and constructing a mill. Dresser Magcobar, a division of Dresser Industries, is a joint owner. At yearend, the 19-foot-diameter production shaft was down to its designed depth of 1,220 feet, and a Koepe hoist frame was installed. A contractor also was drilling the 6-foot auxiliary and ventilation shaft, about ½ mile east of the main shaft. Target date for production was early 1968.

St. Joseph Lead Co. began using its newly expanded Herculaneum smelter in Jefferson County which had been under construction for the past 2 years. The plant expansions included a thawhouse, concentrate unloading stations, sintering plant using an updraft roasting principle, larger blast furnaces, and a simplified drossing plant of four 250-ton kettles. A sulfuric acid plant for waste smelter gases was planned. The expansions increased the smelter capacity to more than 200,000 tons of refined lead per year.

Construction of Missouri Lead Operating Co.'s (MOLOC) smelter near Bixby, Iron County, is expected to be completed by yearend 1967. The smelter will consist of a sinter-roasting plant, blast furnaces, refinery, casting plant, and sulfuric acid plant. Capacity is 100,000 tons per year of refined lead. An estimated 50,000 tons per year will be produced from MOLOC's Buick mine concentrates; the other 50,000 tons will be produced on a toll basis from Cominco-Dresser's Magmont mine concentrates.

American Smelting and Refining Company (ASARCO) began building a multimillion dollar custom lead smelter at Glover in Iron County. The plant will process the concentrate from the mill now being constructed by Ozark Lead Co., a wholly owned subsidiary of Kennecott Copper Corp. The smelter, reportedly, also will process concentrates from ASARCO's lead

deposit at West Fork, when and if the mine is developed there, and may provide custom smelting facilities for small mines in the Mississippi Valley. The smelter, being built by Kaiser Engineers, Oakland, Calif., would have an initial capacity of about 80,000 tons of refined lead per year with provisions for future expansion. The plant was expected to be in operation by early 1968. The facility, adjacent to the Missouri-Pacific Railroad, would employ about 150 men.

Zinc.—Output of zinc, a coproduct of lead, is expected to increase as development progresses at the new mines. Mining activity in the Missouri part of the Tri-State District resumed on a small scale for the first time since 1957. Paul Childress reopened the old Hyde Park shaft near Duenweg in Jasper County.

MINERAL FUELS

Production of mineral fuels approximated that of 1965. Coal output had the greatest value. A small amount of petroleum was recovered. Leading coal producing counties were Henry, Macon, Boone, and Putnam.

Coal.—The Thomas Hill steam-generating plant of the Associated Electric Cooperative, under construction in western Randolph County, was completed. The facilities will produce 150,000 kilowatts of electricity that will go into a Statewide power network suppling five private utilities and six cooperatives. The plant, located on the western edge of the largest coal basin in the State, will consume 2,000 tons of coal per day. Coal was to be supplied by the Peabody Coal Co. Bee Veer mine, Macon County, from strip-mine operations of the Bevier and Wheeler coalbeds. A coal supply, adequate for 40 years, has been developed.

Table 19.—Coal (bituminous) production

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	2,829	$12,151
1962	2,896	12,057
1963	3,174	13,196
1964	3,254	13,285
1965	3,564	14,779
1966	3,582	14,834

Plans to construct a $25 million, steam-generating plant in Jasper County by the Empire District Electric Co. and the development of a coalfield in adjacent Barton County be the Pittsburg & Midway Coal Mining Co. to serve the plant were made public in a joint announcement by the two companies. The plant, with a capacity of 200,000 kilowatts, will be located in the extreme northern part of Jasper County, just south of Barton County where Pittsburg & Midway holds substantial coal reserves. Coal will be delivered directly from the strip mine by conveyor belts to the powerplant. The plant and mine were scheduled to be in production by mid-1970.

Petroleum.—Output of petroleum in the State, although not large, was a record high in 1966. At yearend, the State had 150 producing oil wells. Some wildcat activity was reported in the "Boot Heel" area in extreme southeast Missouri. Shell Oil Co. completed its evaluation of two thermal recovery pilot projects in Vernon County. The Marathon Oil Co. expanded its secondary recovery projects at the Clark-Miller oilfield in Jackson County. Heavy oil activity, reported in 1965 for west-central Missouri, apparently was not continued.

REVIEW BY COUNTIES

Mineral production was reported in 92 of the 114 counties in Missouri, 14 less than in 1965. The newest county to be added was Andrew County with reported production of stone for riprap.

Andrew.—Mineral production was reported in Andrew County for the first time since 1962; Missouri City Stone Co. quarried and crushed sandstone for riprap.

Audrain.—The county was the leading clay producer in the State. Seven companies mined refractory clays for manufacturing firebrick, blocks, and high-alumina mortars.

Barton.—Coal was produced by Palmer Rock and Coal Co. and crushed limestone by John J. Stark Contractors.

Bates.—Bates County Rock, Inc., Underwood Quarry, and Wade Agricultural Products Co. quarried and crushed limestone for concrete aggregate, roadstone, and aglime (agricultural lime).

Boone.—The Peabody Coal Co. Mark Twain mine near Hinton was one of the

Table 20.—Value of mineral production in Missouri, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Adair	$107,400	----------	
Andrew	----------	W	Stone.
Atchison	9,790	$12,131	Petroleum.
Audrain	1,433,885	1,458,175	Clays, stone.
Barry	W	148,920	Stone.
Barton	W	216,396	Stone, coal, asphaltic sandstone.
Bates	W	W	Stone.
Boone	4,188,047	4,280,716	Coal, stone, sand and gravel, clays.
Buchanan	382,075	394,584	Sand and gravel, stone.
Butler	15,314	W	Sand and gravel, clays.
Caldwell	254,096	148,472	Stone, natural gas.
Callaway	2,097,627	1,760,938	Clays, stone, coal, sand and gravel.
Camden	258,900	----------	
Cape Girardeau	12,721,664	10,319,770	Cement, stone, clays, sand and gravel.
Carter	12,000	----------	
Cass	576,349	280,350	Stone, petroleum, clays.
Cedar	155,047	110,685	Stone, sand and gravel.
Christian	11,000	----------	
Clark	W	291,546	Stone, coal.
Clay	1,516,267	1,288,962	Stone.
Clinton	186,823	838,061	Stone, natural gas.
Cole	495,000	464,280	Sand and gravel, stone.
Cooper	351,658	334,567	Stone, sand and gravel.
Crawford	5,623,264	6,354,555	Lead, copper, zinc, sand and gravel.
Dade	199,800	193,402	Stone, coal.
Dallas	28,000	----------	
Daviess	539,400	438,496	Sand and gravel, stone.
De Kalb	373,477	220,834	Stone.
Dent	3,000	----------	
Douglas	115,000	W	Sand and gravel.
Dunklin	53,000	W	Do.
Franklin	629,843	593,796	Stone, sand and gravel, clays.
Gasconade	1,124,050	1,657,593	Clays.
Gentry	W	W	Stone, sand and gravel.
Greene	3,449,637	3,827,328	Stone, lime.
Grundy	278,960	237,842	Stone.
Harrison	W	450,021	Do.
Henry	W	W	Coal, stone.
Hickory	8,000	----------	
Holt	W	W	Stone.
Howard	362,791	W	Stone, sand and gravel.
Howell	W	115,355	Iron ore.
Iron	9,469,799	9,514,281	Lead, stone, copper, zinc.
Jackson	13,633,377	12,395,635	Cement, stone, sand and gravel, clays, petroleum.
Jasper	2,914,783	3,218,535	Stone, sand and gravel, zinc, lead.
Jefferson	5,889,893	13,196,132	Cement, stone, sand and gravel, clays.
Johnson	545,803	613,806	Stone.
Knox	W	W	Do
Laclede	41,000	W	Do.
Lafayette	441,771	544,238	Stone, sand and gravel.
Lawrence	654,075	W	Stone.
Lewis	579,253	677,000	Sand and gravel, stone.
Lincoln	446,450	328,396	Stone, sand and gravel, clays.
Linn	244,343	250,659	Stone.
Livingston	645,615	667,284	Stone, clays, sand and gravel.
McDonald	39,123	W	Stone.
Macon	W	W	Coal.
Madison	W	W	Stone.
Maries	144,050	135,487	Stone, clays.
Marion	1,038,169	986,236	Stone, lime.
Mercer	346,155	W	Stone.
Miller	183,000	W	Sand and gravel.
Mississippi	22,000	----------	
Moniteau	94,750	105,134	Stone.
Monroe	429,109	460,115	Clays, stone, sand and gravel.
Montgomery	913,464	688,264	Stone, clays, sand and gravel.
Morgan	32,000	----------	
Newton	139,840	W	Stone.
Nodaway	W	613,203	Stone, sand and gravel.
Oregon	46,000	85,500	Stone.
Osage	24,355	W	Clays.
Ozark	W	82,426	Stone, sand and gravel.
Pemiscot	277,000	W	Sand and gravel.
Perry	W	287,950	Stone, sand and gravel.
Pettis	W	W	Stone.
Phelps	106,245	98,727	Stone, clays, sand and gravel.
Pike	513,058	627,093	Stone.
Platte	222,864	192,706	Clays, stone, petroleum.
Polk	28,000	----------	

See footnotes at end of table.

Table 20.—Value of mineral production in Missouri, by counties [1]—Continued

County	1965	1966	Minerals produced in 1966 in order of value
Pulaski	$255,000	W	Stone, sand and gravel.
Putnam	437,292	$441,216	Coal, stone.
Ralls	7,862,133	6,437,821	Cement, stone, clays, sand and gravel.
Randolph	W	W	Stone.
Ray	877,500	821,900	Stone.
Reynolds	8,000	----------	
St. Charles	2,031,489	1,540,836	Stone, sand and gravel, clays.
St. Clair	157,098	W	Stone.
St. Francois	24,888,998	22,397,256	Lead, lime, iron ore, stone, copper.
Ste. Genevieve	20,059,481	22,074,269	Lime, stone, sand and gravel.
St. Louis	32,653,471	29,019,460	Cement, stone, sand and gravel, clays, petroleum.
Saline	640,440	544,543	Stone.
Scotland	W	W	Stone, sand and gravel.
Scott	W	W	Stone.
Shannon	W	W	Do.
Shelby	15,121	----------	
Stoddard	W	W	Sand and gravel.
Stone	6,000	----------	
Sullivan	3,000	----------	
Taney	W	32,400	Stone.
Texas	23,000	W	Sand and gravel.
Vernon	274,102	331,784	Coal, asphaltic sandstone, petroleum, stone, sand and gravel.
Warren	314,424	254,024	Stone, clays, sand and gravel.
Washington	38,419,711	41,312,065	Iron ore, lead, barite, copper, zinc, sand and gravel.
Wayne	W	W	Stone, iron ore.
Webster	57,206	----------	
Worth	W	W	Stone.
Wright	188,000	W	Do.
Undistributed	18,730,026	20,535,844	
Total	225,568,000	227,950,000	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] The following counties were not listed because no production was reported in 1965 or 1966: Benton, Bollinger, Carroll, Chariton, New Madrid, Ripley, and Schuyler.

State's major coal producers. Columbia Brick and Tile Co. mined clay and shale and manufactured building brick. Adrian Materials Co., Boone Quarries, Inc., and Garrets City Quarries, Inc., produced crushed stone for concrete aggregate, roadstone, and agricultural uses. Brown Quarries produced stone for riprap. Columbia Sand Co. recovered sand for building, paving, and fill.

Buchanan.—A new producer, E. F. Brosnahan, reported output of crushed limestone for riprap, concrete aggregate, and aglime. Everett Quarries, Inc., and L. S. Stafford continued producing crushed stone. Pioneer Sand Co. produced sand for building, paving, and railroad ballast.

Callaway.—The county again ranked third in value of clay output with four firms producing fire clay from 12 pits. Four firms crushed stone for riprap, roadstone, railroad ballast, and aglime. Callaway Sand Co. processed sand for building. Clayton-Hensley strip mined coal at the Hammitt pit.

Cape Girardeau.—The county was an important producer of stone, clay, and cement, the stone and clay being used mostly by Marquette Cement Manufacturing Co. Brick and pottery were produced by Kasten Clay Products, Inc., and Ceramo Co., Inc., respectively. Crushed limestone was produced by Federal Materials Co., Inc., and Farmers Limestone Co. A new limestone quarry was opened by Southeast Missouri Stone Co. to produce crushed stone and riprap.

Cass.—Acme Brick Co. processed clay into building brick near Harrisonville. Deitz-Hill Development Co., Hackler & Limpus Quarry, and Marino & Hoover Construction Co., Inc., produced limestone for roadstone, riprap, and aglime.

Clark.—Baker Quarry Co. quarried and crushed limestone for various uses. A small tonnage of coal was strip mined by Hamlin Bros. Coal Co. for local use.

Clinton.—Everett Quarries, Inc., operated several quarries in the county and crushed stone for various local uses. The Turney gasfield continued to produce for local heating use.

Cole.—Three commercial operators washed and screened sand and gravel for building, paving, and other uses. Jeff-Cole quarries at Jefferson City and Boone Quarries, Inc.,

at Marion produced crused limestone for concrete aggregate, roadstone, and aglime.

Crawford.—Over 500,000 tons of lead-zinc-copper ore was mined from the St. Joseph Lead Co. No. 27 mine.

Dade.—Tyler Coal Co. strip mined coal east of Arcola. Allen Quarries mined and crushed limestone for concrete aggregate, roadstone, and aglime.

Daviess.—Snyder Quarries, Inc., produced crushed limestone and sand and gravel for various uses. Bethany Falls Transit Mixed Concrete processed sand for building and paving purposes. Hallett Construction Co. produced gravel for fill.

Douglas.—Welton & Gray Gravel Co. increased its output of gravel for extensive paving projects in the area.

Franklin.—Four firms mined fire clay at seven pits for making firebrick and blocks. Five firms produced stone principally for riprap on Missouri River projects. Sand and gravel were produced by three commercial firms and by the U.S. Army Corps of Engineers.

Gasconade.—The county ranked first in value of clay produced. Eight companies mined fire clay for refractory use at more than 50 pits.

Greene.—Carthage Marble Co. quarried marble blocks at the Phoenix quarry and processed the blocks into commercial building stone. Ash Grove Lime & Portland Cement Co. quarried limestone for conversion to hydrated lime and quicklime at its Galloway plant.

Henry.—Henry County was the State's leading coal producer; three strip mines were active. Peabody Coal Co. operated the Power mine and the Tebo mine, and Madole Bros. Coal Co. operated the Black Snake mine. Four firms produced crushed limestone for riprap, concrete aggregate, and agricultural uses.

Holt.—A large limestone quarry was operated by Gordon Bros. Quarries, Inc. The crushed stone was used for riprap, concrete aggregate, roadstone, and aglime.

Howell.—Plateau Iron Ore Corp. mined and washed brown iron ores in the first quarter for shipment to Alabama. The Missouri brown iron ore has very low phosphorus content.

Iron.—The Viburnum mill of St. Joseph Lead Co. treated nearly 2 million tons of lead-zinc-copper ore during the year, about 650,000 tons of which came from the company's mine in Iron County. Heyward Granite Co. quarried and processed granite near Graniteville for dimension construction stone and for monumental stone. The Ruberoid Co. had its first full year of operation at Annapolis where it quarried, crushed, and processed felsite into roofing granules.

Jackson.—The county ranked second in the State in stone output with 12 producers. Shale and limestone were mined by Missouri Portland Cement Co. for processing into cement at its Sugar Creek plant. Acme Brick Co. mined shale for making building brick. Zonolite Co. exfoliated crude vermiculite from Montana at its Kansas City plant. A small quantity of crude oil was produced.

Jasper.—Geo. M. Baker Co., Independent Gravel Co., Joplin Stone Co., Nelson Quarries, and Valentine Supply produced crushed stone for a variety of uses. Two producers accounted for a small quantity of zinc and lead concentrates.

Jefferson.—Value of mineral output in Jefferson County increased substantially over the past few years because of new cement facilities and increased sand, gravel, and stone output for highway construction and building needs. River Cement Co. produced limestone, sandstone, and loess for cement manufacture. Three companies, Pittsburgh Plate Glass, Masters Bros., and Manley Sand Division of Martin Marietta Corp., produced silica sand for glassmaking and other industrial sand uses. Five companies quarried and crushed limestone, and a sixth, Fred Weber Contractors, Inc., began clearing for a limestone quarry south of Festus-Crystal City. Marble Products Co. of Georgia and Paul H. Guidicy crushed marble for terrazo chips.

Lafayette.—Deitz-Hill Development Co. crushed limestone for concrete aggregate, roadstone, and agricultural use. Red Stone Co. crushed stone for riprap. Kemco Sand & Gravel and Raymond Drivers Sand Co. produced sand for building and paving use.

Lewis.—Missouri Gravel Co. processed sand and gravel, and quarried and crushed limestone for aglime and roadstone. Hamill Lime Co. produced crushed limestone near Monticello, largely for road uses.

Lincoln.—Harbison-Walker Refractories Co. mined fire clay near Whiteside for making firebrick, block, and mortar. Crushed stone was produced by Dawson

Dameron, Presley & Roberts, R & B Rock Co., and Watson Quarries. Kimaterials and Glacial Gravel Co. recovered sand and gravel for building, paving, fill, and other uses.

Livingston.—Midland Brick & Tile Co. mined and processed shale for building brick and heavy clay products. Cooley Gravel Co. produced sand for building and fill purposes. Farmers Stone Products Co., Green Quarries, Inc., Fred McVey Quarry, and Trager Quarries, Inc., crushed stone for riprap, concrete aggregate, and aglime.

Macon.—The county was second in coal output with the State's largest strip mine, the Bee Veer mine of Peabody Coal Co.

Maries.—Kaiser Refractories and H. K. Porter Co., Inc., produced fire clay from three pits for firebrick and blocks. Crushed limestone was produced by the Virgil Smith Quarries.

Monroe.—Walsh Refractories Corp., Joe Gilliam Mining Co., and Christy Firebrick Co. produced fire clay for zinc retorts, firebrick, and block. Hamilton Lime Co. and Wilkerson Bros. quarried limestone for concrete aggregate and aglime. Wilkerson Bros. also produced sand and gravel.

Montgomery.—Wellsville Fire Brick Co., General Refractories Co., and Kaiser Refractories produced fire clay from 12 pits for firebrick and block. Edwin Bebermeyer and McClain Lime Quarry crushed limestone for roadstone and agriculture use. The Two Rivers Sand and Gravel Co. produced sand largely for building use.

Pike.—Galloway Limestone Co., Inc., Magnesium Mining Co., and Smith's Grandview Quarries produced crushed limestone for concrete aggregate, riprap, and agricultural use.

Platte.—Shale was mined and processed into lightweight aggregate by the Carter Waters Corp. at its Haydite plant near New Market.

Putnam.—Coal was produced from three underground and three open-pit mines in the county. Putnam County Stone, Inc., produced crushed limestone for aggregate, surfacing, and aglime.

Ralls.—Universal Atlas Cement Division of United States Steel Corp. mined shale and limestone for cement at its plant south of Hannibal. Central Stone Co. crushed stone for roadstone, railroad ballast, and agricultural use.

Reynolds.—The Fletcher mine of St. Joseph Lead Co., scheduled for completion early in 1967, started stockpiling lead ore at the end of 1966. Ozark Lead Co., northwest of Ellington, continued developing its lead mine and mill which are scheduled to go into production in early 1968.

St. Charles.—Pennsylvania Glass Sand Corp. processed sand for use in glass, molding, and industrial uses. Fire clay was produced at Kilker by General Refractories Co. Highland Fire Clay Co. mined shale at St. Charles for building brick. Crushed limestone was produced for a wide range of uses by Consumers Stone & Supply Co., Defiance Quarry Co., Joerling Bros., O'Fallon Quarry & Supply Co., St. Charles Quarry Co., and Schiermeier Quarry.

St. Francois.—The county was the State's leading producer of lead and copper. Trap Rock Materials & Engineering Co. processed felsite mine tailings for roadstone and concrete aggregate from the wastepiles at Iron Mountain. St. Joseph Lead Co. produced more than 3 million tons of lead-copper ore from its Federal Division mines. Valley Dolomite produced refractory dolomite (burned dolomite) and marketed crushed stone for a variety of uses. Dolomite tailings (chats) from the St. Joseph Lead Co. operations were shipped to in-State and out-of-State markets for aglime.

Ste. Genevieve.—The mineral commodity with highest value produced in the county was quicklime and hydrated lime which was processed by the Mississippi Lime Co. Crushed limestone for concrete aggregate, roadstone, aglime, and other uses was produced by Cliffdale Quarry & Manufacturing Co., Mississippi Lime Co., and Roth Building Stone Co. Tennessee Marble Co. and Weiler Marble Co. quarried rough marble blocks. Dressed dimension stone for building and other uses was produced by Roth Building Stone Co. Several companies maintained limestone quarries in the county that were operated intermittently for riprap.

St. Louis.—St. Louis County mineral output was the second highest in the State, and the county ranked first in production of crushed limestone and sand and gravel. Eleven firms produced stone in the county for a wide range of uses. Fourteen companies produced sand and gravel. Five producers mined and processed clay and shale for building brick, heavy clay products, cement, firebrick, and block. Two plants, Alpha Portland Cement and Missouri Portland Cement, produced cement. A barite

grinding plant, a vermiculite exfoliating plant, and a perlite popping plant contributed to the large and varied mineral industry of the county.

Vernon.—Asphaltic sandstone for road surfacing was produced by Midwest Silica Rock Co. Ellis Coal Co. and Nichols Coal Co. strip-mined coal for local markets. Nevada Limestone Co. quarried and crushed limestone for roadstone. Pilot plant studies conducted by Shell Oil Co. on fireflooding of heavy-oil deposits near Richards were discontinued.

Warren.—Fire clay was mined and processed into brick, block, and mortar by Harbison-Walker Refractories Co. and Kaiser Refractories. Joerling & Narup, Sprick Quarry, and Brown Quarries quarried and crushed limestone for concrete aggregate, riprap, and agricultural uses.

Wayne.—Taft-Dow, Inc., mined brown iron ore and treated it at a washing plant in Williamsville during the year. Harris Lime Co. quarried and crushed dolomite for aglime.

Washington.—The county ranked first in the State in value of mineral output. Twelve firms mined barite from numerous pits throughout the county. Meramec Mining Co. increased its output of iron pellets from the Pea Ridge mine and mill. The St. Joseph Lead Co. Indian Creek Division and Viburnum No. 29 mines produced about 1 million tons of lead-zinc-copper ores.

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 Fred V. Carrillo,[1] Ronald P. Collins,[2] and William N. Hale [1]

Montana's 1966 mineral production value was the highest ever recorded—$245 million. The advance of $17 million over that of 1965 was the result of greater production of copper, petroleum, silver, and phosphate rock. The gain in value furnished by these commodities more than offset production and value declines in lead, zinc, and stone. Production of copper and crude petroleum continued to show strong annual gains—nearly three-fourths of the State's total production value was derived from these two mineral commodities. The ratio of combined copper and petroleum values to the total value has grown steadily—67 percent in 1964, 71 percent in 1965, and 73 percent in 1966.

The Butte district operations of The Anaconda Company contributed 97 percent of the State's copper, lead, zinc, gold, and silver output value. The Anaconda Company, in response to industrial demands, strove to expand facilities that would increase copper production. The firm an-

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[2] Economist, Bureau of Mines, Albany, Oreg.

Table 1.—Mineral production in Montana [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	76	$98	53	$56
Coal (bituminous and lignite) do	364	1,050	419	1,290
Copper (recoverable content of ores, etc.) short tons	115,489	81,766	128,061	92,639
Gem stones	NA	77	NA	109
Gold (recoverable content of ores, etc.) troy ounces	22,772	797	25,009	875
Iron ore (usable) thousand long tons, gross weight	9	71	12	93
Lead (recoverable content of ores, etc.) short tons	6,981	2,178	4,409	1,833
Lime thousand short tons	159	1,512	225	2,116
Manganese ore and concentrates (35 percent or more Mn) short tons, gross weight	23,621	W	W	W
Manganiferous ore and concentrate (5 to 35 percent Mn) do	1,968	W	1,755	28
Natural gas million cubic feet	28,105	2,305	30,685	2,547
Petroleum (crude) thousand 42-gallon barrels	32,778	79,624	35,380	86,273
Pumice thousand short tons	-----	-----	22	5
Sand and gravel do	12,048	13,587	13,816	13,523
Silver (recoverable content of ores, etc.) thousand troy ounces	5,207	6,733	5,320	6,878
Stone thousand short tons	5,512	5,971	4,150	5,212
Zinc (recoverable content of ores, etc.) short tons	33,786	9,866	29,120	8,445
Value of items that cannot be disclosed: Antimony (1966), barite, cement, fluorspar, gypsum, natural gas liquids, peat, phosphate rock, talc, tungsten (1966), uranium (1966), vermiculite, and values indicated by symbol W	XX	r 22,528	XX	23,846
Total	XX	r 228,163	XX	245,268

r Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes bentonite; included with "Value of items that cannot be disclosed."

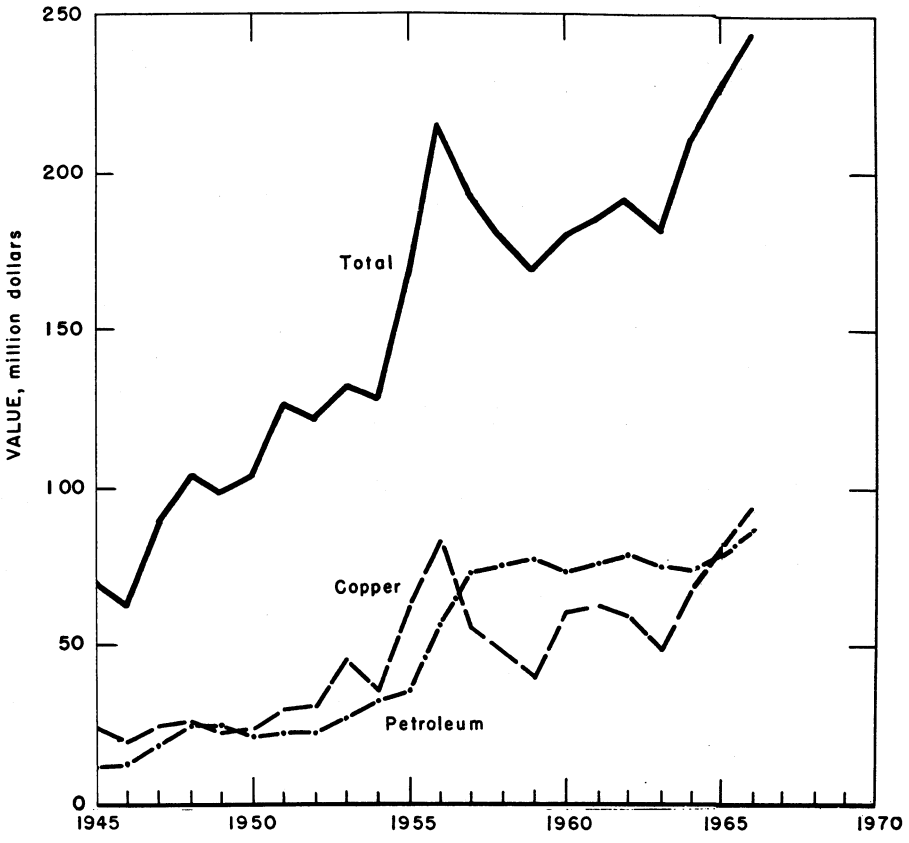

Figure 1.—Value of copper, petroleum, and total value of mineral production in Montana.

nounced that the copper mill at Anaconda, idle since 1964, had been activated; that the Butte concentrator was to be enlarged by 1967 to recover additional copper from acid-soluble ores; and that a sixth converter was to be added to the Anaconda copper smelter where the fifth was already under construction.

Anaconda Aluminum Company announced that a fifth potline was to be built at its Columbia Falls smelter after construction underway on the fourth was finished in 1968. The planned additions were to add 70,000 tons to the plant's rated annual capacity.

Lead and zinc production and value decreased because of reduced output from the Badger State mine and the slag-fuming plant at East Helena; nevertheless, the combined production value of the two metals amounted to nearly $10 million.

The value of silver output increased primarily as a result of the byproduct silver produced from Butte district copper and zinc mines.

The petroleum industry experienced significant growth, as the value of crude petroleum output advanced 8 percent, reaching an alltime high exceeding $86 million. The Williston Basin supplied 60 percent of the total production.

Strong growth trends were shown in the production of phosphate rock, lime, cement (except masonry), and natural gas. The value of sand and gravel output remained about the same as the 1965 figure—$13.5 million.

Economic indicators of business activity (table 3) were closely alined to the national profile—personal income and employment were up, and construction activity was down. Because of a national monetary

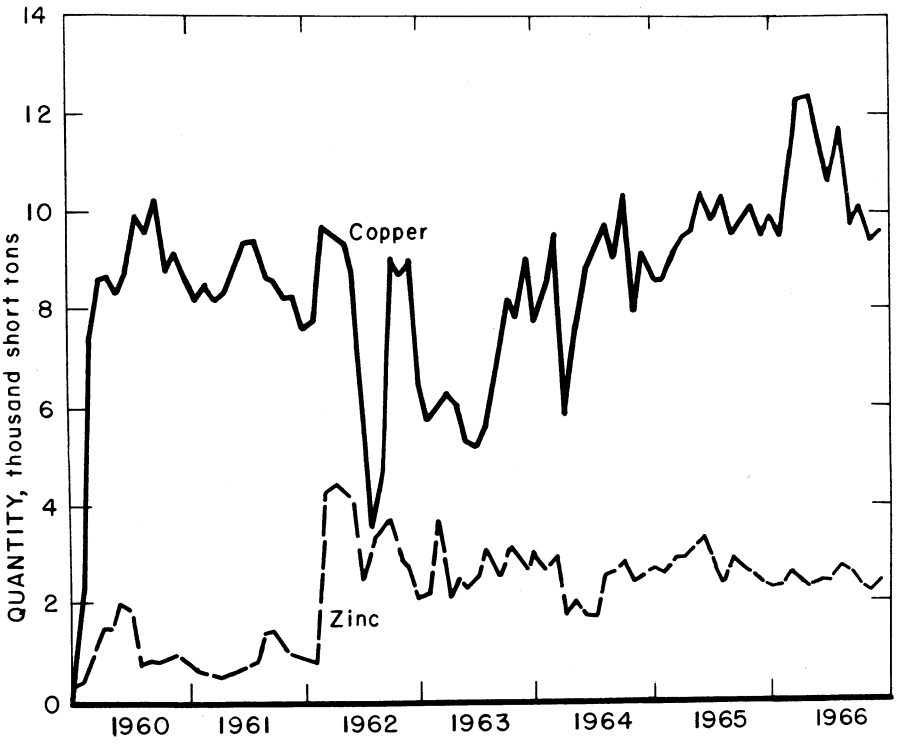

Figure 2.—Mine production of copper and zinc in Montana, by months, in terms of recoverable metals.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]
1961	$181,973
1962	186,172
1963	177,307
1964	200,209
1965	208,120
1966	221,537

[1] Data for 1961–65 Revised.

policy that limited the flow of investment funds, interest rates rose, exerting heavy pressure on the construction sector of the economy. However, construction activity did increase in the State late in the year. The Libby Dam project, Lincoln County, and the addition to the aluminum reduction plant of Anaconda Aluminum Co., Flathead County, required greater numbers of workers. Aided by fairly mild weather conditions far into the winter months throughout most of the State, income from agricultural activity increased nearly 20 percent.

Employment.—According to reports by the Montana State Employment Service, record-breaking nonfarm employment reached crests each month that exceeded the respective monthly figures of the previous year. Total employment averaged 185,000 workers, a gain of 4,100 above the 1965 average figure. A record total employment for 1 month was reached in July when 195,000 wage earners were reported. Declines caused by seasonal factors existed in many sectors, but the adjusted levels were higher than in past years. Increased employment was evidenced in Government, construction manufacturing, and service industries. Serious shortages of qualified workers were reported in logging, metal mining, and trade industries. The average

Table 3.—Indicators of Montana business activity

		1965	1966 p	Change, percent
Personal income:				
Total	million dollars	1,714.0	1,836.0	+7.1
Per capita	dollars	2,438.0	2,615.0	+7.3
Construction activity:				
Building permits	million dollars	33.6	25.5	−24.1
Heavy engineering awards	do	128.1	107.4	−16.2
Highway construction contracts awarded	do	41.6	36.5	−12.3
Cement shipments to and within Montana	thousand 376-pound barrels	1,493.3	1,412.5	−5.4
Cash receipts from farm marketings	million dollars	420.5	500.4	+19.0
Mineral production	do	228.2	245.4	+7.5
Annual average employment:				
Total nonagricultural industries	thousands	181.3	185.4	+2.3
Total manufacturing	do	22.2	23.4	+5.4
Lumber and timber industries	do	8.6	9.3	+8.1
Metal-mining and primary-metal industries	do	8.2	8.7	+6.1
Contract construction	do	12.0	11.4	−5.0
Transportation and utilities	do	17.5	17.6	+0.6

p Preliminary.

Source: Survey of Current Business, Construction Review, Pacific Builder & Engineer, Montana Highway Commission, The Farm Income Situation, Montana Labor Market, and Bureau of Mines.

Table 4.—Employment for selected mineral industries

Year	Total mining	Metal mining	Nonmetals, including coal	Petroleum and natural gas	Processing	
					Primary metals	Petroleum refining
1957–61 (average)	8,400	5,200	740	2,480	3,900	1,000
1962	6,800	3,800	800	2,200	3,500	1,000
1963	7,100	4,100	900	2,100	3,200	1,200
1964	7,600	4,800	900	1,900	3,300	1,200
1965	7,500	4,600	1,100	1,800	3,600	1,100
1966 p	7,400	4,800	1,000	1,600	3,900	1,100

p Preliminary.

Source: Montana State Employment Service, Montana Labor Market. Excludes proprietors and self-employed. Industry groups may vary from those in the Bureau of Mines canvass.

Table 5.—Hours and earnings data in mining and related industries

Industry	1962	1963	1964	1965	1966
Mining:					
Average weekly earnings	$111.24	$113.85	$114.76	$119.12	$125.51
Average weekly hours	41.2	41.2	38.9	38.8	39.1
Average hourly earnings	$2.70	$2.77	$2.95	$3.07	$3.21
Metal mining:					
Average weekly earnings	$107.25	$110.76	$111.97	$114.39	$122.80
Average weekly hours	39.0	39.0	37.7	36.9	37.9
Average hourly earnings	$2.75	$2.84	$2.97	$3.10	$3.24
Primary-metals processing:					
Average weekly earnings	$102.82	$105.74	$110.40	$116.40	$122.25
Average weekly hours	39.7	39.9	40.0	40.7	41.3
Average hourly earnings	$2.59	$2.65	$2.76	$2.86	$2.96

Source: Montana State Employment Service, Montana Labor Market. Hours and earnings data exclude administrative and salaried personnel. Average weekly and hourly earnings include overtime and other premium pay.

Table 6.—Employers, wage earners, and wages in mining

Fiscal year	Average number of employers	Average number of wage earners	Wages (thousands)	Average annual wage
1957–61 (average)	472	8,771	47,932	5,465
1962	464	6,882	41,800	6,075
1963	421	6,837	43,107	6,316
1964	433	7,163	45,225	6,314
1965	421	7,456	49,048	6,578
1966	423	7,579	51,262	6,764

Source: Unemployment Compensation Commission of Montana, Montana Labor Market. Industries and employment covered under unemployment insurance laws of Montana.

Table 7.—Employment 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
1965:								
Coal and peat	111	151	17	132	-----	9	67.96	1,495
Metal	4,391	254	1,115	8,920	7	149	17.49	6,768
Nonmetal	861	265	229	1,829	2	31	18.05	7,186
Sand and gravel	807	196	158	1,268	-----	23	18.15	484
Stone	548	205	112	905	-----	18	19.89	551
Total	6,718	243	1,631	13,054	9	230	18.31	5,731
1966: p								
Coal and peat	105	149	16	124	1	9	80.65	49,984
Metal	4,160	301	1,254	10,030	7	189	19.54	5,623
Nonmetal	855	263	225	1,797	-----	29	16.14	541
Sand and gravel	1,025	184	188	1,459	-----	34	23.30	554
Stone	515	216	111	887	-----	18	20.29	407
Total	6,660	269	1,794	14,297	8	279	20.07	4,528

p Preliminary.

weekly earnings of mining industry workers had increased to $125.51 in 1966 from $108.14 in 1961; the average hourly work week declined in the same period from 40.2 hours in 1961 to 39.1 hours in 1966. The average annual wage had increased by nearly $1,300 to $6,764 from the 1957–61 average mark of $5,465.

Government Programs.—The Office of Minerals Exploration (OME) approved one new contract and continued three contracts already in effect. Carroll R. Bennett received a $66,220 contract to develop a silver property (Florence mine) in Cascade County. The American Mining Co. contract ($61,880) continued at the Nancy Hanks mine in Granite County. Two contracts in Jefferson County were active at two mines: The Ruby mine belonging to Ruby Silver Mines, Inc. ($132,000), and the Meadow mine of Mascot Silver-Lead Mines, Inc. ($28,200).

REVIEW BY MINERAL COMMODITIES

METALS

Aluminum.—According to The Anaconda Company annual report, aluminum production from the Anaconda Aluminum Co. plant at Columbia Falls was 105,821 tons, an increase of 24,978 tons over the 1965 total. This record production resulted from the first full year's operation of three potlines. Construction continued on a fourth potline, and work began on an additional potline; when completed in 1968, they will increase the company's annual aluminum capacity from 105,000 to 175,000 tons.

Antimony.—A carload of antimony concentrates was shipped from the Stibnite mine in Sanders County to the National Lead Co. smelter at Laredo, Tex.

Beryllium.—The Anaconda Company continued research on the extraction of beryllium from ore at its pilot-plant electrolytic-beryllium-refining operation at Anaconda.

Cadmium.—The Anaconda Company recovered cadmium as a byproduct from electrolytic zinc sludge. Production at Great Falls was 822 tons, highest since 1957 and a 26-percent increase over that of 1965.

Copper.—Production increased 10.9 percent over the 1965 total as The Anaconda Company continued to expand and modernize copper-producing facilities in the State. Mines at Butte yielded 127,885 tons of copper, of which 79,178 tons came from the Berkeley pit. The firm reactivated the Anaconda Reduction Works East Mill at Anaconda, Deer Lodge County, which had been idled and partially dismantled when all copper milling activities were switched to the Butte concentrator late in 1964. Vein ore from the Butte Hill mines (Mountain Con, Leonard, and Steward) was shipped to the Anaconda concentrator beginning in February, but Berkeley pit ore continued to be processed at the nearby Butte concentrator. Recovery of copper from precipitates increased to over 11,000 tons compared with 7,800 tons in 1965.

Copper-smelting capacity at the Anaconda Reduction Works was being expanded by the addition of a fifth converter, and the firm announced plans to add a sixth unit. Installation of the two converters was to raise the operation's annual anode-producing capacity by 50 percent. The new furnaces were to be housed in a 105-foot extension of the old converter building equipped with a 100-ton overhead crane and a new fan system to maintain good environmental conditions in the working area.

A study of the Pacific Northwest copper, lead, and zinc industries by the Bureau of Mines for the Bonneville Power Administration was published.[3]

Gold.—Production of gold rose nearly 9 percent because of increased recovery from copper ore, offsetting decreased output from zinc ore produced at Butte mines by The Anaconda Company. Approximately 86 percent of the State total originated in the Butte district.

Placer output from five operations totaled 423 ounces compared with 171 ounces in 1965. The largest production came from the LaChambre placers and the Twin Creek placers in Missoula County.

Indium.—The Anaconda Company produced indium during the year at the Great Falls smelter. Yearly production totaled 177,000 ounces and reached a monthly rate of 16,000 ounces by November.

Iron Ore.—Production of iron ore, entirely by R & S Iron Co. from the Iron Cross mine near Radersburg, increased because of greater requirements at a Gallatin County cement plant.

Lead.—Production of lead was 36.8 percent below that of 1965 largely because of curtailed output from the Badger State block-caving operation at Butte and from the slag-fuming plant at East Helena. Not only was less ore processed at the Badger State mine, about 10 percent below 1965, the lead content of the ore mined was also lower.

Most of the lead not produced by The Anaconda Company at Butte or East Helena came from the Nancy Lee mine (E.G. Smith), Mineral County, and from the Maulden mine (Ida B. Hand), Beaverhead County.

Manganese.—Shipments of manganese ore and concentrate (35 percent or more manganese) dropped sharply because of reduced sales of stockpiled nodules by The Anaconda Company. Taylor-Knapp Co. shipments of manganese concentrate were slightly below those of 1965. Taylor-Knapp was the sole shipper of manganiferous ore and concentrate (5 to 35 percent manganese); the ore originated from the firm's Philipsburg operation.

The outlook for ferromanganese, silicomanganese, and other ferroalloys was surveyed by the Federal Bureau of Mines for the Bonneville Power Administration.[4]

Silver.—The increasing industrial demand and the declining U.S. Treasury silver stocks prompted considerable interest in silver-bearing properties. Despite reduced output from Butte zinc mines, silver production increased 2.1 percent over 1965

[3] Knostman, Richard W., and Gary A. Kingston. Copper, Lead, and Zinc Industries in the Pacific Northwest. Bonneville Power Administration Pacific Northwest Economic Base Study for Power Markets, v. 2, pt. 7C, 1966, 139 pp.

[4] Kingston, Gary A., and Robert A. Miller. Alloy Metals Outlook in the Pacific Northwest States. Bonneville Power Administration Pacific Northwest Economic Base Study for Power Markets, v. 2, pt. 7D, 1966, 76 pp.

Table 8.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1957–61 (average)	122	14	11,108	33,724	$1,180	3,941	$3,581
1962	107	5	11,835	24,387	854	4,561	4,948
1963	117	8	9,506	18,520	648	4,242	5,426
1964	110	8	14,872	29,115	1,019	5,290	6,840
1965	121	11	15,634	22,772	797	5,207	6,733
1966	117	5	17,645	25,009	875	5,320	6,878
1862–1966	-----	-----	NA	17,777,581	406,669	857,516	653,764

Year	Copper		Lead		Zinc		Total value (thousands)
	short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1957–61 (average)	88,816	$52,941	7,386	$1,846	26,884	$6,101	$65,648
1962	94,021	57,917	6,121	1,126	37,678	8,666	73,511
1963	79,762	49,133	5,000	1,080	32,941	7,576	63,864
1964	103,806	67,682	4,538	1,189	29,059	7,904	84,634
1965	115,489	81,766	6,981	2,178	33,786	9,866	101,340
1966	128,061	92,639	4,409	1,333	29,120	8,445	110,171
1862–1966	8,205,099	2,890,338	944,129	150,050	2,834,005	548,068	4,648,888

NA Not available.
[1] Includes recoverable metal content of gravel washed (placer mines), ore milled, and ore, old slag, copper precipitates, and cleanings shipped to smelters during the calendar year indicated. Owing to rounding, individual items may not add to totals shown.
[2] Does not include gravel washed.

Table 9.—Mine production of gold, silver, copper, lead, and zinc in 1966, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Ore:							
Dry gold	6	1,110	458	900	1,400	300	1,800
Dry gold-silver	11	2,513	507	12,637	4,400	4,900	6,600
Dry silver	34	18,897	442	110,585	52,200	136,800	219,600
Total	51	22,520	1,407	124,122	58,000	142,000	228,000
Copper	6	16,595,434	19,635	3,553,060	232,695,200	-----	-----
Lead	28	17,632	665	65,750	220,800	1,969,400	673,200
Lead-zinc	11	1,239	119	13,717	2,700	411,800	191,400
Zinc	5	926,455	2,057	1,479,414	1,306,100	5,263,100	47,563,000
Total	50	17,540,760	22,476	5,111,941	234,224,800	7,644,300	48,427,600
Other lode material:							
Gold-silver old tailings and gold cleanings	4	1,731	358	13,235	4,600	-----	100
Silver old tailings	8	14,867	342	56,205	49,900	10,400	13,200
Copper precipitates	1	-----	-----	-----	21,782,300	-----	-----
Lead assay sweepings and lead-zinc cleanings	2	7	3	172	100	4,200	600
Lead-zinc and zinc slag	3	64,880	-----	14,095	2,300	1,017,100	9,570,500
Total	18	81,485	703	83,707	21,839,200	1,031,700	9,584,400
Total lode material	117	17,644,765	24,586	5,319,770	256,122,000	8,818,000	58,240,000
Total placer	5	[3]	423	15	-----	-----	-----
Grand total	122	17,644,765	25,009	5,319,785	256,122,000	8,818,000	58,240,000

[1] Detail will not necessarily add to total, because some mines produce more than one class of material.
[2] Combined to avoid disclosing individual company confidential data.
[3] 36,139 cubic yards.

Table 10.—Gold production at placer mines

Year	Mechanical and hydraulic methods [1]			Small-scale hand methods			Total [2]		
	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)
1957–61 (average)	6	113	578	7	4	54	14	117	632
1962	3	7	64	2	4	46	5	11	110
1963	2	2	16	6	5	40	8	8	56
1964	5	27	270	3	2	22	8	29	292
1965	7	93	161	4	1	10	11	94	171
1966	[3]4	36	422	1	(4)	1	5	36	423

[1] Combined to avoid disclosing individual company confidential data.
[2] Owing to rounding, individual items may not add to totals shown.
[3] Includes three dragline dredges and one power rocker.
[4] Less than ½ unit.

Table 11.—Mine production of gold, silver, copper, lead, and zinc in 1966, by counties, in terms of recoverable metals

County	Mines producing		Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
Beaverhead	13	-----	513	$18	35,386	$46
Broadwater	4	-----	1	(1)	324	(1)
Cascade	2	-----	-----	-----	23	(1)
Fergus	4	-----	2	(1)	190	(1)
Granite	19	-----	556	19	217,948	282
Jefferson	21	1	729	25	102,251	132
Lewis and Clark	9	-----	56	2	21,615	28
Madison	16	-----	939	33	13,598	18
Missoula	1	2	317	11	80	(1)
Park	2	-----	10	(1)	163	(1)
Powell	5	1	89	3	1,125	1
Sanders	3	-----	1	(1)	2,260	3
Silver Bow	5	-----	21,608	756	4,863,997	6,289
Undistributed [2]	13	1	188	7	60,825	79
Total [3]	117	5	25,009	875	5,319,785	6,878

County	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
Beaverhead	8	$6	373	$113	74	$21	$204
Broadwater	-----	-----	2	1	3	1	2
Cascade	-----	-----	(1)	(1)	-----	-----	(1)
Fergus	W	W	1	(1)	W	W	1
Granite	15	11	222	67	1,498	434	814
Jefferson	22	16	137	41	150	44	258
Lewis and Clark	7	5	571	172	4,783	1,387	1,595
Madison	3	2	7	2	2	1	55
Missoula	W	W	W	W	W	W	W
Park	1	1	(1)	(1)	(1)	(1)	2
Powell	(1)	(1)	9	3	2	1	8
Sanders	-----	-----	142	43	59	17	63
Silver Bow	127,885	92,512	2,411	729	22,284	6,462	106,749
Undistributed [2]	120	87	534	161	265	77	421
Total [3]	128,061	92,639	4,409	1,333	29,120	8,445	110,171

W Withheld to avoid disclosing individual company confidential data.
[1] Less than ½ unit.
[2] Includes values and quantities that cannot be shown separately for Deer Lodge, Flathead, Gallatin, Lincoln, Meagher, Mineral, and Ravalli Counties, and items indicated by symbol W.
[3] Owing to rounding, individual items may not add to totals shown.

Table 12.—Mine production of gold, silver, copper, lead, and zinc, in 1966, 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 (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Concentration and smelting of concentrates	21,952	5,055,539	233,548,300	6,455,600	48,168,400
Direct smelting:					
Ore	1,931	180,524	734,500	1,330,700	487,200
Old tailings	690	69,430	54,500	10,400	13,200
Assay sweeps and cleanings [1]	13	182	100	4,200	700
Precipitates	-----	-----	21,782,300	-----	-----
Old slag	-----	14,095	2,300	1,017,100	9,570,500
Total	2,634	264,231	22,573,700	2,362,400	10,071,600
Placer	423	15	-----	-----	-----
Grand total	25,009	5,319,785	256,122,000	8,818,000	58,240,000

[1] Combined to avoid disclosing individual company confidential data.

to a total of 5,319,785 ounces. Silver recovered from copper ores accounted for over 3.6 million ounces of the total silver produced.

Exploration and development activities were reported in Beaverhead, Jefferson, Lewis and Clark, Madison, Mineral, and Sanders Counties. The OME signed a $66,200 agreement with Carroll R. Bennett to explore the Florence mine near Neihart.

Thorium.—Sawyer Petroleum Co. and Union Pacific Railroad Co. signed an agreement to pursue development, mining, and marketing of Sawyer's thorium and rare earth deposits in the Lemhi Pass area of Beaverhead County. Initially, Union Pacific planned to conduct market and engineering feasibility studies. The Union Pacific agreement covered 64 mining claims and did not affect a 1965 contract under which Lemhi Minerals Co. was to process ore from a 100-acre segment of Sawyer's property at a Baker, Idaho, mill.

Zinc.—Production of zinc declined about 15 percent largely because of reduced output from Anaconda operations at the Badger State mine in the Butte distrist and at the slag-fuming plant adjacent to the American Smelting and Refining Company (Asarco) smelter at East Helena. Zinc production from the Badger State mine was to be terminated for economic reasons early in 1967 after all existing undercut cave blocks were mined.

Despite the bleak outlook for zince mine production at Butte, the future of slab zinc production in the State was greatly improved by the availability of foreign concentrates. Anaconda began producing slab zinc in September at a reactivated electrolytic plant at Anaconda after signing an agreement to smelt 9,000 to 10,000 tons of concentrates produced annually by Pine Point Mines, Ltd., a subsidiary of Cominco of Canada, Ltd., at Pine Point, Northwest Territories, Canada. Reopening the plant required rehabilitating ore-roasting facilities and four electrolytic units that had been idle since January 1961.

NONMETALS

Barite.—The tonnage of barite ground declined 53 percent below the 1965 figure. Ore was beneficiated from stockpiled material by Baroid Division, National Lead Co., at a plant near Greenough, Missoula County. In November, the operation was shut down. It reportedly was not competitive with alternate sources in domestic markets, and preparations were made to dismantle the mill and ship it to another location.

Cement.—The quantity and value of cement shipments increased 15 and 9 percent, respectively, over 1965 totals. Output was by Kaiser Cement & Gypsum Corp. (Jefferson County) and Ideal Cement Co. (Gallatin County). Destinations within the State accounted for 57 percent of the cement sold. Shipments also were made to Colorado, Idaho, North Dakota, Utah, Washington, and Wyoming.

Of the total portland cement shipped, 59 percent was transported by rail and 41 percent by truck. The ratio of bulk to paper bag shipments was about 8:1. Approxi-

mately 48 percent of the portland cement produced was distributed to firms manufacturing commercial concrete products, such as ready-mixed concrete companies (37 percent), concrete products manufacturers (5 percent), and building material dealers (6 percent). The remaining 52 percent was sold to highway (24 percent), and other contractors (23 percent), miscellaneous customers (5 percent), and to Federal, State, and local government agencies (less than 1 percent).

Clays.—Miscellaneous clay and shale sold or used by producers declined 30 percent, and bentonite output dropped 6 percent below the 1965 total. Miscellaneous clay and shale for making heavy clay products such as building brick was dug in Fergus and Yellowstone Counties. Gallatin and Jefferson Counties were sources of clay and shale used for manufacturing cement. Shale from Cascade and Yellowstone Counties was expanded for use as lightweight aggregate. Bentonite dug in Carter County was used as oil-well-drilling mud.

Fluorspar.—Roberts Mining Co. mined fluorspar at the Crystal Mountain mine in Ravalli County. Ore was trucked 26 miles to Darby for processing at the company heavy-media separation plant. Metallurgical-grade fluorspar from the processing operation was marketed largely to the steel industry. Some was sold for smelting nickel and for manufacturing cement.

Gypsum.—The quantity of crude gypsum mined declined 3 percent below the 1965 total. Mines in Carbon, Fergus, and Judith Basin Counties furnished the production. Output from a Fergus County mine was calcined and sold as ground gypsum. Uncalcined material was sold for agricultural purposes.

Lime.—Output of lime, all for captive use, increased 42 percent above the 1965 total. Lime was manufactured in Deer Lodge County for metallurgical use and water treatment. It was manufactured by two sugar companies for refining sugar in Big Horn, Richland, and Yellowstone Counties. The open-market primary lime plant in Powell County was destroyed by a fire in 1965. A captive plant at a sugar refinery in Missoula County was inactive.

Phosphate Rock.—The quantity and value of marketable phosphate rock increased 9 and 21 percent, respectively, over the 1965 production. Mining was conducted in Beaverhead, Granite, Powell, and Silver Bow Counties. Elemental phosphorus, made at Silver Bow from Beaverhead and Silver Bow County rock, was shipped to Stauffer Chemical Co. processing plants at Chicago Heights, Ill., and South Gate and Richmond, Calif. Low-grade rock from Powell County was milled at Hall, and the concentrate was shipped to fertilizer manufacturing plants in Canada. Some rock mined in Powell County was shipped directly to fertilizer plants in Canada. Phosphate rock was defluorinated to make animal-feed products at a plant in Powell County.

The future of the phosphate industry in Montana was reviewed in October at an industrial seminar at Butte. The meeting, designed to stimulate interstate cooperation on western phosphate production and processing, was sponsored by the Montana Bureau of Mines and Geology and the State Planning Board.

Sand and Gravel.—A 15-percent advance in sand and gravel output was attributed to increased demand for the materials in road construction and maintenance by the State highway department and Bureau of Public Roads.

Commercial firms operated 46 plants in producing 2.4 million tons. Government-and-contractor production (largely for roads and dam construction by Federal, State, and local government agencies) totaled 11.4 million tons.

Sand and gravel was produced in 50 counties. Output exceeded 1 million tons in Cascade, Phillips, and Yellowstone Counties. The use distribution of sand and gravel output was road material, 89 percent; building, 5 percent; and miscellaneous uses, including fill and railroad ballast, 6 percent.

Stone.—The tonnage of stone, produced in 39 counties, dropped 25 percent owing to smaller requirements at State highway department projects.

Basalt, granite, limestone, marble, miscellaneous stone (unclassified as to type), and sandstone were produced. The basalt, granite, and miscellaneous stone were used largely in road construction, although some was used as riprap and for railroad ballast.

Output of 1.3 million tons of limestone valued at $1.6 million was used largely in manufacturing cement, lime, and sugar.

Table 13.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	828	$1,227	678	$984
Road material	2,135	1,746	1,383	1,462
Fill	231	202	115	75
Other [1]	139	169	193	175
Total	3,333	3,344	2,369	2,696
Government-and-contractor operations:				
Building	7,914	9,403	10,927	10,325
Road material	293	177	216	127
Fill	508	663	304	375
Other [1]				
Total	8,715	10,243	11,447	10,827
All operations:				
Building	828	1,227	678	984
Road material	10,049	11,149	12,310	11,787
Fill	524	379	331	202
Other [1]	647	832	497	550
Total	12,048	13,587	13,816	13,523

[1] Sand and gravel used for railroad ballast and miscellaneous and unspecified purposes.

Some was used for riprap, in road construction, and for metallurgical purposes. It was produced in Big Horn, Broadwater, Carbon, Deer Lodge, Gallatin, Jefferson, Madison, and Teton Counties.

Marble, produced in Carbon and Madison, and travertine in Park Counties, was used mainly for building purposes as dimension stone. Some crushed and sized material included products for marble whiting, terrazzo, and roofing granules.

Sandstone, quartz, and quartzite output for use as industrial silica totaled 158,263 tons valued at $382,780. It came from Beaverhead, Deer Lodge, Gallatin, and Jefferson Counties and was used for manufacturing abrasives, cement, ferrosilicon, and for metallurigcal purposes. Sandstone also was produced in Cascade, Missoula, and Teton Counties for use as riprap, railroad ballast, and for use in road construction. Quartz deposits in Montana were the subject of a report.[5]

Sulfur.—Production, as well as the average unit value, of high-purity elemental sulfur by Montana Sulphur & Chemical Co. advanced above the 1965 totals. Two oil refineries near Billings, Yellowstone County, continued to furnish raw material to the recovery plant.

Pyrometallurgical, hydrometallurgical and electrolytic processes aimed at recovering metals from sulfide ores and at the same time recovering sulfur as a byproduct were reviewed.[6]

Talc.—Production of talc advanced 12 percent, but value declined 11 percent compared with 1965 output. The talc mined by three companies came from one mine in Beaverhead County and four mines in Madison County. It was ground and sized at plants in Beaverhead, Gallatin, and Lewis and Clark Counties.

The use distribution of talc by industry was paper, 36 percent; paint, 22 percent; ceramics, 9 percent; and exports and miscellaneous uses, including insecticides, textiles, toilet preparations, refractories, rice polishing, and roofing, 33 percent.

Vermiculite.—Crude vermiculite output advanced 6 percent above the 1965 total. The Zonolite Division, W. R. Grace & Co., open-pit operation near Libby, Lincoln County, continued to be the principal source of vermiculite in the United States. Much of the milled material was shipped out-of-State to be exfoliated. Some was exfoliated by a company in Great Falls, Cascade County.

[5] Chelini, J. M. Some High-Purity Quartz Deposits in Montana. Montana Bureau of Mines and Geology, Bull. 54, 1966, 43 pp.

[6] Habashi, Fathi. The Recovery of Elemental Sulfur from Sulfide Ores. Montana Bureau of Mines and Geology, Bull. 51, 1966, 41 pp.

MINERAL FUELS

Coal.—Output of bituminous coal and lignite increased 15 percent above the 364,473 tons produced in 1965. Of 12 active mines in eight counties, 8 were underground, and 4 were open-pit operations.

Nine mines—seven underground and two open-pit supplied the bituminous coal. Carbon County led in bituminous coal production, followed by Musselshell, Blaine, Big Horn, and Rosebud Counties.

Lignite was produced at three mines—one underground and two open-pit operations. The open-pit operation in Richland County led in production. Lignite also came from an underground mine in Sheridan County and an open-pit operation in Powder River County.

Construction began in May at Billings on the Montana Power Co. coal-fired electric generating plant. The source of lignite coal for the operation was to be the Colstrip mine, Rosebud County, about 100 miles east of Billings. At peak operation, the steam generator was designed to consume about 100 tons of coal per hour, or about 1 million tons annually. In its first year of operation, scheduled for 1968, company officials estimated that 2½ trainloads of coal would be brought into Billings each week to fuel the steam-electric plant.

The State Land Board adopted leasing procedures whereby coal operators in the State were required to restore stripped areas and spoil banks to a suitable condition in keeping with the concept of beneficial land use. An auction was held in May offering 171,498 acres of coal-mining leases on State-owned land. Coal leases were offered for a maximum of 10 years on lands in Big Horn, Custer, Dawson, Fallon, Powder River, Prairie, Richland, Rosebud, Treasure, and Wibaux Counties.

Proceedings of the first Montana Coal Resources Symposium and other articles directly related to coal in Montana were published.[7]

Petroleum and Natural Gas [8].—Recovery of crude petroleum was an alltime high totaling 35.4 million barrels valued at $86.3 million. Crude oil represented about 35 percent of the Montana mineral production value. Over 60 percent of the total crude oil produced came from the Williston Basin. About 32 percent of the petroleum recovered came from three fields, the Cabin Creek and Pine fields in the Williston Basin, and the Cut Bank field in north-central Montana. Each field had output exceeding 3 million barrels. Other oilfields exceeding 1 million barrels each were Elk Basin, Flat Lake, Fred and George Creek, Lookout Butte, Pennel, and Weldon.

Marketed production of natural gas totaled 30.7 billion cubic feet, and withdrawal of natural gas continued to be highest in the Cut Bank-Reagan field with output totaling 8.3 billion cubic feet. The Keith Block field ranked second with production of 4.8 billion cubic feet. More than 3 billion cubic feet came from the Cedar Creek field, and over 2 billion cubic feet was withdrawn from the Bowdoin field. Output in excess of 1 billion cubic feet was recorded from the Cabin Creek, Dry Creek, Elk Basin, Lake Basin, and Whitlash fields.

Exploratory drilling totaled 198 wells, of which 10 were oil discoveries, 3 were gas wells, and 185 were dry holes. Development drilling totaled 284 wells, and 179 were oil producers, 9 were gas wells, and 96 were dry holes. Exploratory and development drilling continued to be highest in Toole County, particularly in the vicinity of Fred and George Creek field, where 136 wells were drilled. The average well depth continued to be less than 2,500 feet, and 39 were oil producers, 3 were gas wells, and 94 were dry holes.

Nine refineries processed 33.4 million barrels of crude oil. Montana wells supplied 32 percent of the crude oil refined; 54 percent came from Wyoming and 14 percent from Canadian wells.

There were 36 secondary recovery projects active; 33 were waterflooding, and 3 were gas injection projects. Four waterflooding-secondary-recovery projects were

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[7] Bryson, R. P., and N. W. Bass. Geologic Map and Coal Sections of the Moorhead Coal Field, Montana. U.S. Geol. Survey open-file report, 1966. 15 pp.

Gilmore, Ernest H., and Gardar G. Dahl, Jr. Index Map and Bibliography of Coal Studies in Montana. Montana Bur. Mines and Geol., Spec. Pub. 39, 1966, 1 p.

Montana Bureau of Mines and Geology. Proceedings of the First Montana Coal Resources Symposium. Spec. Pub. 36, 1966, 89 pp.

[8] Montana Oil and Gas Conservation Commission. Montana Oil and Gas Statistical Bulletin and Annual Review, v. 10, 1966.

started, one each in the Big Wall, Keg Coulee, Little Beaver, and Ragged Point fields.

Exploratory and development practices and other aspects of the petroleum industry in the Williston Basin were described.[9]

The petroleum industry was the major water user in Montana, followed by the copper and zinc industries.[10]

REVIEW BY COUNTIES

Mineral production for 1966 was reported from all of the State's 56 counties. Silver Bow County accounted for 44 percent of the total mineral output value. Only counties with significant metal, nonmetal, or fuel developments are discussed in the following review.

Beaverhead.—Metal production value from 13 mines increased $16,000 over that of 1965 to $203,700. The largest producer in the county was Ida B. Hand's Maulden mine in the Argenta mining district. Gold, silver, and lead output from the Maulden mine increased to 398 ounces, 9,599 ounces, and 324 tons, respectively. From 2,130 tons of ore shipped to the East Helena lead smelter 2 tons of copper and 45 tons of zinc were recovered. Nearly 7,000 ounces of silver and small tonnages of copper, lead, and zinc were produced from the Lively Mining Co. Hecla and Keokuk mines in the Bryant (Franklin) area.

Golden Eagle Consolidated Mines Co. uncovered high-grade silver ore in an open-pit operation near Wisdom. A limited exploration program was conducted by Newmont Mining Co. on the Ermont gold property south of Argenta.

Sawyer Petroleum Co. signed an agreement with the Union Pacific Railroad Co. for studies of thorium and rare-earth metals ore reserves on the Sawyer property in the Lemhi Pass district.

Asarco completed an exploratory drilling program in the Hecla district, but results were not sufficiently encouraging to justify further work. Minerals Engineering Co. dewatered the Calvert Creek tungsten pit and began diamond drilling from the bottom of the pit.

Phosphate rock produced by Stauffer Chemical Co., Industrial Chemical Division, at the Canyon Creek and East La Marche mines was shipped to the company elemental phosphorus plant at Silver Bow. Quartz from the Maiden Rock quarry was used as a flux in the elemental phosphate furnaces. Chas. Pfizer & Co., Inc., Minerals, Pigments, and Metals Division acquired the Tri-State Minerals Co. talc mining Smith-Dillon and Crown mine and processing operations. Talc output from the property was shipped for processing to a company mill at Barratts. Additional milling, screening, and materials-handling facilities were installed by the company at the talc mining and milling complex.

Big Horn.—Recovery of crude oil from four fields totaled 155,864 barrels. Limestone was calcined for use at the Holly Sugar Corp. plant at Hardin.

Broadwater.—Gold, silver, lead, and zinc valued at $2,074 were recovered from 50 tons of ore extracted at four mines. Iron ore (magnetite) containing 45 percent iron was trucked from the Iron Cross mine of R & S Iron Co., near Radersburg, to a cement plant at Trident.

Carbon.—The county continued to rank second in value of nonmetals and fuels output. Recovery of crude oil from the Elk Basin field, fourth largest source of oil in the State, totaled 3 million barrels. Natural gas withdrawals from the Dry Creek field totaled 1.1 billion cubic feet. The principal source of bituminous coal in Montana was the Brophy Coal Co. Brophy No. 2 mine. Limestone output from the Warren quarry of Big Horn Limestone Co. was used at sugar plants in Wyoming and at Hardin and Sidney.

Carter.—The county continued as the leading source of clay in the State. Bentonitic clay for use in oil-well-drilling mud was produced by National Lead Co.

Cascade.—Productive capacity of The Anaconda Company's electrolytic copper refinery at Great Falls was increased to 30 million pounds of copper per month by adding cells within the existing plant structure.

[9] Hamke, J. R., L. C. Marchant, and C. Q. Cupps. Oilfields in the Williston Basin in Montana, North Dakota, and South Dakota. BuMines Bull. 629, 1966, 487 pp.

[10] Hale, William N. Water Requirements and Uses in Montana Mineral Industries. BuMines Inf. Circ. 8305, 1966, 103 pp.

Table 14.—Value of mineral production in Montana, by counties

(Thousand dollars)

County	1965	1966	Minerals produced in 1966, in order of value
Beaverhead	W	W	Phosphate rock, stone, sand and gravel, lead, talc, silver, zinc, tungsten, gold, copper.
Big Horn	$1,015	$537	Petroleum, lime, sand and gravel, stone, coal, natural gas.
Blaine	356	509	Petroleum, sand and gravel, stone, natural gas, coal.
Broadwater	540	239	Sand and gravel, iron ore, stone, zinc, lead, silver, gold.
Carbon	9,410	9,030	Petroleum, coal, stone, natural gas, sand and gravel, gypsum, uranium.
Carter	443	W	Sand and gravel, clays.
Cascade	834	111	Stone, clays, lead, silver.
Chouteau	26	W	Stone.
Custer	1,461	328	Sand and gravel, petroleum, stone.
Daniels	203	11	Sand and gravel.
Dawson	3,752	3,888	Petroleum, sand and gravel, stone.
Deer Lodge	1,694	2,252	Lime, stone, sand and gravel, silver, gold, copper, lead, zinc.
Fallon	19,049	19,798	Petroleum, sand and gravel, natural gas, stone.
Fergus	727	369	Gypsum, sand and gravel, clays, lead, zinc, silver, gold, copper.
Flathead	1,326	1,393	Sand and gravel, stone, silver, copper, gold.
Gallatin	W	W	Cement, sand and gravel, stone, clays, pumice, lead, zinc, silver.
Garfield	279	250	Sand and gravel, stone.
Glacier	1,881	2,269	Petroleum, sand and gravel, stone.
Golden Valley	----	121	Stone, sand and gravel.
Granite	W	W	Phosphate rock, manganese ore, zinc, silver, sand and gravel, lead, manganiferous ore, gold, copper.
Hill	719	135	Sand and gravel, stone.
Jefferson	W	W	Cement, stone, silver, zinc, lead, gold, copper, sand and gravel, clays.
Judith Basin	35	116	Sand and gravel, gypsum.
Lake	64	237	Sand and gravel, peat, stone.
Lewis and Clark	3,437	2,093	Zinc, sand and gravel, lead, silver, copper, gold, stone.
Liberty	1,908	1,971	Petroleum, natural gas, sand and gravel.
Lincoln	W	W	Vermiculite, stone, sand and gravel, lead, zinc, silver.
McCone	3,008	5,557	Petroleum, sand and gravel, stone.
Madison	1,324	1,055	Talc, stone, sand and gravel, gold, silver, copper, lead, zinc.
Meagher	W	W	Lead, zinc, silver, copper, gold.
Mineral	1,073	W	Lead, copper, zinc, stone, silver, sand and gravel, gold.
Missoula	808	947	Sand and gravel, stone, barite, gold, zinc, lead, silver, copper.
Musselshell	3,163	2,686	Petroleum, coal.
Park	W	W	Stone, sand and gravel, copper, gold, silver, lead, zinc.
Petroleum	48	7	Sand and gravel.
Phillips	W	1,388	Sand and gravel, natural gas, stone.
Pondera	365	871	Sand and gravel, petroleum.
Powder River	102	162	Petroleum, sand and gravel, coal, stone.
Powell	W	W	Phosphate rock, sand and gravel, stone, gold, lead, silver, zinc, copper.
Prairie	159	140	Sand and gravel, stone.
Ravalli	W	W	Fluorspar, sand and gravel, silver, lead, zinc.
Richland	1,155	1,628	Petroleum, coal, lime, sand and gravel.
Roosevelt	6,643	W	Petroleum, sand and gravel.
Rosebud	W	2,398	Petroleum, sand and gravel, coal, stone.
Sanders	W	244	Sand and gravel, stone, lead, zinc, antimony, silver, gold.
Sheridan	5,276	6,720	Petroleum, coal.
Silver Bow	99,517	107,297	Copper, zinc, silver, gold, lead, phosphate rock, manganese ore, sand and gravel, stone.
Stillwater	16	104	Natural gas.
Sweet Grass	12	113	Sand and gravel.
Teton	385	394	Sand and gravel, stone, petroleum.
Toole	4,709	5,058	Petroleum, sand and gravel, natural gas.
Treasure	8	489	Stone, sand and gravel.
Valley	212	67	Do.
Wheatland	483	377	Sand and gravel, stone.
Wibaux	6	103	Do.
Yellowstone	3,310	2,825	Sand and gravel, petroleum, lime, stone, clays.
Combined counties [1]	21,140	23,733	
Undistributed [2]	r 26,082	35,248	
Total	r 228,163	245,268	

r Revised. W Withheld to avoid disclosing individual company confidential data inlcuded with "Undistributed."

[1] Petroleum and natural gas production from fields underlying two or more counties. See "Combined Counties."

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

Combined output of two mines, the Bull of the Woods and the Mogul Lode, was 7 tons of lead and silver ore for the total metal mining production of the county.

Treasurlite, Division of Treasure State Industrial Products, Inc., expanded shale for lightweight aggregate.

Dawson.—Recovery of crude oil from five fields totaled 1.2 million barrels. The Gas City field was the principal source.

Deer Lodge.—Gold and silver output declined in the county as the number of operating mines was reduced to two.

The Anaconda Company constructed a new plant at the Anaconda Reduction Works to receive copper concentrates shipped as a slurry in tank cars from Butte. Construction began on two additional converters which would increase capacity 50 percent and result in closer balance between the mines and the smelter.

The electrolytic zinc plant at Anaconda was rehabilitated during 1966 with four production units. Approximately 9,000 to 10,000 tons of zinc concentrate a month was shipped to the Anaconda plant from Pine Point, near Great Slave Lake, Canada. During 1966, the Anaconda plant produced 400,000 pounds of treated zinc concentrate, but plans were made at yearend to phase out the zinc concentrating owing to the closing of the Badger State zinc mine at Butte.

Work continued throughout the year at the electrolytic-beryllium-refining pilot plant at Anaconda. Improvements in the process were being tested on beryllium concentrates from Spor Mountain, Utah. Work on manganese was suspended.

Limestone from Brown's quarry was calcined by The Anaconda Company and used for metallurgical and water purification purposes.

Fallon.—Crude oil recovery increased slightly from 7.8 to 8.0 million barrels. The Cabin Creek field accounted for 3.1 million barrels, and the Pennel and Lookout Butte fields contributed 2.1 and 1.9 million barrels, respectively, to the total.

Fergus.—Twenty-three tons of ore containing 2 tons of lead and zinc and small quantities of gold, silver, and copper was shipped from four mines.

Gypsum was mined near Heath by United States Gypsum Co. Clay was mined near Lewistown by Lewistown Brick & Tile Co. to make heavy clay products.

Flathead.—Minor amounts of gold, silver, and copper were produced from the Sanko Creek mine in the Star Meadow district and from the West Flathead mine in the Hog Heaven district.

Gallatin.—The Ideal Cement Co. plant at Trident was the leading mineral industry operation in the county. Limestone for manufacturing cement came from the Trident quarry adjacent to the cement plant, and silica from a quarry several miles east of the operation. Talc from Madison County quarries was ground at the Three Forks plant of Sierra Talc & Chemical Co., Division of Cyprus Mines Corp.

Glacier.—Crude oil output totaling 763,000 barrels was from seven fields.

Granite.—The significant increases in the quantity and value of silver, lead, and zinc production occurred principally in the Flint Creek (Philipsburg) district where Taylor-Knapp mines accounted for the major portion of the ore mined. Output of copper and gold declined from 1965 levels both in quantity and value. The total number of nonferrous and precious metal mines being operated in the county dropped from 22 in 1965 to 19 in 1966. Lead and zinc production in the Henderson district ceased.

The Taylor-Knapp Co. continued its exploration and development program at the Algonquin, Scratch All, True Fissure, and Moorlight properties throughout the year, mining silver-lead-zinc ores. Processing of manganese ores continued at Philipsburg where the ore was upgraded to battery-grade concentrates.

Phosphate rock from the Douglas Creek mine and from mines in Powell County was upgraded at the Cominco American, Inc., flotation concentrator near Hall. The concentrate was shipped to fertilizer manufacturing plants at Trail and Kimberley, British Columbia, Canada.

Jefferson.—Ore output from 21 nonferrous lode mines increased from 14,590 tons in 1965 to 25,472 tons, in 1966. Silver production increased from 41,732 ounces in 1965 to 102,251 ounces, and gold production from 544 ounces to 728 ounces. In addition, 21 tons of copper, 137 tons of lead, and 150 tons of zinc were produced. Significant shipments of silver, copper, and

zinc were obtained from tailings at the Eva Mae property and the Crystal mine in the Basin/Cataract district. Shipman Mining & Exploration Co. shipped some high-grade silver ore from the Hope-Bullion mine in the same area. The firm also reopened the Elkhorn Queen shaft and shipped 17 tons of ore containing 120 ounces of silver and 2,600 pounds of lead and zinc. Preliminary exploration work was started in the Ruby mine area of the Lowlands district by The Anaconda Company. Amax, Inc., engaged in exploratory drilling near Wickes.

Cement production was up sharply at the Kaiser Cement & Gypsum Corp. Montana City plant, the leading nonmetal mineral industry operation in the county. Greater tonnages of limestone were quarried by the firm at the Montana City quarry for manufacturing cement and by Maronick Construction Co. at the McClellan Creek quarry for metallurgical purposes.

Lewis and Clark.—The Anaconda Company slag dump accounted for 98 percent of the ore treated in the county. Zinc production from the slag-fuming plant at East Helena was down 35 percent from 1965 to 4,737 tons. Lead production declined 55 percent to 497 tons. Five small mines were responsible for the remaining 2 percent of gold, silver, copper, lead, and zinc production.

Asarco completed installation of a new $1.5 million updraft sintering machine at the East Helena lead smelter and began successful operations. A new building, requiring 500 tons of steel, housed the facility which replaced nine Dwight-Lloyd units formerly used.

Mascot Silver-Lead Mines, Inc., continued silver exploration at the New Meadow mine south of Helena under a contract with the OME. The Anaconda Company continued developing a large low-grade copper-molybdenum deposit in the Mike Horse mine area near Lincoln. About 85 men were engaged in drilling, sampling, and metallurgical analysis. Bear Creek Mining Co. was actively drilling in the Heddleston district.

Liberty.—Recovery of crude oil from four fields totaled 554,000 barrels. Natural gas withdrawals increased to 8.1 billion cubic feet. Principal gasfields were Keith Block (4.8 billion cubic feet), which continued as the second largest source of gas in the State, and Whitlash (1.9 billion cubic feet).

Madison.—Relatively small amounts of base and precious metal ore were extracted at 16 mines in six mining districts as 3,402 tons of ore yielded $32,865 gold and $17,582 silver. Small amounts of copper, lead, and zinc added to a total value of $55,159 for the year. Northern Pacific Railway Co. initiated exploratory work in the Pony district.

Talc was mined by three companies at four operations: The Bozo Lobo mine of American Chemet Corp.; The Yellowstone mine of the United Sierra Division, Cyprus Mines Corp.; and the Regal-Keystone and Treasure State mines of Chas. Pfizer & Co., Inc.

McCone—Crude oil recovery from four fields totaled 2.3 million barrels. Production from the Weldon field increased 1 million barrels to 2.1 million barrels.

Meagher.—Production from the Yellowstone mine (Hamilton Mines, Inc.) and the Cumberland mine (United Nuclear Corp.) accounted for all the metal output in the county. Harpoon, Inc., a subsidiary of United Nuclear Corp., continued exploratory drilling at the Cumberland mine.

Mineral.—Four mines produced limited amounts of gold, silver, copper, lead, and zinc. An 8-foot vein of copper-silver ore was reportedly found on the 940 level of the Nancy Lee mine, near Superior, and plans were announced to extend discovery work below the 940 level. Nancy Lee Mines, Inc., signed working agreements with seven neighboring mining properties and also added 70 newly located claims to its holdings, giving it control of an area 3½ miles wide and more than 7 miles long.

Missoula.—Barite mined in previous years at the Elk Creek mine was processed at the Baroid Division, National Lead Co., plant at Greenough. The mining operation ceased in 1965, and plans were made to dismantle the mill. The lime kiln at the American Crystal Sugar Co. plant at Missoula was inactive.

Musselshell.—Crude oil recovery from 13 fields totaled 1 million barrels. The Big Wall, Keg Coulee, and Ivanhoe fields furnished most of the output. Bituminous

coal output from five mines totaled 34,362 tons.

Powell.—Five small lead-zinc lode mines and one placer produced small amounts of gold, silver, lead, and zinc valued at approximately $8,000.

Bear Creek Mining Co. located 82 quartz claims in the area northwest of Avon.

Phosphate rock production was greater than the 1965 total. Operations of Cominco American, Inc., (Anderson-Brock, Gimlet, and Luke mines) and George Relyea (Relyea mine) were active. Most of the output was exported to Trail, British Columbia, Canada, for manufacturing phosphate fertilizers by the Consolidated Mining & Smelting Co. of Canada, Ltd. Rocky Mountain Phosphates, Inc., operating a phosphate-rock defluorinating plant at Garrison, continued to be involved in litigation over alleged responsibility by the company for air pollution at Garrison. On April 3, a district court at Bozeman awarded seven Garrison area ranchers $123,283 after a trial in which the ranchers claimed both their livestock and their land were damaged by the plant's fluoride emisssions.

Richland.—Lignite production from the Savage mine of Knife River Coal Mining Co. at Sidney, increased moderately. Output was used as fuel at the Sidney steam-electric plant of Montana-Dakota Utilities Co. Limestone was calcined by Holly Sugar Corp. for use at its refinery.

Roosevelt.—The county ranked fourth in output of petroleum. Crude oil production from 12 fields totaled 2.5 million barrels. A large part of the production came from the Poplar and Tule Creek fields.

Rosebud.—Crude oil recovery totaled 820,000 barrels, most of which came from the Sumatra field.

Sanders.—Lucky Star Mining Co. resumed underground exploration and development for lead-zinc-silver ore at the Blue Creek mine. Silver, lead, and zinc valued at $62,800 were produced from three mines.

Knute Kirkenburg mined 400 tons of ore from the Stibnite mine west of Thompson Falls. The ore was trucked to a flotation plant at Copper King for concentration and shipment to Laredo, Tex.

Bear Creek Mining Co. was actively drilling in the Prospect Creek district.

Sheridan.—Crude oil output from 10 oilfields totaled 3 million barrels, and the county ranked third as a petroleum source. A large part of the production came from the Flat Lake and Goose Lake fields. Exploratory and development drilling, in terms of total footage drilled, continued to be highest for any county in the State. Two oil discoveries came from exploratory drilling 18 wells, and 22 oil producers resulted from development drilling of 30 wells.

Silver Bow.—Production by The Anaconda Company from Butte district mines supplied 97 percent of the State's gold, silver, copper, lead, and zinc output value. These mines furnished 86.4 percent of the gold, 91.4 percent of the silver, 99.8 percent of the copper, 54.7 percent of the lead, and 76.5 percent of the zinc.

Virtually uninterrupted production throughout the year enabled the 42,000-ton-per-day Butte copper concentrator to be operated at near capacity. Construction continued on a concentrator addition designed to increase recovery by treating acid-soluble ores not amenable to standard flotation procedures and was to be completed early in 1967.

Anaconda continued programs designed to modernize mining, haulage, and hoisting systems at its Butte Hill mines. A pipeline distribution system was being installed to transport tailings for mine fill from the Butte concentrator to the Kelley mine where a suitable product was to be prepared and distributed to the 2000 level of the Leonard mine, the 3000 level of the Steward mine, and the 4200 level of the Mountain Con mine. Completion of the Kelley No. 2 shaft was planned for early in 1967 to replace the High Ore as the pump shaft for all Butte Hill mines. Planned expansions of the Berkeley pit were to encroach on the High Ore shaft. A pump station was cut on the 3900 level of the Kelley No. 2 shaft and equipped with eight 11-stage centrifugal pumps rated at 1,000 gallons per minute each, and capable of lifting mine water 4,100 feet in a single lift.

A large-size haulageway from the Kelley mine to the Steward mine was completed on the 4200 level. Work was also begun on a 4600-level connection to the Steward subshaft.

Table 15.—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 [1] (thousand short tons)	Gold, lode and placer (troy ounces)	Silver, lode and placer (thousand troy ounces)
	Lode	Placer			
1957–61 (average)	15	1	10,980	20,702	3,453
1962	9	1	11,654	17,657	4,027
1963	10	2	9,346	14,287	3,951
1964	10	-----	14,694	20,999	4,614
1965	8	2	15,462	18,420	4,790
1966	5	-----	17,503	21,608	4,864
1882–1966	-----	-----	[2] 338,687	2,423,827	643,179

	Copper (short tons)	Lead (short tons)	Zinc (short tons)	Total value (thousands)
1957–61 (average)	88,660	4,378	19,669	$62,256
1962	93,845	4,319	28,636	70,176
1963	79,636	3,185	24,140	60,850
1964	103,600	2,678	20,239	80,455
1965	115,279	4,594	25,629	97,373
1966	127,885	2,411	22,284	106,749
1882–1966	8,164,972	415,361	2,406,002	3,971,659

[1] Does not include gravel washed.
[2] Complete data not available for 1904–66.

Additional refrigeration and dehumidifier units were added for improvement of underground air conditioning. Old-style reciprocating compressor units were replaced with modern centrifugal ones.

"Phasing out" of the Badger State mine, the only operating zinc mine in Butte, was completed at the end of the year. The mine was closed because it was unprofitable under present cost and market conditions, although production for the year totaled 22,284 tons. Concentrating equipment at Anaconda which was used for Badger State zinc ore was scheduled to be converted for treatment of ores from deep mines at Butte.

Van Butte Exploration Co. of Butte engaged in deep diamond drilling on the north and east margins of the Butte district.

Phosphate rock production from the Maiden Rock mine near Melrose by Stauffer Chemical Co., Industrial Chemical Division, was greater than 1965 output. Elemental phosphorus was produced at the company's Silver Bow plant.

Toole.—Crude oil recovery increased from 1.9 to 2.1 million barrels. Production was from seven fields, but a large part, 1.5 million barrels, came from the Fred and George Creek field. Exploratory and development drilling continued to be highest in the State in terms of number of wells drilled, but most wells were drilled at shallow depths (less than 2,500 feet), and the area ranked second in total footage drilled.

Yellowstone.—Crude oil production from the two fields in the county totaled 330,000 barrels, 125,0000 barrels above the 1965 output. Elemental sulfur was recovered by Montana Sulphur & Chemical Co. from oil refinery waste gases supplied by the Continental Oil Co. and Humble Oil & Refining Co. operations at Billings. The county continued to rank first in sand and gravel output. Shale from the Lockwood Flats pit was expanded to lightweight aggregate by Montana Lightweight Aggregate Co. Clay dug near Billings by Lovell Clay Products Co. was used to make heavy clay products. Limestone was calcined for use at the Great Western Sugar Co. refinery.

Combined Counties.—The following counties have been combined into areas as indicated because a major oilfield or gasfield underlies parts of more than one county, and its production cannot be assigned to a single county.

Dawson, Fallon, Prairie, and Wibaux.—Crude oil recovery from the Pine field, which continued as the largest source of petroleum in the State, totaled 4 million

barrels. Natural gas withdrawn from the Pine field totaled 778 million cubic feet.

Glacier and Toole.—Production of crude oil from the Cut Bank field, the second largest source of petroleum in the State, totaled 4 million barrels, compared with 3 million barrels in 1965. Successful waterflooding projects in the Cut Bank field continued to augment response to secondary production. Natural gas withdrawn from the Cut Bank-Reagan field, the leading source of natural gas in the State, totaled 8.3 billion cubic feet.

Golden Valley and Stillwater.—Natural gas withdrawn from the Big Coulee field totaled 1 billion cubic feet.

Phillips and Valley.—Withdrawals of natural gas from the Bowdoin field totaled 2.1 billion cubic feet, compared with 2.2 billion cubic feet in 1965.

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 Nebraska Geological Survey for collecting information on all minerals except fuels.

By Matthew J. Sheridan [1] and William C. Henkes [2]

Nebraska's 1966 mineral output, continuing a downward trend since the 1962 peak of $108.4 million, was valued at $78.5 million, a decrease of $5.3 million or 6 percent less than the 1965 total. This 4-year decline can be directly attributed to decreasing oil production and lack of exploratory success by the petroleum industry. The value of mineral fuels production in 1966 dropped to $41.1 million. 16-percent below 1965. Crude oil, natural gas, and natural gas liquids, however, comprised 52 percent of the State mineral value.

Other mineral commodities, including cement, clays, lime, pumice, sand and gravel, and stone, had a significant gain of $2.3 million (7 percent), but this was insufficient to offset the loss in output value of fuels.

Of the 93 counties in Nebraska, 88 reported mineral production. The five leading counties in rank of production value were Cass, 22 percent; Kimball, 15 percent; Cheyenne, 13 percent; Banner, 12 percent; and Red Willow, 7 percent. Cass, Hall, Lancaster, Madison, and Platte Counties registered record high values for minerals produced.

Employment and Injuries.—Final data for 1965 and preliminary data covering 1966 complied by the Federal Bureau of Mines for employment and injuries in the Nebraska mineral industries, excluding all mineral fuels except coal, are reported in table 3.

[1] Mining engineer, Bureau of Mines, Denver, Colo.
[2] Petroleum engineer, Bureau of Mines, Denver, Colo.

Table 1.—Mineral production in Nebraska [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	r 141	r $141	153	$153
Gem stones	NA	5	NA	5
Natural gas (marketed) million cubic feet	10,720	1,565	10,196	1,621
Natural gas liquids:				
LP gases thousand gallons	16,946	847	19,670	1,141
Natural gasoline and cycle products do	7,822	516	9,195	653
Petroleum (crude) thousand 42-gallon barrels	17,216	45,796	13,850	37,673
Sand and gravel thousand short tons	11,993	13,697	13,539	14,179
Stone do	4,198	6,637	5,055	7,916
Value of items that cannot be disclosed: Cement, lime, and pumice	XX	14,622	XX	15,180
Total	XX	r 83,826	XX	78,521

r Revised. NA Not available. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

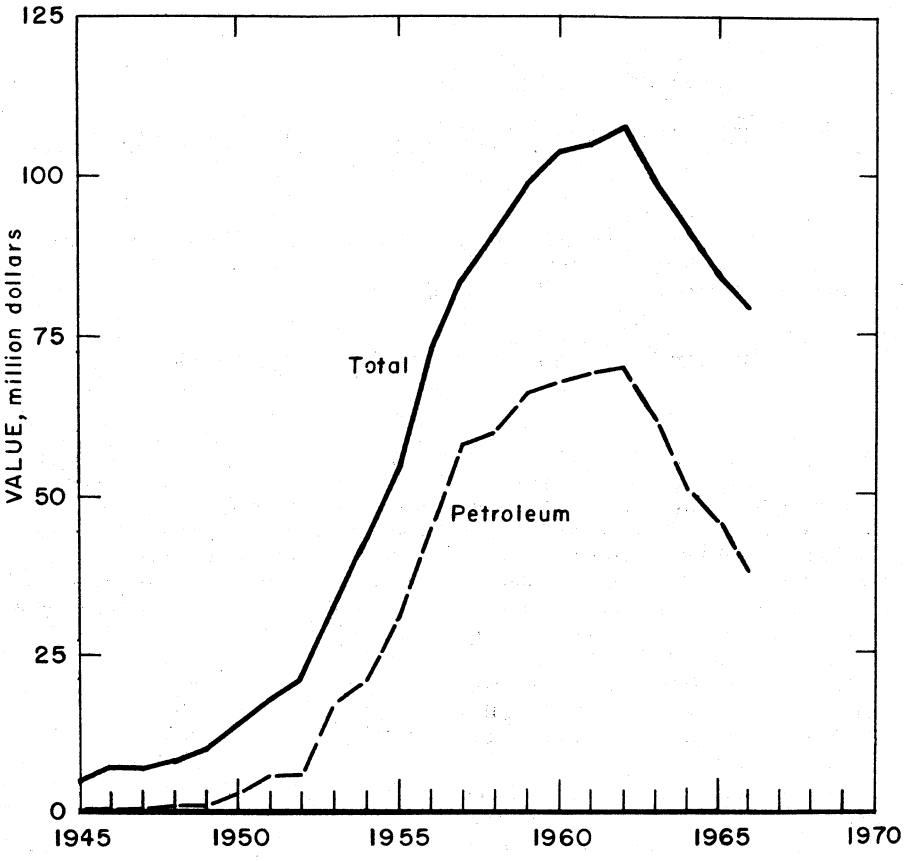

Figure 1.—Value of petroleum and total value of mineral production in Nebraska.

Table 2.—Value of mineral production in constant 1957–59 dollars
(Thousands)

Year	Value [1]
1957	$82,414
1958	90,076
1959	97,717
1960	101,337
1961	104,420
1962	106,487
1963	97,569
1964	91,192
1965	83,322
1966	77,126

[1] Data for 1957–65 revised.

Government Programs.—Federal, State, county, and municipal construction prouects were major markets for cement, stone, and sand and gravel. State highway contracts awarded during the year totaled $15.8 million for the National System of Interstate and Defense Highways, $24.9 million for the Federal-Aid Primary and Secondary System, and $1.6 million for 100-percent State-financed projects.[3] The total, $42.2 million, was 6 percent or $2.7 million less than that of 1965. By the end of the calendar year, 300 of 478 miles designated in the Interstate highway system was open to traffic, a gain of 59 miles; 65 miles was under construction; and 113 miles was in the design or right-of-way acquisition stage.[4]

[3] Engineering News-Record. State Highway Department's Construction Contracting Plans for 1967 . . . and Budgets for Maintenance: Highway Construction Spending Will Reach For a Record This Year. V. 178, No. 12, Mar. 23, 1967, pp. 24–25.

[4] Bureau of Public Roads. Quarterly Report on The Federal-Aid Highway Program, Dec. 31, 1966. Press Release BPR 67–5, Feb. 1, 1967.

Table 3.—Employment 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
1965:								
Nonmetal	14	249	3	28	---	---	---	---
Sand and gravel	937	225	211	2,045	4	16	9.78	11,953
Stone	566	265	150	1,248	1	16	13.63	5,962
Total	1,517	240	364	3,321	5	32	11.14	9,602
1966: p								
Nonmetal	70	234	16	141	---	7	49.65	922
Sand	1,030	224	231	2,160	1	24	11.57	3,182
Stone	575	282	162	1,342	---	14	10.43	321
Total	1,675	244	409	3,643	1	45	12.63	2,041

p Preliminary.

The Federal Bureau of Reclamation continued construction at the Frenchman-Cambridge Division and the Ainsworth, Farwell, and Red Willow units of the Missouri River Basin project. This construction, all contracted to construction or irrigation companies, absorbed selected earth fill for canal lining, aggregate mixes for road surfacing, concrete for drainage structures, and riprap for erosion control and bank stabilization.

The U.S. Army Corps of Engineers engaged in 13 flood control, river bank stabilization, and recreation facility projects, all by contractors, totaling $6.7 million. The following projects were in the $500,000 to $1.4 million category: The Branched Oak Dam and Reservoir near Lincoln; Flood Protection project, Stage 1 near Norfolk; Missouri River bank stabilization near Bellevue; Missouri River bank stabilization near Brownville; channel improvement on Little Papillion Creek near Omaha; and channel stabilization of the North Platte River and tributaries near Gering. These projects included construction or repair of dams, outlet works, spillways, levees, channels, roads, railroad and railroad bridges, revetments, drainage structures, and parking areas. Construction materials utilized included concrete, riprap, sand and gravel, track ballast, and dimension stone.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Natural Gas.—Marketed natural gas declined 5 percent because of lower production of casing head gas associated with petroleum. Although output of dry gas increased 9 percent, the gain did not offset the 22-percent drop in yield of casing head gas. Cheyenne County, with 64 percent of the output, was again the leading producer of natural gas. No gas discoveries were made during the year. At yearend, according to the Nebraska Oil and Gas Conservation Commission, 37 dry-gas wells were producing; 7 were shut in.

The American Gas Association (AGA) and the American Petroleum Institute (API) reported[5] that proved reserves of natural gas in the State at yearend were 72.8 billion cubic feet, a 9-percent decrease. Additions because of extensions and revisions of existing fields failed to offset losses to reserves caused by production.

Kansas-Nebraska Natural Gas Co. constructed approximately 125 miles of 4- to 16-inch gas pipelines in the central part of the State. Some of the work was looping of existing lines; some was installation of gathering and distribution lines.

Natural Gas Liquids.—Output of natural gas liquids was 17 percent higher than in 1965. Yield of natural gasoline was 9.2 million gallons compared with 7.8 million in 1965; liquefied petroleum (LP) gases amounted to 19.7 million gallons compared with 16.9 million.

The Kansas-Nebraska Natural Gas Co. plant at Big Springs field was shut down during the year. Operations at the Ante-

[5] The Oil and Gas Journal. V. 65, No. 14, Apr. 3, 1967, p. 130.

Table 4.—Crude petroleum production, by counties

(Thousand 42-gallon barrels)

County	1965	1966	Principal fields in 1966
Banner	4,836	3,463	Willson Ranch, Singleton, Harrisburg, Vedene, Johnson, Olsen [1].
Cheyenne	3,192	2,873	Juelfs-Gaylord, Southwest Potter, Reimers, Doran, Filon.
Dundy	14	9	Indian Creek, Pierce Lake, Rock Canyon.
Frontier	(2)	14	Spring Creek.
Furnas	3	4	Wilsonville.
Garden	10	11	Richards, McCord.
Harlan	32	26	South Alma, Prairie Dog Creek.
Hayes	3	1	Blackwood Creek.
Hitchcock	213	253	Reiher, Dry Creek, Bush Creek, Culbertson.
Kimball	5,218	3,946	Sloss, Enders, Fernquist, Long, Kimball, Heideman.
Lincoln	9	4	Red Willow Creek.
Morrill	708	726	Waitman, Dunlap, Lindberg.
Red Willow	1,966	1,764	Sleepy Hollow, Silver Creek, Ackman, Midway.
Richardson	59	59	Dawson, Falls City, Barada.
Scotts Bluff	953	697	Cedar Valley, Stage Hill [3], Minatare.
Total	17,216	13,850	

[1] Partly in Morrill County.
[2] Less than ½ unit.
[3] Partly in Banner County.
Source: Nebraska Oil and Gas Conservation Commission.

Table 5.—Drilling for petroleum in 1966, by counties

County	Oil	Gas	Dry	Total	Footage
Exploratory completions:					
Banner	1	--	25	26	159,816
Box Butte	--	--	1	1	4,160
Chase	--	--	2	2	10,505
Cheyenne	8	--	18	26	129,460
Clay	--	--	1	1	3,250
Dakota	--	--	1	1	1,097
Dawes	--	--	1	1	3,205
Deuel	--	--	2	2	6,305
Dundy	--	--	2	2	7,200
Frontier	--	--	2	2	8,186
Furnas	1	--	1	2	7,460
Gosper	--	--	1	1	3,800
Hitchcock	--	--	4	4	16,715
Holt	--	--	2	2	3,557
Jefferson	--	--	1	1	2,902
Kearney	--	--	1	1	4,400
Keya Paha	--	--	1	1	2,344
Kimball	3	--	35	38	244,627
Lincoln	--	--	3	3	14,176
Morrill	1	--	11	12	55,515
Otoe	--	--	1	1	1,010
Platte	--	--	1	1	2,595
Red Willow	4	--	7	11	41,448
Richardson	--	--	3	3	8,619
Scotts Bluff	--	--	28	28	144,752
Sheridan	--	--	1	1	3,230
Sherman	--	--	1	1	3,680
Sioux	--	--	1	1	5,373
Total	18	--	158	176	899,387
Development completions:					
Banner	4	--	11	15	92,934
Cheyenne	10	1	19	30	145,693
Frontier	3	--	--	3	11,613
Garden	--	--	1	1	3,295
Hitchcock	--	--	3	3	12,567
Kimball	15	--	15	30	188,612
Lincoln	--	--	1	1	4,509
Morrill	5	--	7	12	54,207
Red Willow	6	--	5	11	39,342
Scotts Bluff	1	--	6	7	31,533
Total	44	1	68	113	584,305
Total all drilling	62	1	226	289	1,483,692

Source: Committee on Statistics of Drilling, American Association of Petroleum Geologists.

lope Gas Producers Co. plant at Long field, the Kansas-Nebraska plant at Huntsman, and the Marathon Oil Co. plant at West Sidney were continued.

Estimates by API and AGA [6] gave the State reserves of 2.5 million barrels of natural gas liquids, a decline of 1.2 million barrels.

Petroleum.—For the fourth consecutive year since the record high of 1962, crude oil production declined. Output in 1966 declined 20 percent and was approximately at the same rate as in late 1955, 6 years after the discovery of oil in western Nebraska. The decline in production roughly paralleled the decline in drilling, which reached a high of 1,005 wells in 1961, then decreased steadily to the 289 wells drilled in 1966, the lowest level of activity since 1952. The discovery ratio, however, suggested that better quality prospects were being drilled. Success ratios were 1966, 10.2 percent; 1965, 3.8; 1964, 10.5; 1963, 8.5; and 1962, 6.5 percent. The number of discoveries made in 1966 was the lowest since 1953, a fact also evident in the steady decline in production.

Output of petroleum in Kimball County, the largest source, was down 1.3 million barrels, a loss of $3.1 million. Banner County production declined by 1.4 million barrels. Production from the major fields was down significantly. No field yielded more than 1 million barrels of oil; whereas, in 1965, two fields were over that mark. The largest numerical decline was in the Singleton field where output dropped by 349,200 barrels to 662,600 barrels. Large decreases were also evident at the Sloss (down 300,200 barrels) and Sleepy Hollow (down 259,800) fields.

Proved petroleum reserves, estimated by API and AGA [7], were 57.1 million barrels, 13.5 million barrels less than estimated at the end of 1965. Additions resulting from new discoveries and extensions of older fields exceeded by only 500,000 barrels the losses resulting from revisions of previous estimates, and were not sufficient to offset the 1966 production.

The Nebraska Oil and Gas Conservation Commission reported that, at yearend, 1,511 wells were on production and that 583 wells were temporarily abandoned or shut in. Of the producing wells, 409 were in Kimball County, 348 were in Red Willow County, 272 in Banner County, and 269 in Cheyenne County; these four counties had 86 percent of the producing wells.

The three fields in the Nebraska part of the Forest City basin yielded 58,723 barrels of oil from 14 wells. Four unsuccessful wildcat wells were drilled in the basin: Three in Richardson County and one in Otoe County.

Overall drilling activity was 31 percent less than in 1965; exploratory drilling was down 16 percent, the lowest level since 1953. Most of the drilling was in the Denver basin part of the State, with the Chadron-Cambridge Arch region second. Only scattered drilling was conducted in central and eastern Nebraska.

Several important discoveries were made in the Denver basin. White Feather Petroleum completed a wildcat in Banner County for 320 barrels of oil per day from the "J" Sandstone (Cretaceous). Regal Drilling Co. and Tom Vessels Oil & Gas Co. discovered the Clara field, Cheyenne County; the discovery well initially yielded 208 barrels of oil per day. Petroleum, Inc., discovered the East Simpson field, Kimball County, with its No. 1 Rodman-B well; initial daily production was 182 barrels of oil.

The Bed Canyon field, found by Ben J. Taylor and Pubco Petroleum Corp. in July, was a significant discovery in the Cambridge Arch area. The discovery well, the No. 1 Doyle, Red Willow County, pumped 110 barrels of oil per day from the Reagan sandstone (Cambrian). At yearend, the field had nine producing wells.

In October, crude oil prices were raised 5 cents per barrel for Denver basin petroleum, the first price increase since 1957. The increase brought the posted price of 40 to 44.9° API crude oil to $2.93 per barrel.

Because of the decline in petroleum output in the State, the Oil and Gas Conservation Commission increased its levy on oil and gas production to 1.75 mills per dollar value at the wellhead, effective January 1, 1966. On September 1, the levy, designed to provide operating revenues for the Commission, was further increased to 2.00 mills per dollar value.

[6] Work cited in footnote 5.
[7] Work cited in footnote 5.

NONMETALS

Cement.—Shipments of portland cement increased 5 percent in quantity and 3 percent in value, whereas shipments of masonry cement decreased 9 percent in both quantity and value. Ideal Cement Co. supplied consumers in Nebraska, Iowa, and Kansas; Ash Grove Lime & Portland Cement Co. shipped to consumers in Nebraska, Iowa, Minnesota, Missouri, North Dakota, and South Dakota. Major users were ready-mixed concrete companies and highway contractors.

Clays.—Output of clays increased 9 percent to 153,000 tons. Ash Grove Lime & Portland Cement Co., Endicott Clay Products Co., Omaha Brick Works, Western Brick and Supply Co., and Yankee Hill Brick Manufacturing Co. produced the entire output. Most of the clay was used in manufacturing building brick; the remainder constituted part of the raw material mix for portland cement.

Lime.—Utilization of 100 percent of Nebraska's sugar beet acreage quota, combined with favorable growing conditions, effected a near-record production of 1.2 million tons of beets processed at four plants of The Great Western Sugar Co. The high beet output stimulated a 24-percent increase in production of lime, used as milk of lime in refining beet sugar liquors. Value of lime, however, was up 44 percent because of higher consumption and an increase in production cost.

Perlite.—Crude perlite mined outside of the State was expanded by Western Mineral Products Co. of Omaha for use as lightweight aggregate in concrete and plaster. Plant output was 30 percent below that of 1965.

Pumice.—Crude pumicite ore mined at its La Master property in Lincoln County was treated by LaRue-Axtell Pumice Co. near Callaway. The tonnages of finished products increased 47 percent and their values increased 41 percent. Virtually the entire output of processed pumice was used in cleansing and scouring compounds.

Sand and Gravel.—The 14 million tons of sand and gravel produced from 83 of the 93 counties in the State represented a 13-percent increase in quantity and a 4-percent increase in value. Of this output, 64 percent was used in highways and associated structures and 27 percent in building. The five leading suppliers were Central Sand & Gravel Co., Hartford Sand & Gravel Co., Luther & Maddox Gravel Co., Lyman-Richey Sand & Gravel Corp., and Western Sand & Gravel Co.

Stone.—Increasing demand for crushed, broken, and dimension limestone generated a production of 5.1 million tons in 1966. Contractors for the U.S. Army Corps of Engineers consumed 13 percent of the output as riprap in public works facilities. The aggregate industries marketed 58 percent for use in concrete, base course, and road surfacing material and for riprap and rubble. The remainder was used in producing cement, lime, and whiting; for filler in asphalt and other products and for poultry grit; and as agricultural stone for soil conditioning and as railroad ballast. The four major suppliers of stone were Ash Grove Lime & Portland Cement Co., Fort Calhoun Stone Co., Hopper Bros. Quarries, and United Rock Construction, Inc.

Talc.—United Sierra Division of Cyprus Mines Corp. (formerly Sierra Talc and Chemical Co.) obtained ore from a company-owned mine in Montana and from the Grantham mine in California. The crude ore was processed at the company Grand Island plant and shipped to domestic buyers for use in manufacturing paper, paint, ceramics, rubber, textiles, tile, and toilet preparations; some was exported.

Vermiculite.—Crude vermiculite mined out-of-State was exfoliated at the Omaha plant of Western Mineral Products Co. and shipped to consumers for use as loose-fill insulation, plaster aggregate, acoustical material, and pet litter.

METALS

The American Smelting and Refining Co. (Asarco) lead refinery in Omaha was operated at a slightly higher rate than that of the previous year, refining lead bullion received from smelters in El Paso, Tex., East Helena, Mont., and Tooele, Utah. The bullion was derived from lead ores that originated principally in western United States, South America, and Canada.

Commercial grades of refined lead were

Table 6.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	2,267	$2,606	2,351	$2,209
Paving	981	1,179	990	918
Railroad ballast	[1] 570	[1] 646	[2]	[2]
Fill	[1]	[2]	785	680
Other	---	---	[2] 11	[2] 12
Total	3,818	4,431	4,137	3,819
Gravel:				
Construction:				
Building	1,265	1,519	1,293	1,545
Paving	5,079	5,923	5,500	6,414
Railroad ballast	[3] 209	[3] 240	84	106
Fill	[3]	[3]	259	222
Other	---	---	1	1
Miscellaneous	50	61	101	120
Total	6,603	7,743	7,238	8,408
Total sand and gravel	10,421	12,174	11,375	12,227
Government-and-contractor operations:				
Sand:				
Paving	483	482	549	549
Gravel:				
Building	12	13	13	6
Paving	1,077	1,028	1,602	1,397
Total	1,089	1,041	1,615	1,403
Total sand and gravel	1,572	1,523	2,164	1,952
All operations:				
Sand	4,301	4,913	4,686	4,368
Gravel	7,692	8,784	8,853	9,811
Total	11,993	13,697	13,539	14,179

[1] Railroad ballast and fill sand combined to avoid disclosing individual company confidential data.
[2] Railroad ballast and "Other" sand combined to avoid disclosing individual company confidential data.
[3] Railroad ballast and fill gravel combined to avoid disclosing individual company confidential data.

produced and shipped to fabricators and manufacturers throughout eastern and midwestern United States.

Other metals recovered from the bullion were gold, silver, antimony, bismuth, and tellurium, some of which were shipped as salable products in refined or alloyed form and the others were concentrated for further treatment at plants outside Nebraska.

REVIEW BY COUNTIES

Banner.—Although production dropped 1.4 million barrels, the county again ranked second in petroleum output. Marketed natural gas was 45 percent less than in 1965. Of the 5 county oilfields ranked among the State's 25 largest, the Willson Ranch field was the largest, displacing the Singleton field.

Of 26 wildcat wells drilled, only 1 was successful, a discovery of an unnamed field by White Feather Petroleum. A significant exploratory failure was drilled by Sinclair Oil & Gas Co. in the Singleton field; this well was drilled to a total depth of 7,595 feet (in Permian) without finding oil or gas below the Cretaceous. The county had 15 development wells drilled; 4 were completed as oil wells.

The entire output of sand and gravel was produced by the county highway department.

Buffalo.—Eight commercial producers, Bruner Bros., C. H. Luther Sand & Gravel Co., Johnson Gravel Co., Leonard Sand & Gravel, Olsen Sand & Gravel Co., Triplett Sand & Gravel Co., Carl W. Whitney, and

Table 7.—Sand and gravel production in 1966, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value	County	Quantity	Value
Adams	93	$114	Keya Paha	9	$9
Antelope	80	88	Kimball	38	36
Banner	8	9	Knox	301	298
Boone	W	W	Lancaster	58	58
Box Butte	52	52	Lincoln	243	267
Boyd	24	24	Logan	2	2
Brown	133	100	Loup	28	35
Buffalo	511	556	Madison	448	530
Butler	142	159	McPherson	4	6
Cass	568	454	Merrick	139	145
Cedar	110	116	Morrill	W	W
Chase	5	2	Nance	64	82
Cherry	18	18	Nemaha	17	16
Cheyenne	151	80	Nuckolls	43	50
Clay	90	82	Otoe	32	32
Colfax	78	78	Pawnee	W	W
Cuming	332	361	Perkins	41	13
Custer	166	166	Phelps	213	244
Dakota	59	61	Pierce	86	86
Dawson	398	478	Platte	670	874
Deuel	100	100	Polk	W	W
Dixon	23	29	Red Willow	246	299
Dodge	891	837	Rock	19	19
Douglas	1,492	1,365	Saline	194	212
Fillmore	12	12	Sarpy	568	535
Franklin	108	126	Saunders	946	945
Furnas	98	81	Scotts Bluff	238	216
Gage	161	184	Seward	3	3
Garden	11	13	Sheridan	2	2
Garfield	W	W	Sherman	21	21
Grant	2	2	Sioux	40	21
Hall	1,053	1,318	Stanton	77	77
Hamilton	186	216	Thayer	124	132
Harlan	87	92	Thomas	15	19
Hayes	W	W	Thurston	17	17
Hitchcock	W	W	Valley	138	155
Holt	141	166	Wayne	47	47
Hooker	12	14	Webster	77	112
Howard	76	92	Wheeler	21	20
Jefferson	246	253	York	107	120
Johnson	W	W	Undistributed	238	245
Kearney	92	103			
Keith	156	178	Total	13,539	14,179

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

Table 8.—Stone sold or used by producers, by uses

Use	1965		1966	
	Short tons	Value	Short tons	Value
Dimension stone: Rubble	9,335	$48,869	12,783	$68,281
Crushed and broken stone:				
Riprap	1,539,953	1,910,966	1,982,203	2,371,941
Concrete and roadstone	1,747,328	2,962,000	1,885,875	3,145,080
Agriculture	(1)	(1)	208,927	358,257
Other	[1] 901,545	[1] 1,715,005	[2] 965,351	[2] 1,972,164
Total	4,188,826	6,587,971	5,042,356	7,847,442
Total stone	4,198,200	6,636,840	5,055,100	7,915,723

[1] Stone used for agriculture combined with "Other" to avoid disclosing individual company confidential data; combined data includes stone used in agriculture, asphalt filler, cement, lime, other filler, poultry grit, and rubber filler.

[2] Includes stone used in asphalt filler, cement, lime, other filler, poultry grit, railroad ballast, and rubber filler.

Whitney Sand & Gravel, Inc., and two contractors for the Nebraska Department of Roads and Crews of the Buffalo County Highway Department produced 511,000 tons of sand and gravel valued at $556,000. Seventy-four percent was used in road construction.

Cass.—Value of mineral production increased 16 percent, reaching a record $16.9 million owing to a higher demand for cement, stone, and clay. A 12-percent increase in the value of portland cement produced by the Louisville plant of Ash Grove Lime & Portland Cement Co. and a substantial increase in value of stone were the principal factors that effected the overall increase. Sand and gravel output increased substantially in tonnage but dropped slightly in value.

Crushed and broken limestone, used mainly as cement rock, riprap, aggregate, soil conditioner, and filler, was produced by Ash Grove Lime & Portland Cement Co., Heebner Quarries, Hopper Bros. Quarries, Tanner & Lockhart, United Mineral Products Co., United Rock Construction, Inc., and Kerford Limestone Co. Adolfe Fedde and one other supplier produced limestone for use as rough building stone. Tanner & Lockhart provided crushed stone for the Cass County Highway Department; United Mineral Products Co. supplied crushed rock to the Nebraska Department of Roads; and Midwest Construction Co. produced riprap for the U.S. Army Corps of Engineers.

Clay mined by Ash Grove Lime & Portland Cement Co. was used in manufacturing cement.

Fedde Sand & Gravel, Lyman-Richey Sand & Gravel Corp., Western Sand & Gravel Co., and two Nebraska Department of Roads contractors produced 568,000 tons of sand and gravel valued at $454,000. Roads and associated structures absorbed 51 percent and buildings 44 percent of the output.

Cheyenne.—Ranked first in marketed natural gas, the county also ranked third in crude oil output. The two gasoline plants yielded 51 percent of the State total natural gas liquids. Six of the county oilfields —4 in 1965—were ranked among the top 25 in the State. The county had the most successful exploratory program of the State; 26 wildcats resulted in 8 oil discoveries. Initial production in the new fields ranged from 208 barrels of oil per day in the Clara field to 20 barrels per day in the Flah field; the other discoveries were the Larson Ranch, Pasha, and Ursa fields and one as yet unnamed.

The Cheyenne County Highway Department, White Excavating & Ditching, and two contractors for the Nebraska Department of Roads, produced 151,000 tons of sand and gravel valued at $80,000, all for use in road construction.

Custer.—Sand and gravel totaling 166,000 tons and valued at $166,000 was produced by Arnold Redi-Mix, Middle Loup Sand & Gravel, Inc., and contractors for the Nebraska Department of Roads and the Custer County Highway Department.

The only pumice processor in the State, the LaRue-Axtell Pumice Co., treated pumicite from its mine in Lincoln County. Value of finished pumice products increased 41 percent.

Dawson.—Sand and gravel, 398,000 tons valued at $478,000, was produced by C. H. Luther Sand & Gravel Co., C. Kirpatrick & Son Sand & Gravel, G. F. Luther Sand & Gravel, Lindekugel Sand & Gravel, Worley Sand & Gravel, and contractors for the Nebraska Department of Roads and the Dawson County Highway Department. Highways and related structures consumed 63 percent, and buildings used 25 percent of the output.

Deuel.—In marketed natural gas, the county, with 1.5 billion cubic feet valued at $238,000, was ranked second after Cheyenne County. No natural gas liquids were produced because the plant of Kansas-Nebraska Natural Gas Co. at Big Springs field was shut down during the year. The only drilling in the county was two unsuccessful wildcats south of the Big Springs fields.

Sand and gravel, totaling 100,000 tons, was produced by suppliers contracted by the Nebraska Department of Roads and by crews and a contractor for the Deuel County Highway Department.

Dodge.—Suppliers of sand and gravel in Dodge County marketed 891,000 tons valued at $837,000. Building construction absorbed 44 percent, and roads and related structures used 36 percent of the output. Producers were Christensen Gravel, Inc., Christensen Sand & Gravel Co., Cowles Gravel Co., Lincoln Sand & Gravel Co., Lux Sand & Gravel Co., Lyman-Richey

Table 9.—Value of mineral production in Nebraska, by counties[1]

County	1965	1966	Minerals produced in 1966 in order of value
Adams	W	$114,000	Sand and gravel.
Antelope	$171,000	88,000	Do.
Banner	13,010,000	9,503,000	Petroleum, natural gas, sand and gravel.
Blaine	8,000	------	
Boone	W	W	Sand and gravel.
Box Butte	------	52,270	Sand and gravel, stone.
Boyd	25,000	24,000	Sand and gravel.
Brown	76,000	100,000	Do.
Buffalo	502,000	556,000	Do.
Butler	164,000	159,000	Do.
Cass	r 14,561,090	16,916,979	Cement, stone, sand and gravel, clays.
Cedar	91,000	116,000	Sand and gravel.
Chase	9,000	2,000	Do.
Cherry	7,000	18,000	Do.
Cheyenne	10,051,000	9,858,000	Petroleum, natural gas, LP gases, natural gasoline, sand and gravel.
Clay	W	82,000	Sand and gravel.
Colfax	100,000	78,000	Do.
Cuming	274,968	W	Sand and gravel, stone.
Custer	W	W	Sand and gravel, pumice.
Dakota	------	61,000	Sand and gravel.
Dawes	------	13,658	Stone.
Dawson	522,000	478,000	Sand and gravel.
Deuel	478,000	338,000	Natural gas, sand and gravel.
Dixon	66,118	60,512	Stone, sand and gravel.
Dodge	1,015,000	837,112	Sand and gravel, stone.
Douglas	1,608,097	1,456,138	Sand and gravel, stone, clays.
Dundy	88,000	25,000	Petroleum.
Fillmore	18,000	12,000	Sand and gravel.
Franklin	305,000	W	Sand and gravel, stone.
Frontier	23,000	38,000	Petroleum, natural gas.
Furnas	70,000	92,000	Sand and gravel, petroleum.
Gage	W	W	Sand and gravel, stone.
Garden	66,000	43,000	Petroleum, sand and gravel.
Garfield	------	W	Sand and gravel.
Grant	------	2,000	Do.
Hall	1,058,000	1,318,000	Do.
Hamilton	133,000	216,000	Do.
Harlan	136,000	163,000	Sand and gravel, petroleum.
Hayes	87,000	W	Do.
Hitchcock	579,000	703,000	Petroleum, sand and gravel.
Holt	204,000	166,000	Sand and gravel.
Hooker	------	14,000	Do.
Howard	4,000	92,000	Do.
Jefferson	W	W	Sand and gravel, clays.
Johnson	1,000	11,547	Sand and gravel, stone.
Kearney	140,000	103,000	Sand and gravel.
Keith	257,000	178,000	Do.
Keya Paha	------	9,000	Do.
Kimball	14,783,000	11,841,000	Petroleum, LP gases, natural gasoline, natural gas, sand and gravel.
Knox	217,000	298,000	Sand and gravel.
Lancaster	W	384,188	Stone, sand and gravel, clays.
Lincoln	371,000	278,000	Sand and gravel, petroleum.
Logan	2,000	2,000	Sand and gravel.
Loup	7,000	35,000	Do.
Madison	297,350	530,000	Do.
McPherson	------	6,000	Do.
Merrick	W	145,000	Do.
Morrill	2,047,900	2,182,000	Petroleum, sand and gravel, lime, natural gas.
Nance	W	82,000	Sand and gravel.
Nemaha	W	W	Stone, sand and gravel.
Nuckolls	W	W	Cement, sand and gravel.
Otoe	116,679	171,057	Stone, clays, sand and gravel.
Pawnee	171,130	162,130	Stone, sand and gravel.
Perkins	62,000	13,000	Sand and gravel.
Phelps	117,000	244,000	Do.
Pierce	98,000	86,000	Do.
Platte	W	W	Sand and gravel, stone.
Polk	W	W	Sand and gravel.
Red Willow	5,379,000	5,097,000	Petroleum, sand and gravel.
Richardson	167,027	381,512	Stone, petroleum.
Rock	------	19,000	Sand and gravel.
Saline	256,000	212,000	Do.
Sarpy	W	W	Sand and gravel, stone.
Saunders	1,383,000	945,000	Sand and gravel.
Scotts Bluff	2,997,350	2,487,455	Petroleum, lime, sand and gravel, natural gas, stone.
Seward	W	W	Stone, sand and gravel.
Sheridan	------	9,875	Do.

See footnotes at end of table.

Table 9.—Value of mineral production in Nebraska, by counties[1]—Continued

County	1965	1966	Minerals produced in 1966 in order of value
Sherman	84,000	21,000	Sand and gravel.
Sioux	11,348	26,782	Sand and gravel, stone.
Stanton	W	77,000	Sand and gravel.
Thayer	187,000	132,000	Do.
Thomas	26,000	19,000	Do.
Thurston	------	17,000	Do.
Valley	57,000	156,920	Sand and gravel, stone.
Washington	W	W	Stone.
Wayne	------	47,000	Sand and gravel.
Webster	55,000	112,000	Do.
Wheeler	10,000	20,000	Do.
York	149,000	120,000	Do.
Undistributed[2]	r 8,866,115	8,063,865	
Total	r 83,826,000	78,521,000	

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

[1] The following counties are not listed because no production was reported: Arthur, Burt, Gosper, and Greeley.

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

Sand & Gravel Corp., and a contractor for the U.S. Army Corps of Engineers. Ebsen Construction Co. produced riprap for its use as a contractor for the U.S. Army Corps of Engineers at the Elkhorn River Basin flood protection project near Hooper.

Douglas.—Mineral output was valued at $1.4 million. Hartford Sand & Gravel Co., Johnson Aggregate Co., two plants of Lyman-Richey Sand & Gravel Corp., McCann Sand & Gravel Co., Ready Sand & Gravel, Inc., and Sorensen Sand & Gravel produced 1.5 million tons of aggregate; 37 percent was used in highway construction and 51 percent in buildings. A contractor for the U.S. Army Corps of Engineers produced and used gravel for road construction.

Dugdale Construction Co., Martin R. Eby Construction Co., Miller Excavating Co., and Peter Kiewit Sons' Co. supplied crushed limestone for their own use on projects for the Nebraska Department of Roads; Hawkins Construction Co. produced riprap for its U.S. Army Corps of Engineers project.

Hall.—Although Hall County produced only sand and gravel, a record mineral output was established in 1966. Armour Construction Co., H & M Equipment Co., Inc., Luther & Maddox Gravel Co., Meister Bros. Sand & Gravel, and Third City Sand Co. produced 1.1 million tons valued at $1.3 million. Construction of Interstate 80 and other highways and related structures consumed 64 percent, and building, mainly in Grand Island, accounted for 16 percent of the county output.

Hitchcock.—The county was one of the few which had increases in yield of crude oil. This increase was mainly the result of a marked increase in output from the Reiher field which more than offset declines in other fields. The Reiher field moved up to be ranked 15th among the fields in the State. Drilling in the county consisted of seven unsuccessful wells, four wildcats, and three development wells.

G & J Gravel Co. and Stratton Gravel Co. produced aggregate used equally in building and road construction.

Keya Paha.—One of the most remote wildcats drilled in the State was in the eastern part of the county, a 2,300-foot test to granite with no shows of oil or gas. Contractors for the Nebraska Department of Roads produced 9,000 tons of paving gravel.

Kimball.—The county again was ranked first in petroleum production, second in natural gas liquids, and third in marketed natural gas. Although yield of petroleum and natural gas declined, the total production of natural gas liquids, because of increased output of LP gases, was up 19 percent. Output of petroleum was down 1.5 million barrels, a loss of $3.1 million. Six of the 25 largest fields in the State were in the county; Sloss and Enders were among the top 5 fields. Kimball County had the largest number of wells drilled: Of the 38 wildcat wells, 3 were successful, and 15 of the development wells were oil producers. Two of the discoveries appeared to have significant production: East Simpson field (see Petroleum section) and the

unnamed discovery by Regal Drilling Co. and Petroleum, Inc., at their No. 1 Bostrom well, appear to have significant initial production. This well was completed for 142 barrels of oil per day.

Wilson Bros., Inc., and a contractor for the Nebraska Department of Roads produced 38,000 tons of sand and gravel valued at $36,000. Highway structures absorbed 68 percent of the output, and buildings used 26 percent.

Lancaster.—Value of the three mineral commodities—stone, sand and gravel, and clay—produced in Lancaster County totaled a record $384,188.

J. D. Schwarck Quarries, Inc., produced limestone for use as aggregate, soil conditioner, and rubble. Brandt Construction, Inc., produced riprap and concrete aggregate for its own use as a contractor for the Lancaster County Highway Department and riprap for its use at a U.S. Army Corps of Engineers project. Yankee Hill Brick Manufacturing Co. mined clay for manufacturing brick and hollow tile at its plant in Lincoln.

Lincoln.—Output at the Red Willow Creek field declined sharply to 4,461 barrels of crude oil.

Production of sand and gravel by Brewer Sand & Gravel, James E. Simon Co., Inc., Lyman-Richey Sand & Gravel Corp., Worley Sand & Gravel, and the Nebraska Department of Roads contractors totaled 243,000 tons, 89 percent of which was used in road construction.

Madison.—Value of mineral production attained a record $530,000. Five suppliers of sand and gravel, Bill's Sand and Gravel, Central Sand & Gravel Co., Einung Sand & Gravel Co., Elkhorn Construction Co., and Midwest Bridge and Construction Co., produced 448,000 tons. Sixty-seven percent of the output was used in road construction.

Morrill.—Increased petroleum production was the result of a threefold gain in yield at the Waitman field; the field was unitized and a waterflood program initiated in November 1964. Although no marked change was apparent in 1965, during 1966 response to the waterflooding was dramatic; production rose from 88,000 barrels in 1965 to 269,000 in 1966. Morrill County had one successful wildcat well and five oil development completions.

Production of lime at the Bayard plant of The Great Western Sugar Co. increased 30 percent in tonnage and 49 percent in value.

Output of sand and gravel by Lyman-Richey Sand & Gravel Corp., Morrill County Highway Department, and contractors for the Nebraska Department of Roads increased substantially in tonnage but decreased slightly in value.

Nemaha.—Value of mineral output dropped 6 percent. All the sand and gravel, produced by Wittwer Brothers, Inc., was used in road construction. The output of crushed limestone by Nelson Quarries, Inc., was used for concrete aggregate, roadstone, and agricultural stone.

Nuckolls.—Mineral output dropped 19 percent in value because of a reduced demand for masonry and portland cements by Ideal Cement Co. and because of a sharp decline in the output of sand and gravel. Virtually the entire output of aggregate was used in constructing roads.

Otoe.—The county produced three mineral commodities, all of which increased in quantity.

Western Brick and Supply Co. mined clay for its plant at Nebraska City. Contractors for the Nebraska Department of Roads produced 32,000 tons of sand and gravel. Hopper Bros. Quarries produced crushed limestone for aggregate and agricultural stone; Tanner & Lockhart supplied limestone aggregate to the Otoe County Highway Department.

Platte.—Value of mineral production increased threefold, a record high. Ace Sand & Gravel Co., Central Sand & Gravel Co., Columbus Sand & Gravel, Lyman-Richey Sand & Gravel Corp., and a contractor for the Nebraska Department of Roads produced 670,000 tons of aggregate valued at $874,000. Sixty percent was used in road construction and 27 percent was used in building construction.

Ace Sand & Gravel Co. produced crushed limestone for riprap.

Red Willow.—With petroleum production declining by 202,000 barrels, the county was ranked fourth in oil yield. The State's largest oilfield, Sleepy Hollow, was in the county, as were 3 others of the 25 largest fields. Output of the Sleepy Hollow field was down 260,000 barrels. The significant new field discovery, Bed Canyon field, was on the Red Willow-Frontier county line. Four other discoveries were recorded in the county; six successful development wells were drilled.

Davidson Gravel Co., Midwest Sand & Gravel Co., and McCook Hollostone Co. produced 246,000 tons of sand and gravel, an increase of 103 percent; road construction absorbed 85 percent of this output.

Richardson.—Total output of the three Forest City basin oilfields was relatively unchanged. Three unsuccessful wildcat wells were drilled. Crews of the Richardson County Highway Department mined 177,210 tons of limestone for concrete aggregate and roadstone. For the first time in several years no sand and gravel production was recorded.

Sarpy.—The value of the two mineral commodities produced in the county declined 5 percent. Three plants of Lyman-Richey Sand & Gravel Corp., Sorensen Sand & Gravel, Maystrick Brothers, Johnson Sand & Gravel, and contractors for the Nebraska Department of Roads produced 568,000 tons of sand and gravel valued at $535,000. Building construction consumed 52 percent and road construction used 42 percent of the output. City Wide Rock & Excavation Co. mined limestone for riprap and as aggregate for concrete and roadstone; Welsh Stone Co., Inc., produced crushed limestone for road construction.

Saunders.—Wolf Sand & Gravel Co., Lyman-Richey Sand & Gravel Corp., Western Sand & Gravel Co., and Ashland Ready Mix marketed 946,000 tons of aggregate valued at $945,000. Road construction absorbed 55 percent and building 45 percent of the output.

Scotts Bluff.—Petroleum production declined 27 percent and marketed natural gas was down 22 percent. Output of the county's largest field, Cedar Valley, decreased by 22,813 barrels to 234,757 barrels. Stage Hill field, partly in Banner County, had a 52-percent decline in production to 198,777 barrels. Scotts Bluff County had 28 exploratory wells (second to Kimball County); all were dry. Only seven development wells were drilled and six were unsuccessful. The State's only refinery, owned by Cooperative Refining Association, Inc., located at Scottsbluff, had a crude oil throughput of 966,000 barrels, down 7 percent from that of 1965.

Sand and gravel output of 238,000 tons was valued at $216,000. Producers were Eisele Concrete Products Co.; Kembel Sand & Gravel Co., Inc.; Willis Young, Sand & Gravel; Scotts Bluff County Highway Department; and the Nebraska Department of Roads contractors. Roads and related structures consumed 58 percent and building construction used 36 percent of the production. Industrial Builders, Inc., used 970 tons of limestone riprap valued at $1,455 at a U.S. Army Corps of Engineers project.

Washington.—Fort Calhoun Stone Co. produced limestone for riprap, concrete aggregate, roadstone, and agricultural stone for soil conditioning. No production of sand and gravel was reported.

The Mineral Industry of Nevada

This chapter has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines, United States Department of the Interior, and the Nevada Bureau of Mines.

By L. E. Davis [1]

The value of Nevada's mineral production was the third highest on record, exceeded only by that of 1955 and 1956 when government purchase programs for tungsten and manganese were in effect. Metals represented 72 percent of the total value, nonmetals 27 percent, and mineral fuels, 1 percent. Mineral exploration activity in 1966—chiefly for gold, copper, mercury, and silver—reached a record level.

Of the metals and metal ores produed in Neveda, decreases were reported only for iron and uranium ores. More mercury was produced, but the overall value was less. Declines, however, were reported for half the nonmetallic minerals produced in 1966.

Petroleum output from Nevada's only oilfield was much higher despite a lack of transportation and refining facilities. No new wells were completed to production.

[1] Physical scientist, Bureau of Mines, San Francisco, Calif.

Table 1.—Mineral production in Nevada [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ore and concentrate (content)--short tons--	26	$19	68	$63
Barite----thousand short tons--	91	583	139	933
Copper (recoverable content of ores, etc.)-short tons--	71,332	50,503	78,720	56,946
Gem stones	NA	100	NA	100
Gold (recoverable content of ores, etc.)--troy ounces--	229,050	8,017	366,903	12,842
Gypsum----thousand short tons--	710	2,518	594	2,023
Iron ore (usable)---thousand long tons, gross weight--	1,141	5,330	1,000	4,931
Lead (recoverable content of ores, etc.)----short tons--	2,277	710	3,581	1,083
Mercury----76-pound flasks--	3,333	1,902	3,355	1,482
Perlite----short tons--	13,780	121	W	W
Petroleum (crude)-----thousand 42-gallon barrels--	209	W	307	W
Pumice, pumicite and volcanic cinder thousand short tons--	68	187	55	190
Sand and gravel----do----	9,455	11,796	9,085	9,134
Silver (recoverable content of ores, etc.) thousand troy ounces--	507	656	867	1,122
Stone----thousand short tons--	1,248	2,247	2,002	2,519
Sulfur ore----long tons--	336	6	---	---
Talc and soapstone----short tons--	3,592	31	4,715	24
Zinc (recoverable content of ores, etc.)-----do----	3,858	1,127	5,827	1,690
Value of items that cannot be disclosed: Brucite, cement, clays, diatomite, fluorspar, lime, lithium minerals (1966), magnesite, molybdenum concentrates (content), peat, salt, tungsten concentrate, uranium ore, and values indicated by symbol W----	XX	r 14,113	XX	17,550
Total----	XX	r 99,966	XX	112,632

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

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

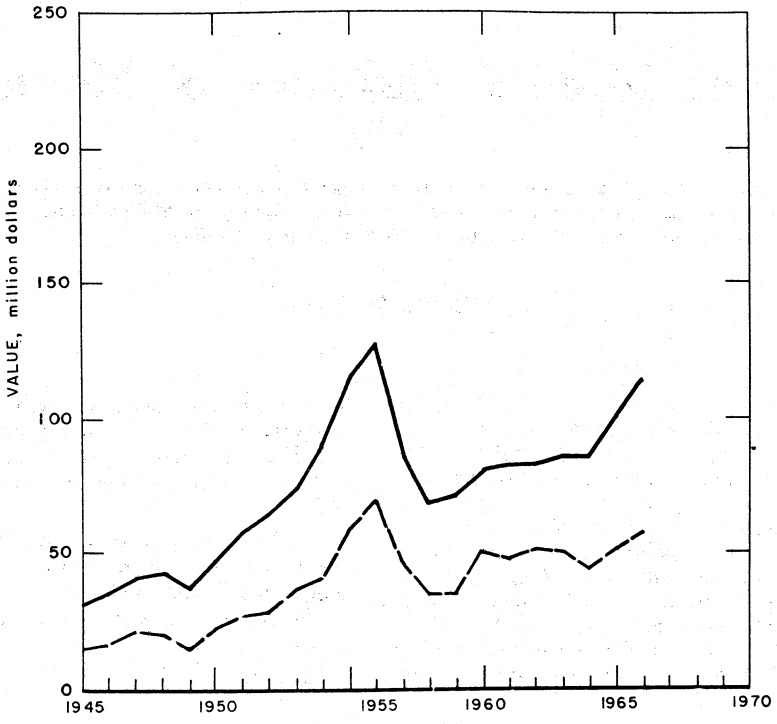

Figure 1.—Value of copper and total value of mineral production in Nevada.

Consumption, Trade, and Markets.—All of Nevada's requirements for mineral fuels and meals, and virtually all its nonmetallic mineral needs other than construction materials, were supplied by out-of-State processors. Most of the barite and perlite and some of the gypsum and limestone produced was shipped out of the State in crude form. Much of the lime output went to customers in California, Washington, and Arizona. All petroleum production was consigned to refineries in Utah and California. Metal ores, concentrates, precipitates, and residues, with few exceptions, were processed in mills and smelter outside the State. The one smelter in Nevada (copper) was dependent on Nevada ores. All usable iron ore was exported or shipped to steel plants in other States. In Clark County, an electrolytic manganese dioxide plant operated on ore obtained through a New Mexico broker, and a titanium sponge plant used imported titanium minerals. A tungsten carbide plant in Mineral County utilized purchased tungsten concentrates, principally from the General Services Administration stockpile.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]	Year	Value [1]
1957	$84,408	1962	$80,556
1958	72,297	1963	82,156
1959	69,018	1964	78,398
1960	75,968	1965	87,935
1961	79,645	1966	[p] 97,844

[p] Preliminary.
[1] Data for 1957–65 revised.

Trends and Developments.—Exploration for gold was in progress in Clark, Douglas, Elko, Eureka, Humboldt, Mineral, Nye, Pershing, Storey, and White Pine Counties. Carlin Gold Mining Co., Eureka County, completed its first full year of production and became the second largest gold mine in the United States. The Atlanta gold mine, Lincoln County, closed in September for an indefinite period.

Federal Resources Corp. began shipping lead-silver ore from the Simon mine near Mina, Mineral County, to its Bellevue, Idaho, pilot mill. Exploration for silver ore was underway in Elko, Esmeralda, Eureka, Lander, and White Pine Counties.

Several companies were exploring for copper ores in Elko, Humboldt, Lincoln, Lyon, Mineral, Pershing, and Washoe Counties. Development of the Lander County copper-gold-silver properties of Duval Corp., which was initiated in 1965, proceeded on schedule throughout 1966. At yearend, most of the overburden stripping had been completd and one of two precipitation plants was in operation. Construction of the milk and the second precipitation plant was nearing completion. Both were scheduled for production early in 1967. The $4.5 million additional copper sulfide ore milling facility of The Anaconda Company was nearing completion at Weed Heights, Lyon County. In White Pine County, Kennecott Copper Corp. announced that operations at the Liberty Pit were to be terminated after 60 years of continuous operation. Mining was moved to the two adjacent pits, Tripp and Veteran. Phasing out at the Liberty, and stripping at the Tripp-Veteran, were conducted simultaneously so there would be no interruption in production.

Anaconda reported that drilling at the Hall molybdenum prospect, Nye County, had defined the characteristics of a large low-grade molybdenum orebody. Duval Corp. obtained an option to purchase the Gibellini vanadium property, Eureka County. Exploration for mercury ore was conducted in Elko, Humboldt, Nye, and Pershing Counties. Negotiations were completed for sale of the Cordero mercury mine, Humboldt County, to Fred H. Lenway & Co., Inc. of San Francisco, Calif. The purchaser was to assume operational control of the property January 1, 1967. Antimony Reduction Co. had a 25-ton-per-day antimony oxidizing plant under construction at Panaca, Lincoln County. Titanium Metals Corporation of America (TMCA) announced a multimillion dollar expansion program at its Henderson, Clark County, facility. The company planned a 50-percent increase in ingot melting capacity, with new furnaces capable of melting 15,000-pound ingots; a 60-percent increase in output of sponge titanium including installation of a new electrolytic sponge plant using a new production process. The company expects that the new process will have significent influence on the price and quality of titanim products by 1970.

Foote Mineral Co. dedicated its lithium-mineral recovery facility at Silver Peak, Esmeralda County, in August, and began shipping lithium carbonate. Georgia-Pacific Corp. announced purchase of the Tule Valley gypsum deposit, Lincoln County. Western Marble Co. began developing a white marble quarry near Lages Station, White Pine County. In May, General Refractories Co. (GREFCO, Inc.) acquired the assets and liabilities of the Mining and Mineral Products Division, Great Lakes Carbon Corp., including a diatomite mining and processing facility in Esmeralda County. The limestone quarry of Kennecott Copper Corp., White Pine County, was leased to Morrison & Weatherly Chemical Products Co. The latter planned to install a kiln to supply lime to Kennecott and others, with full operation scheduled for early 1967. All sulfur holdings (land and equipment) of Sulphur Products, Inc., Humboldt County, were sold to Great American Industries, Inc. of New York. Exploration for sulfur was in progress in the area and in Esmeralda, Eureka, and Washoe Counties.

Legislation and Government Programs.—There were no reported revisions or additions to the Nevada State mining laws by the Nevada Legislature. Public land orders withdrew nearly 5,300 acres of land from mineral location under U.S. mining laws, 4,400 acres of which was withdrawn by the Bureau of Reclamation in Clark County. Land orders also restored about 7,200 acres to mineral location and leasing, 2,400 acres by the Bureau of Land Management in Pershing County. Nevada received a U.S. Treasury check for $279,982.31 in bonuses, royalties, and rentals covering mineral

leases and permits for the first 6 months of 1966. The amount due the State for the last 6 months had not been announced.

On October 5, 1965 the Lead-Zinc Stabilization Program was extended to December 31, 1969, by enactment of Public Law 89-238. Revisions under the law required producers to be recertified after June 1, 1966, to be eligible for stabilization payments. Of the 11 (corrected figure) applications received from Nevada producers, since enactment of the program in October 1962, 2 had been recertified, 2 were denied, and 7 had been withdrawn, suspended, or otherwise disqualified. No payments were made on 1966 production.

The Bureau of Mines provided consulting services to the Atomic Energy Commission (AEC) during 1966 on four preshot and postshot surveys of selected mines and tunnels within and adjacent to the Nevada Test Site to determine the extent of structural damage that might be attributed to underground nuclear tests.

Research on electrowinning of rare-earth metals and refractory metal compounds at the Bureau of Mines Reno Metallurgy Research Center, Reno, included studies (a) to better define reactions involved in preparing rare-earth and other reactive metals from molten salts, (b) to measure the physical properties of refractory metals, (c) to develop high-strength alloys, and (d) to develop methods of separating and purifying rare-earth oxides. Ferrous rare-earth metal alloys and rare-earth metals with very low impurity content, electrowon from their oxides, were found to have distinctive magnetic properties. Tungsten carbide having a hardness equal to commercial grade material was prepared by electrodeposition. Also, a study as initiated to extract gold from refractory ores.

The Bureau of Mines Boulder City Metallurgy Research Laboratory continued to specialize in the winning and refining of specialty metals in molten salt electrolytes, obtaining extremely high purity vanadium and beryllium metals. These high-purity metals were sought by university, private, and various government agencies for further research on alloy development and for determination of physical properties.

The Region II Field Office, Office of Minerals Exploration (OME), U.S. Geological Survey, received 12 applications from persons interested in exploring for Nevada minerals under the OME programs. Of these, nine applications were processed, three contracts were let, and four contracts were active at yearend.

Table 3.—Employment 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
1965:								
Metal	2,189	297	650	5,206	1	117	22.67	1,746
Nonmetal and peat	772	276	213	1,712	---	47	27.45	3,503
Sand and gravel	648	205	133	1,072	---	12	11.20	192
Stone	213	290	62	494	---	7	14.18	352
Total	3,822	277	1,058	8,484	1	183	21.69	1,823
1966: p								
Metal	2,210	293	648	5,229	2	141	27.35	3,460
Nonmetal and peat	735	257	189	1,521	---	38	24.98	1,384
Sand and gravel	610	200	122	977	---	19	19.45	657
Stone	205	263	54	433	---	5	11.55	460
Total	3,760	269	1,013	8,160	2	203	25.12	2,578

p Preliminary.

REVIEW BY MINERAL COMMODITIES

METALS

Antimony.—Mines in Lander County yielded all the antimony ore mined in 1966. The Last Chance mine was the major producer. Although some lump ore was shipped, most of the ore was concentrated in the Stevens mill at Austin before shipment. Stevens also shipped concentrates produced from ores mined in preceding years. All shipments were made to the antimony smelter in Laredo, Tex.

Copper.—Copper production was 10 percent greater than in 1965, and the highest since 1963. The Nevada copper industry was again dominated by The Anaconda Company, Lyon County, and Kennecott Copper Corp., White Pine County. Only four other mines, one copper producer each in Elko and Pershing Counties, a lead-zinc producer in Lincoln County, and a silver-lead-zinc producer in White Pine County, contributed appreciably to the total copper output. Lesser quantities of copper were recovered as a byproduct from complex lead, zinc, and silver ores.

At yearend the copper operations of Duval Corp. at Copper Basin and Copper Canyon, Lander County, were nearing the production stage.

Gold.—Production was reported at 16 lode gold mines, but only 2 mines contributed more than 5,000 ounces each to the total output. The Carlin mine and mill, Eureka County, was chiefly responsible for the 60-percent increase over the 1965 output. The Getchell mine, Humboldt County, was the other major lode gold mine in production, although the Atlanta mine, Lincoln County, made substantial output before it closed for an indefinite period shortly after midyear. Byproduct gold at other lode mines, principally copper mines, accounted for 8 percent of the lode gold recovered.

Placer gold recovery was insignificant by comparison. Only one property, Nevada Porphyry in Nye County, yielded more than a few ounces.

Table 4.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing [2]		Material sold or treated [3] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
1957–61 (average)	82	10	10,886	81,527	$2,853	719,611	$653
1962	39	4	13,121	62,863	2,200	245,164	266
1963	37	7	13,676	98,879	3,461	214,976	275
1964	38	6	13,383	90,469	3,166	172,447	223
1965	48	5	15,817	229,050	8,017	507,113	656
1966	51	10	16,229	366,903	12,842	867,567	1,122
1904–66 [4]	---	---	NA	16,015,422	408,560	318,320,457	219,805

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1957–61 (average)	71,354	$42,676	2,853	$719	1,295	$302	$47,203
1962	82,602	50,883	771	142	281	65	53,556
1963	81,738	50,351	1,126	243	571	131	54,461
1964	67,272	43,861	809	212	582	158	47,620
1965	71,332	50,503	2,277	710	3,858	1,127	61,013
1966	78,720	56,946	3,581	1,083	5,827	1,690	73,683
1904–66 [4]	3,110,474	1,308,002	400,214	64,678	494,192	96,594	2,097,638

NA Not available.
[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings or slimes retreated, and ore and old tailings shipped to smelters during calendar year indicated.
[2] Excludes itinerant prospectors, "snipers," "high graders," and others who gave no evidence of legal right to property.
[3] Does not include gravel washed.
[4] The first satisfactory annual canvass of mine production was made in 1904.

Table 5.—Mine production of gold, silver, copper, lead, and zinc in 1966, by counties, in terms of recoverable metals

County	Mines producing [1]		Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Troy ounces	Value	Troy ounces	Value
Elko	8	1	29	$1,015	22,337	$28,882
Eureka	3	---	W	W	2,919	3,774
Humboldt	6	2	W	W	7,275	9,406
Lander	2	1	54	1,890	24	31
Lincoln	2	---	4,000	140,000	473,938	612,802
Nye	5	3	715	25,025	W	W
Ormsby	1	---	1	35	2	3
Pershing	5	2	19	665	3,597	4,651
Washoe	2	1	51	1,785	639	826
Undistributed [2]	17	---	362,034	12,671,190	356,836	461,389
Total	51	10	366,903	12,841,605	867,567	1,121,764

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Elko	W	W	106	$32,165	39	$11,295	$73,357
Eureka	1	$977	92	27,872	268	77,734	110,357
Humboldt	W	W	W	W	W	W	9,406
Lander	---	---	---	---	---	---	1,921
Lincoln	22	16,240	2,495	754,223	5,265	1,526,676	3,049,941
Nye	---	---	W	W	W	W	25,025
Ormsby	---	---	---	---	---	---	38
Pershing	W	W	[3]	136	[3]	102	5,554
Washoe	[3]	36	16	4,852	1	392	7,891
Undistributed [2]	78,696	56,928,795	871	263,288	254	73,631	70,398,293
Total	78,720	56,946,048	3,581	1,082,536	5,827	1,689,830	73,681,783

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed".
[1] Excludes itinerant prospectors, "snipers," "high-graders," and others who gave no evidence of legal rights to property.
[2] Includes Churchill, Clark, Douglas, Esmeralda, Lyon, Mineral, White Pine counties and counties indicated by symbol W.
[3] Less than ½ unit.

Table 6.—Mine production of gold, silver, copper, lead, and zinc in 1966, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines [1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold	16	1,254,946	336,359	10,826	---	[2]	[2]
Silver	13	26,020	103	149,913	27	290	146
Copper	5	14,628,899	29,214	199,669	78,657	---	---
Lead	11	3,705	54	29,136	4	193	68
Lead-zinc	4	311,042	291	475,110	27	2,570	5,335
Zinc	2	1,234	4	1,448	2	95	275
Total	51	16,225,846	366,025	866,102	78,718	3,148	5,825
Other lode material:							
Gold (slag)	[3]	2	561	966	---	---	---
Lead residue	[3]	2,742	---	340	2	433	2
Old tailings	[3]	145	7	2	---	---	---
Total	---	2,889	568	1,308	2	433	2
Total lode material	51	16,228,735	366,593	867,410	78,720	3,581	5,827
Placer	10	[4]	310	157	---	---	---
Total all sources	61	16,228,735	366,903	867,567	78,720	3,581	5,827

[1] Details will not necessarily add to totals shown, because some mines produce more than one class of material.
[2] Less than ½ unit.
[3] From property not classed as a mine.
[4] 7,040 cubic yards.

Table 7.—Mine production of gold, silver, copper, lead, and zinc in 1966, 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 and cyanidation:					
Ore	335,942	8,007	---	---	---
Old tailings	7	2	---	---	---
Concentration and smelting of concentrates:					
Ore	29,040	715,568	76,769	2,805	5,416
Direct smelting:					
Lead residue	---	340	2	433	2
Ore	1,043	142,527	1,949	343	409
Slag	561	966	---	---	---
Total	1,604	143,833	1,951	776	411
Placer	310	157	---	---	---
Grand total	366,903	867,567	78,720	3,581	5,827

Iron Ore.—Production and shipments of usable iron ore totaled nearly 1 million tons, but was 12 percent below the 1965 figure. More than half of the shipments were direct shipping-grade ore; 93 percent of the total output was exported. All mines except the Iron King, Humboldt County, were open pits. Only Standard Slag Co., Douglas County, produced other than direct shipping grade ore. This firm produced at its plant in Wabuska, Lyon County, a concentrate largely for export, with a relatively small quantity sold to a nearby cement plant.

Lead.—Although 11 mines—7 lead, 2 lead-zinc, 1 silver, 1 zinc, and 1 former manganese mine—yielded most of the recoverable lead, the Pan American mine in Lincoln County dominated the lead industry in Nevada and was directly responsible for the 57-percent increase in total output. Lead-zinc ores accounted for 72 percent of State's lead production, silver ores 8 percent, lead ores 5 percent, zinc ores 3 percent, and all other 12 percent. Residues from a former manganese mine in Clark County, and byproduct lead from silver ores of the Ward group of claims, White Pine County, contributed a combined total of nearly 1.5 million pounds of recoverable lead.

Late in 1966 shipments of ore began from the Simon lead mine, Mineral County. Exploration and development had been underway for 2 to 3 years.

Mercury.—Mercury production rose slightly despite a drop in the average unit price to $441.82 per flask from the alltime high of $570.75 in 1965. The number of producing properties declined one-third, and the average grade of ore treated was 25 percent lower. Four properties produced more than 100 flasks each and together accounted for 93 percent of the output. The Cordero mine, Humboldt County, the State's major producer, produced and shipped 68 percent of the total. Twenty operators reported less than 10 flasks each.

Table 8.—Mercury production, by methods of recovery

Year	Direct-furnaced		Retorted		Unclassified[1] flasks	Total		Operating mines
	Ore (short tons)	Flasks	Ore (short tons)	Flasks		Flasks	Value[2] (thousands)	
1957–61 (average)	43,299	6,353	12,502	861	8	7,222	$1,599	28
1962	52,545	6,554	416	18	1	6,573	1,257	14
1963	42,768	4,908	356	36	---	4,944	937	11
1964	42,635	3,181	653	81	---	3,262	1,027	21
1965	48,197	2,877	3,575	456	---	3,333	1,902	42
1966	48,813	3,021	14,633	334	---	3,355	1,482	29

[1] Includes mercury recovered from miscellaneous dump material.
[2] Value calculated at average New York price.

Molybdenum.—Molybdenite was recovered in the McGill concentrator, White Pine County, by Kennecott Copper Corp. as a byproduct in treating copper ore mined in the nearby Robinson district. Production and shipments were more than double the 1965 figures. All shipments were consigned to domestic consumers.

The Anaconda Company stated that drilling at the Hall molybdenum prospect north of Tonopah, Nye County, had defined the characteristics of a large low-grade molybdenum orebody. The company reported no operational decisions at year-end.

Silver.—Recoverable silver production rose 71 percent above the 1965 output. Although decreases were reported in the number of active lode silver properties, and in the tonnage of silver ores treated, the output of recoverable silver from these mines increased 5 percent over that in 1965. Byproduct recovery from gold, copper, and lead ores also was higher but most of the increase in total output was credited to the Pan American lead-zinc mine, Lincoln County. This mine was the State's leading producer of recoverable silver. Lead-zinc ores yielded 55 percent of the total lode silver, copper ores 23 percent, silver ores 17 percent, and all other ores 5 percent.

Less than 160 ounces of silver was recovered from placer gold operations in Nevada.

Tungsten.—No activity was reported from any Nevada tungsten mine. Concentrates produced in preceding years at the Nevada-Massachusetts Co. mine, Pershing County, were shipped from stockpile to a California paratungstate plant. Kennametal, Inc. operated a tungsten carbide plant near Rawhide, Mineral County, on concentrates purchased from the GSA stockpile. The company also purchased a smaller tonnage of scheelite concentrate from a California producer.

Uranium.—Apex Minerals Corp. mined uranium ore from the Rundberg mine, Lander County, and U.S. Mining and Exploration worked the Red Bluff mine (Lowry claims), Washoe County. Both producers shipped to a processing plant at Moab, Utah. Production and shipments were at the lowest level since 1963.

Zinc.—Two zinc mines were in operation during the year, but only the Mountain View mine, Eureka County, yielded an appreciable quantity of recoverable zinc. The 51-percent increase over 1965 was credited to lead-zinc mines, principally the Pan American, which accounted for 90 percent of Nevada's recoverable zinc in 1966. The remaining 10 percent came from other ores, residues, and slags.

NONMETALS

Barite.—Primary barite production was 59 percent above the 1965 figure; sales, including tonnages used by producers, rose 53 percent. Lander County mines yielded 85 percent of the production and 83 percent of the shipments. The major producers were FMC Corp. (Mountain Springs mine) and Magnet Cove Barium Corp. (Greystone group). Magnet Cove and National Lead Co. ground barite in their respective plants near Battle Mountain, Lander County, and Dunphy, Eureka County. National Lead contracted the mining of barite from its own property in Eureka County to supply requirements of the company grinding plant.

Cement.—Nevada Cement Co. produced portland cement in its dry-process plant at Fernley, Lyon County, utilizing limestone from a nearby quarry, clays from Washoe County, gypsum from Pershing County, and iron ore from Douglas County. Bulk and bag shipments were made to ready-mixed plants and building materials dealers in Nevada and northern California. Consumption of cement in Nevada was about 200,000 barrels less than in 1965, principally because of lower demand in Clark County.

Clays.—Industrial Minerals & Chemical Co. mined fuller's earth from its Lyon County mine and prepared the material for use as a filler in animal feeds, and as an absorbent. Bentonite was mined by Silicates Corp. in Esmeralda and Nye County from pits, prepared, and sold for use in cosmetics and pharmaceuticals. Nevada Cement Co. obtained miscellaneous clay from a Washoe County deposit for use in its cement plant.

Diatomite.—Prepared diatomite sales rose 16 percent whereas crude sales were only a fraction of the 1965 figure. Four deposits were worked—one each in Esmeralda, Lincoln, Pershing, and Storey Counties. Major processing plants were operated in Per-

shing and Storey Counties by The Eagle-Picher Co., and in Esmeralda County by GREFCO, Inc., formerly Great Lakes Carbon Corp. United Sierra Division, Cyprus Mines Corp., operated a mine in Churchill County and a plant in Lyon County. The Lincoln County mine of Morgan & Bush, Inc., yielded the only crude sales reported. The material was processed in Dublin, Calif.

Fluorspar.—Production and shipments of fluorspar, higher than in 1965, came from three Nye County mines. Metallurgical and ceramic grade fluorspar from the Crowell mine was shipped to southern California customers. Lower grade material from the Goldspar and Mary mines, the latter a new producer in 1966, was shipped to the producer's California cement plant.

Gypsum.—A depressed homebuilding market was chiefly responsible for a crude gypsum output that was 16 percent less than in 1965, and declined 23 percent in the tonnage of gypsum calcined at plaster and board plants. Gypsum was mined from two deposits in Clark County and one in Pershing County. Output from Pershing County was used for gypsum products manufactured in the Washoe County plant of U.S. Gypsum Co. One Clark County deposit supplied the lath, plaster, and wallboard plant of The Flintkote Co. at Blue Diamond; the other supplied the wallboard plant of Fibreboard Corp. near Apex. Some Clark County crude gypsum was shipped to three gypsum products plants in California. The gypsum deposit in Lincoln County was sold to Georgia-Pacific Corp. and remained idle throughout the year.

Lime.—Nevada's only lime producer, The Flintkote Co., operated three lime plants in Clark County, producing quicklime at Apex and Henderson and hydrated lime at Henderson and Sloan. Combined output exceeded the 1965 figure chiefly because of increased sales to steel plants. Sales to the construction industry declined; those to the chemical and other industries were virtually unchanged. Although shipments were made throughout the Western States, the majority were to southern California consumers.

Morrison & Weatherly Chemical Products Co. leased the McGill limestone quarry from Kennecott Copper Corp. and planned to re-establish lime production early in 1967. Kennecott had discontinued lime production in December 1961.

Lithium Compounds.—Foote Mineral Co. began producing lithium carbonate at its Silver Peak, Esmeralda County, facility. Designed capacity of the operation was 5 million pounds of lithium products per year, but demand was such that capacity was being doubled at yearend. Serious consideration was being given to increasing capacity to 20 million pounds annually. During the year Foote reduced the price of its lithium carbonate at Silver Peak from 45 to 38 cents per pound.

Magnesite and Brucite.—Basic, Inc. at Gabbs, Nye County, operated openpit mines for magnesite and brucite, a milling plant, heavy medium plant, three rotary kilns for deadburning, two Herreshoff furnaces for lightburning, and a special products plant for grinding, blending, and bagging various refractory materials. During the first half of 1966, a new flotation plant was completed as part of Basic's modernization program.

Perlite.—Crude perlite sales declined for the ninth consecutive year. No sales of expanded material were reported in 1966. Three mines were active, two in Lincoln County and one in Pershing County. Crude perlite from the latter deposit was expanded and used in the producer's Washoe County wallboard plant.

Pumice (Volcanic Cinder).—Pumice mined from the Naturalite group of claims, Storey County, was prepared for sale as concrete aggregate, and a small tonnage mined at the Pumco Aggregates property, Mineral County, was used by the producer for the same purpose. In Lincoln County, pumicite was mined at the Lory Free pit, processed at Panaca, and sold for pozzolan in southern California. Volcanic cinder was obtained and prepared for concrete-block aggregate at the Cinder Cone deposit, Nye County, the Cinderlite mine, Ormsby County, and the Steamboat property, Washoe County. Cinder from Cinderlite also was sold for asphalt aggregate, railroad ballast, and landscaping rock. Sales of crude (all material) were above those in 1965 but sales of prepared material dropped appreciably.

Salt.—Solar-evaporated salt was harvested from the surface of a dry lakebed near Sand Springs, Churchill County. The output was sold principally to State, county,

and local agencies in Nevada and Idaho, for ice control. Lesser quantities were used by meat packers, tanners, and dairies.

Sand and Gravel.—Over 9 million tons of sand and gravel was produced at 111 operations, 11 more than in 1965. Of these, 40 were classified as commercial and 71 as Government-and-contractor. Only one commercial operator produced over 500,000 tons; 10 produced between 100,000 and 500,000 tons each; and 29, less than 100,000 tons each.

A larger volume of low-value material was produced for highway construction at Government-and-contractor operations than in 1965 but the output by commercial producers. chiefly for building construction, dropped nearly 2 million tons and accounted for an overall decline in value. A high percentage of the total output was at portable plants, principally Government-and-contractor operations. The stationary plants were operated predominantely by commercial producers.

Production of specialty sands, mainly for glass, molding, and other industrial uses, was limited to operations in the Overton area, Clark County.

Table 9.—Sand and gravel production in 1966, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value
Churchill	29	$27
Clark	4,414	4,654
Douglas	73	53
Elko	705	478
Eureka	229	162
Humboldt	105	141
Lander	187	105
Lincoln	75	59
Lyon	512	468
Mineral	2	2
Nye	345	242
Ormsby	31	31
Pershing	725	403
Washoe	1,581	2,274
White Pine	72	35
Total	9,085	9,134

Table 10.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Glass	W	W	W	W
Molding	W	W	W	W
Building	700	$1,484	520	$1,204
Paving	238	402	52	99
Fill	22	16	134	105
Other	W	W	183	106
Gravel:				
Building	947	1,704	607	1,073
Paving	2,612	3,706	1,333	1,691
Railroad Ballast	W	W	2	3
Fill	419	376	273	315
Other	W	W	1	1
Miscellaneous	129	245	382	575
Undistributed sand and gravel [1]	441	914	175	777
Total sand and gravel	5,508	8,847	3,662	5,949
Government-and-contractor operations: [2]				
Sand:				
Building	27	27	123	90
Paving	72	63	25	26
Fill	5	5	12	24
Other	---	---	---	---
Total	104	95	160	140
Gravel:				
Building	25	25	217	116
Paving	3,633	2,636	4,797	2,629
Fill	185	193	243	291
Other	---	---	6	9
Total	3,843	2,854	5,263	3,045
Total sand and gravel	3,947	2,949	5,423	3,185
All operations:				
Sand	1,446	2,860	1,224	2,431
Gravel	8,009	8,936	7,861	6,703
Grand total	9,455	11,796	9,085	9,134

W Withheld to avoid disclosing individual company confidential data.
[1] Includes fire or furnace sand, other industrial (unground) sand, and items indicated by symbol W.
[2] Includes figures for State, counties, municipalities, and other Government agencies.

Stone.—Stone output exceeded 2 million tons for the first time, up 60 percent from 1965. The previous high was 1.8 million in 1954. The increase was due principally to the marked rise in crushed stone requirements for road construction in Churchill and Clark Counties and to a lesser degree, for crushed limestone for cement manufacture in Lyon County. A marble quarry was activated in White Pine County to supply floor tile and exposed aggregate chips in a wide variety of colors.

Basalt and decomposed granite were quarried for road and building construction in Churchill County; limestone for lime and metallurgical flux, quartz for dimension building stone and flagging, granite and sandstone for roads, and miscellaneous stone for roofing granules in Clark County; granite for riprap and paving material and quartzite for ferrosilicon in Elko County; limestone for road maintenance and repair and miscellaneous stone for railroad ballast in Eureka County; dimension sandstone for building construction in Humboldt County; marble for dimension decorative stone in Lincoln County; limestone for cement and miscellaneous stone for road and building construction in Lyon County; crushed marble for terrazzo in Mineral County; calcareous marl for mineral filler and opaline silca for refractories in Nye County; decomposed granite and miscellaneous stone for road construction in Ormsby County; decomposed granite for road and building construction, and calcareous marl for mineral filler and test shipments in Washoe County; limestone (stockpile) for smelter flux, and dimension quartzite for building stone in White Pine County.

In Lander County, Magnet Cove Barium Corp. ground a few hundred tons of limestone for a producer of animal feeds.

Sulfur.—Despite the high interest in sulfur, and the exploration for sulfur at various localities in Nevada, no sulfur production or shipments was report.

Talc and Soapstone.—All talc and soapstone production came from deposits in Esmeralda County. Two talc and two soapstone deposits were worked. Despite a decrease in producers from seven in 1965 to three in 1966, production and shipments rose 31 percent. All shipments were consigned to California grinding plants.

Table 11.—Stone[1] production in 1966, by counties

County	Short tons	Value
Churchill	700,000	$551,000
Clark	W	W
Elko	41,260	69,515
Eureka	43,218	72,135
Humboldt	W	W
Lincoln	W	W
Lyon	W	W
Mineral	189	14,175
Nye	W	W
Ormsby	16,733	14,298
Washoe	61,108	46,694
White Pine	W	W
Other counties	1,139,859	1,751,531
Total	2,002,367	2,519,348

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

[1] Includes stone used in cement and lime.

Water.—Western Geothermal, Inc., reported disappointing results from three geothermal wells drilled in the Pyramid Lake area and abandoned the project. No work was done in development of thermal energy in any other area.

MINERAL FUELS

Peat.—Reed-sedge peat was obtained from a bog in the Amargosa Desert, Nye County, near Death Valley Junction, Calif., and prepared for use as a soil improvement agent. Production and shipments more than doubled those in 1965.

Petroleum.—Nine wildcat wells were drilled in 1966, five in Nye County, three in White Pine County, and one in Lincoln County. Of these, eight were dry holes and a completion report had not been filled on the ninth at yearend. As a result, no new oilfields were discovered and Nevada's only field, Nye County, was not extended. Despite the lack of new discoveries, improved transportation, or the availability of refining facilities, the yield was 55 percent above that of 1965 and the highest since oil was discovered in 1954. Cumulative production though 1966 was 1,488,500 barrels.

REVIEW BY COUNTIES

Each of Nevada's 17 counties reported production of two or more mineral commodities. However, output in four counties —Clark, Eureka, Lyon, and White Pine— represented 76 percent of the total State mineral value in 1966. These four counties yielded most of the State's copper, gold, gypsum, sand and gravel, and stone.

A number of counties reported exclusive commodity production. All lime came from Clark County, all cement from Lyon County, all molybdenum from White Pine County, all salt from Churchill County, all talc, soapstone, and lithium compounds from Esmeralda County, all antimony from Lander County, all brucite, magnesite, fluorspar, peat, and petroleum from Nye County, and all tungsten from Pershing County. Information on these commodities, and all references to sand and gravel and stone used in the construction industry, will be found in the "Review" by Mineral Commodities" section and the commodity tables.

Churchill.—Eagle-Picher Industries, Inc., mined diatomaceous earth from pits in the Hazen area and processed the material into specialty products in th company's Storey County plant. United Sierra Division, Cyprus Mines Corp. obtained diatomite from a pit in the northwest corner of the county and processed it at Fernley, Lyon County. A silica pit in the Hazen area, a source of silica for use in cement in 1965, was abandoned.

Lead ore from a Chalk Mountain property and silver ore from the San Rafael prospect contained recoverable silver, lead, and zinc. A few ounces of gold was recovered from the lead ore and a small quantity of copper from the silver ore. A few tons of mercury ore from the Red Bird claim, Bernice mining district, was retorted to recover less than 1 flask of the metal.

Clark.—Blue Diamond Co., Division of The Flintkote Co., mined and processed crude gypsum at Blue Diamond, for use in plaster and wallboard. Some crude gypsum

Table 12.—Value of mineral production in Nevada, by counties

County	1965	1966	Mineral produced in 1966 in order of value
Churchill	$85,521	$606,714	Stone, sand and gravel, salt, lead, silver, zinc, mercury, gold, copper.
Clark	12,219,180	11,291,358	Sand and gravel, lime, stone, gypsum, lead, copper, zinc, silver, gold.
Douglas	2,347,112	2,355,006	Iron ore, sand and gravel, mercury, silver, lead, zinc.
Elko	507,997	1,066,050	Sand and gravel, copper, barite, stone, lead, silver, zinc, gold, mercury.
Esmeralda	883,094	1,802,124	Lithium minerals, diatomite, mercury, talc and soapstone, lead, zinc, silver, copper, perlite, clays, gold.
Eureka	6,494,722	10,220,873	Gold, iron ore, sand and gravel, zinc, stone, lead, barite, silver, copper.
Humboldt	4,440,740	4,198,443	Gold, mercury, iron ore, sand and gravel, barite, silver, stone, lead, zinc, copper.
Lander	825,269	940,739	Barite, sand and gravel, antimony, uranium, gold, mercury, silver.
Lincoln	1,726,004	3,224,134	Zinc, lead, silver, gold, perlite, sand and gravel, pumicite, copper, stone, diatomite.
Lyon	28,879,245	33,011,545	Copper, cement, sand and gravel, stone, diatomite, silver, gold, clays.
Mineral	123,481	52,350	Stone, lead, zinc, silver, barite, mercury, sand and gravel, gold, pumice.
Nye	3,694,866	3,201,340	Magnesite, petroleum, brucite, sand and gravel, fluorspar, peat, gold, mercury, silver, volcanic cinder, lead, zinc, clays, stone.
Orsmby	W	145,890	Volcanic cinder, sand and gravel, stone, gold, silver.
Pershing	5,002,103	5,564,641	Diatomite, iron ore, gypsum, sand and gravel, mercury, tungsten, perlite, copper, silver, gold, lead, zinc.
Storey	W	W	Diatomite, pumice.
Washoe	r 4,093,775	2,395,779	Sand and gravel, clays, stone, volcanic cinder, lead, gold, silver, zinc, uranium, copper.
White Pine	26,598,818	30,521,676	Copper, gold, molybdenum, silver, lead, sand and gravel, zinc, stone.
Undistributed [1]	r 2,044,073	2,033,338	
Total	r 99,966,000	112,632,000	

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes gem stones, mercury, gold, tungsten, and silver that cannot be assigned to specific counties and values indicated by symbol W.

was shipped to a company wallboard plant at Fremont, Calif. Southeast of Apex, Fibreboard Corp mined gysum and produced plaster and other gypsum products in a plant (new in 1965) at the mine site. Some crude gypsum also was shipped to company-owned wallboard plants in California.

Gold ore from the Capitol group of claims in El Dorado Canyon also contained recoverable silver. The Sego lily claims in the Yellow Pine district yielded lead-zinc ore from which small quantities of gold and silver also were recovered. Lead residue from the former Three Kids manganese mining and milling facility east of Henderson was treated to recover silver, copper, lead, and zinc.

In the Overton area, silica sand was mined from five established pits and sold for glass manufacture and foundry use. The major producer, Simplot Industries, Inc., operated two pits and two hydroclassification plants.

Douglas.—The Standard Slag Co. mined iron ore from its Minnesota open pit in the Buckskin district and upgraded it at the company concentrator near Wabuska, Lyon County. This mine was Nevada's major producer of usable iron ore and production was at about the 1965 level. All except 1 percent of the plant output was shipped for export; the remainder was sold to a cement producer.

A small tonnage of lead ore from the Silver Crown mine, Red Canyon district, also contained recoverable silver and zinc.

Elko.—Crude barite from the Rossi deposit of National Lead Co.'s Baroid Division was ground for use in well-drilling muds in the company plant at Dunphy. Shipments of ground barite were 11 percent above those of 1965.

Relatively small tonnages of ores mined from the Challenge, Cleveland, Selby, and Tecoma properties, and from the Diamond Jim and Gold Note groups of claims, were shipped to smelters outside the State for recovery of gold, silver, copper, lead, an zinc. Ore from the Annex mine in the Merrimac district yielded silver and copper. Near Mountain City, copper ore was leached at the Rio Tinto mine and copper was recovered by precipitation, a new operation in 1966. Stream gravels in the county were worked by small-scale hand methods and a few ounces of placer gold recovered. About 1 flask of mercury was recovered by retorting ore from the Silver Cloud mine, Ivanhoe district.

Esmeralda.—Diatomite was mined near Basalt by GREFCO, Inc., and processed in the producer's plant. The plant products were sold in bulk and bags, chiefly for filler use in paint, paper, and insecticides. Crude perlite was mined at the Hurry Up claims near Crow Springs and sold for aggregate use. Bentonite from the Blanco pit near Coaldale was sold to the cosmetic and pharmaceutical industries.

Kollsman Mineral & Chemical Co. furnaced ore from the B & B mine, Fish Lake Valley district, and recovered more than 400 flasks of mercury. A few flasks of the metal also were obtained by retorting ores from the Bee, Lucky, Sundown, and Wildhorse claims. Lead-zinc ore from the Sally Louise mine, Lone Mountain district, was smelted in Utah to recover precious and base metals. The mine output was appreciably below that in 1965.

Eureka.—The Carlin open-pit mine, Lynn district, became the Nation's second largest lode gold producer. Gold recovered from the company's adjoining cyanide mill was more than double the 1965 figure. Zinc ore from the Mountain View mine, Lone Mountain district, was shipped to a Utah smelter for recovery of gold, silver, copper, lead, and zinc. Silver ore from the Dorsey No. 1 claim, Safford district, also contained recoverable copper and lead. Direct-shipping-grade hematite ore was mined from the Barth open pit near Carlin and the entire output shipped for export.

Crude barite from the Queen Ann deposit near Carlin was shipped to a California grinding plant.

Humboldt.—The Getchell mine of Goldfield Corp. was the State's second largest lode gold producer. Gold recovery at the treatment plant was nearly 10 percent above that in 1965. Gold ore was mined and treated at the Austin Jumbo property in the Awakening district to recover gold and silver, and old tailings were treated at the Alabama mine where a few ounces of gold and silver were recovered. Three gold properties (Golden Amethyst, Grandview, and Silver Cloud) were active in the Winnemucca (Ten Mile) district with most of the gold and silver output coming from the Silver Cloud mine. An unnamed lead property yielded ore that was smelted

in Tacoma, Wash., to recover gold, silver, copper, lead, and zinc. A dragline was used to work bench gravels on the Seco claims, and a very small quantity of placer gold was recovered. A few ounces of placer gold was obtained from stream gravels near Gold Run using small-scale hand methods. Mercury ores from the Cordero mine, McDermitt district, were furnaced to yield over 2,000 flasks of mercury. At yearend the mine and plant were sold to a California corporation. Four other mercury properties were active part of the year, only one of which, the Cahill mine, Poverty Peak district, produced more than a few flasks of mercury. Direct-shipping grade iron ore was produced at the Iron King underground mine in the Jackson Mountains and the nearby Red Bird open pit mine. All of the Red Bird ore and most of the Iron King ore was consigned to domestic steel plants; some of the Iron King ore was exported.

Crude barite from the Horton claims near Golconda was shipped to a southern California grinding plant. The claims had been sold to Sierra Chemical Co. of Reno, Nev., late in 1965.

Lander.—Five barite mines, all in the Battle Mountain area, were active all or part of the year and their combined output represented 85 perent of the State crude barite production. All producers except Magnet Cove Barium Corp. shipped to grinding plants in California and Utah. Magnet Cove ground its crude barite in a company mill at Battle Mountain. The major producers were the Mountain Springs mine of FMC Corp. and the Greystone group of claims of Magnet Cove.

Apex Minerals Corp. mined and shipped uranium ore from its Rundberg mine near Austin to a Utah processing plant. The mine output was appreciably below that in 1965. Two lode gold properties—Cahill (Birch Creek), Birch Creek district, and the Hilltop, Hilltop district—were worked part of the year. Some gold and silver were recovered in treating the ores. A few ounces of placer gold was obtained by working stream gravels at the Dahl placers near Battle Mountain. Mercury ores from two unknown prospects were retorted and about 4 flasks of the metal was recovered.

Lincoln.—Only two lode mines were active in Lincoln County. The Pan American mine, Comet district, produced throughout the year and continued to be Nevada's largest lead-zinc producer. The Caselton mill treated the ore and produced a lead and zinc concentrate that was shipped to smelters outside the State. The Atlanta gold mine and cyanide mill, Atlanta district, operated until August, and then was shut down. Activity at the Bristol Silver mine, Jack Rabbit district, was limited to exploration and development. The Tempiute mine, Tempiute district, was awarded a contract to explore for silver ore under the Office of Minerals Exploration, U.S. Geological Survey.

Crude perlite was mined at the Hollinger pit near Pioche and the Mackie deposit in the Delamar district, and shipped to California expanding plants. Diatomite was mined and shipped from the Robin claims at Panaca to a preparation plant in Los Angeles, Calif. Pumicite from the Lori Free pit near Cathedral Gorge was processed in a plant at Panaca for use as pozzolan. The Snow Flake gypsum claims near Carp were idle throughout the year.

Lyon.—The Yerington open pit mine of The Anaconda Company yielded both sulfide and oxide copper ores that were treated in the company concentrator or leaching plants at Weed Heights. Concentrates and precipitates were shipped to the producer's smelter in Montana, although most of the sulfide concentrate went to a smelter in Tacoma, Wash. The concentrates contained recoverable gold and silver. Both gold and silver were recovered in cleanup operations at a gold prospect near Dayton.

The Fernley plant of United Sierra Division, Cyprus Mines Corp., processed diatomite from the company mine, Churchill County, for out-of-State customers. Industrial Minerals & Chemical Co. mined fuller's earth from its Jupiter pit near Weeks. The material was sold for use as a filler in animal feeds and as a filtering and clarifying agent.

Mineral.—Three lode mines, two lead and one silver, were active but only the Simon mine, Cedar Mountain district, of Federal Resources Corp. had more than a token production. Lead ore from the Simon mine, containing recoverable silver and zinc, was shipped to an out-of-State company mill. Mercury ores mined from

the Jeanne (Warlock) and New Cardinal properties, Pilot Mountains district, were retorted to recover a few flasks of the metal.

Crude barite was mined and shipped from the Columbus deposit south of Mina to a grinding plant in southern California. A few tons of pumice was obtained from the Pumco pit east of Mina and used by the producer for concrete aggregate.

Nye.—Gold ores from the Crown Point Globe property, Johnnie district, and the Nevada Porphyry mine, Round Mountain district, were treated to recover gold and silver. Ores from the Giant mine, Millett district, and the Tybo mine, Tybo district, were smelted outside the State and yielded gold, silver, lead, and zinc. Placer gold and silver were recovered from bench gravels on the Nevada Porphyry property, and a few ounces of placer gold was recovered from the Georgie No. 1 claim, Manhattan district, by small-scale hand methods. Mercury ore from the Red Bird (Toquima) mine was retorted and more than 40 flasks of mercury produced.

Volcanic cinder was obtained from the Cinder Cone deposit near Beatty and prepared for use as a lightweight concrete aggregate. The New Discovery claims in the Beatty area yielded bentonite that was shipped to California for use in cosmetics and pharmaceuticals.

Ormsby.—Volcanic cinder was obtained from the Cinderlite deposit near Carson City and used for concrete and asphalt aggregate and for landscaping.

A very small quantity of gold was recovered from the ore of a gold prospect at an undisclosed location in the county.

Pershing.—Nevada Barth Mining Corp. mined direct-shipping iron ore on the Section 29 Southern Pacific lease. The entire output was exported. In the adjacent Section 30, Nevada Iron Ore Co., Inc., mined direct-shipping ore that was sold to domestic steel plants.

Eagle Picher Industries, Inc., mined diatomite from pits in the Velvet district west of Lovelock. The material was processed in a plant at Colado for filtration uses. Crude gypsum was quarried at Empire by U.S. Gypsum Co. to supply the company gypsum products plant near Gerlach, Washoe County. The plant also used perlite hauled from the Pearl Hill quarry near Lovelock.

Seven mercury mines were active during the year but only two yielded more than 15 flasks of the metal. Cordero Mining Co. furnaced ore from the Kitten Springs mine, Relief district, and produced more than 250 flasks of mercury. Crofoot Lumber Co. retorted mercury ore produced from the Brinkerhoff (Loretta) mine to recover over 100 flasks. Copper ore from the Big Mike mine, Goldbanks district, was shipped to the Tacoma, Wash., smelter for recovery of copper and silver. Ores from the Keyrock group of claims, Central district, and the Rosal and Wabash mines, Rochester district, were smelted in Utah to recover precious and base metals. A few ounces of gold was recovered in the treatment of ore from the Windy Bay prospect. Stream gravels were worked on several claims in the Sierra district by small-scale hand methods to recover placer gold and silver.

Storey.—Diatomite was mined by Eagle Picher Industries Inc., from its Celatom open-pit mine and processed in a nearby company plant at Clark Station. The plant product was sold to both domestic and foreign customers for a wide variety of uses. Pumice was mined from the Naturalite group of claims near Sutro Springs and prepared for use as a lightweight concrete aggregate.

Washoe.—Nevada Cement Co. obtained clay from a pit near Flanigan and used the material in making cement at its Lyon County plant. Volanic cinder (scoria) was mined from a pit near Sparks and sold to the Bureau of Land Management for use as concrete aggregate.

Ore from the Galen Hill property, Galena district, was shipped to the smelter at Selby, Calif., for recovery of precious and base metals. A few ounces of gold and silver were recovered in treating a small tonnage of ore from the Olinghouse mine, Olinghouse district. In the same district, placer gold and silver were recovered by panning stream gravels. A carlot of uranium ore was mined and shiped from the Red Bluff mine, Pyramid district, to a Utah processing plant.

White Pine.—Kennecot Copper Corp. mine copper ores from the Liberty and Veteran pits, Robinson district, and treated them in the company concentrator and smelter at McGill. The ores yielded considerable gold, silver, and molybdenum, in addition to copper. Ore from the Ward

group of claims, Ward district, was concentrated in the producer's East Ely mill. The concentrate was shipped to a Utah smelter for recovery of precious and base metals. Lead ore from the Grand Prize mine, White Pine district, and silver ore from the Schuette property, Cherry Creek district, were shipped to the same smelter.

The Mineral Industry of New Hampshire

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the New Hampshire Department of Resources and Economic Development for Collecting information on all minerals except fuels.

By William Cochran [1]

Mineral production in New Hampshire in 1966 was valued at $7 million, a 9 percent decrease from a record $7.7 million produced in 1965 when aggregate requirements for interstate highway construction reached a peak. Over 95 percent of the total value of mineral production was derived from products consumed primarily in highway and building construction.

Table 1.—Mineral production in New Hampshire [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ---------- short tons	53,200	$47	50,790	$51
Peat ---------- do	----	----	175	2
Sand and gravel ---------- do	10,584,000	5,559	7,626,000	4,807
Stone ---------- do	153,397	1,932	206,454	2,091
Value of items that cannot be disclosed: Feldspar and gem stone ----------	XX	127	XX	49
Total ----------	XX	7,665	XX	7,000

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

REVIEW BY MINERAL COMMODITIES

NONMETALS

Clays.—Output of clay was about the same as that of 1965. Clay from pits in Grafton, Rockingham, and Strafford Counties was used principally in manufacturing building bricks. One pit in Rockingham County was closed during the year for economic reasons.

Feldspar.—A decline in total value and production of crude feldspar was due to suspended operations in Cheshire County. Two mines and one grinding mill previously operated by Golding-Keene Co. were closed in 1966. The Ruggles Mining Co., Inc., Grafton County, was the only ac-

Table 2.—Value of Mineral Production in constant 1957–59 dollars

(Thousands)

Year	Value [1]
1957 ----------	$3,348
1958 ----------	3,945
1959 ----------	4,674
1960 ----------	5,302
1961 ----------	5,392
1962 ----------	5,900
1963 ----------	6,088
1964 ----------	7,169
1965 ----------	7,615
1966 ----------	[p] 6,882

[p] Preliminary.
[1] Data for 1957–65 revised.

[1] Geologist, Bureau of Mines, Pittsburgh, Pa.

Table 3.—Employment 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
1965:								
Nonmetal and peat	23	179	4	33	---	2	61.30	705
Sand and gravel	329	194	64	536	---	10	18.66	411
Stone	198	219	43	349	---	6	17.18	166
Total	550	202	111	918	---	18	19.61	328
1966: p								
Nonmetal and peat	25	180	5	36	---	1	27.78	139
Sand and gravel	335	183	62	518	---	11	21.24	647
Stone	200	221	44	352	---	12	34.09	344
Total	560	198	111	906	---	24	26.49	509

p Preliminary.

tive operation in the State. Ore was selectively mined and hand sorted. Lump feldspar was shipped by truck to a grinding mill at West Paris, Maine. The finely ground product was used primarily in ceramics, enamel, and as an abrasive in cleaning compounds.

Gem Stones.—Semiprecious gem stones and mineral specimens were collected from pegmatites and other mineral localities in Cheshire, Carroll, and Grafton Counties. Amateur collectors recovered beryl, amethyst, smoky quartz, and topaz crystals including some of gem quality.

Peat.—A limited quantity of reed-sedge peat was recovered from a reactivated bog in Belknap County. The bog had been idle since 1961.

Perlite.—National Gypsum Co. expanded crude perlite in its Portsmouth plant. Raw material was obtained from mines in the western States. The product was used principally in acoustical plaster.

Sand and Gravel.—Compared with that of 1965, most of the 3 million-ton decrease in production was due to a decline in Government-and-contractor usage, principally highway construction. This reflected a decrease in the number of active interstate highway projects. Commercially produced sand and gravel increased 6 percent in volume and 12 percent in value. The average value of washed and screened material from commercial plants remained at $1.08 per ton, but unprocessed material increased 4 cents in value to an average of $0.40 per ton. Bank run material accounted for 21 percent of the commercial production. Of the 44 operations reporting commercial production, 18 had an output of less than 25,000 tons, 15 were in the 25,000-to-100,000-ton range, and 11 operations produced over 100,000 tons each. Ten percent of the commercially produced material was shipped by rail; 90 percent by truck. All Government-and-contractor output was delivered by truck.

Table 4.—Sand and gravel, and stone production by Government-and-contractor operations, by counties

County	Sand and gravel (thousand short tons)		Stone (short tons)	
	1965	1966	1965	1966
Belknap	911	557	21,108	4,898
Carroll	180	108	183	17
Cheshire	462	201	6,812	933
Coos	584	150	2,498	---
Grafton	1,387	743	5,538	63,844
Hillsboro	160	360	80	6,502
Merrimack	453	310	---	5,302
Rockingham	1,043	308	741	59
Strafford	135	140	---	---
Sullivan	266	363	1,917	249
Unspecified	1,582	750	---	---
Total	7,163	3,990	38,877	81,804

Stone.—Total value of stone production increased 8 percent compared with that of 1965, while the total tonnage increased nearly 35 percent. The increase was due primarily to increased requirements for crushed stone in highway construction. The New Hampshire Department of Public Works and Highways produced crushed granite for riprap and fill in all counties except Coos and Strafford. Crushed granite for construction was valued at $0.89 per ton. Rough dimension granite, used primarily for curbing, flagging, and paving blocks, was produced at the Kitledge quarry in Hillsboro County and the Swenson Gray quarry in Merrimack County. Architectural and monument granite was produced from these quarries as well as imported from out-of-State quarries for finishing. Dimension granite was valued at an average of $58 per ton. Quartz was mined and crushed at one operation in Hillsboro County and another in Sullivan County. The product was used as exposed aggregate in decorative precast concrete. The average value of crushed quartz was $23 per ton.

REVIEW BY COUNTIES

Sand and gravel and stone produced by Government-and-contractor operations are shown in table 4 and are not included under the individual county reports that follow.

Belknap.—Tilton Sand & Gravel, Inc., produced sand and gravel for building, paving, fill, and other uses. Perkins Peat Bog in Center Barnstead produced peat for use in soil improvement.

Carroll.—Sand and gravel used primarily for fill was produced by Alvin J. Coleman & Son, Inc., from a pit near Madison. Sparks Construction Co. produced paving sand and gravel from a pit near Ossipee.

Cheshire.—Keene Sand & Gravel, Inc., Keene, and Cold River Sand & Gravel Corp., North Walpole, produced material for building, paving, and fill. Most of the output was washed and screened; oversized gravel was crushed. The feldspar mining and milling operations of Golding-Keene Co., including the Surry and Pearson mines and the Alstead mill, were closed during the year.

Coos.—Sand and gravel was produced by the Lessard Sand & Gravel Co., Inc., near Gorham for building and paving. The Brown Co., Berlin, produced bank run gravel for paving and fill. The Gray Construction Corp., Colebrook, has been dissolved, and sand and gravel production has been suspended.

Grafton.—Sand and gravel for building, paving, and fill was produced from five pits located near Campton, Plymouth, Littleton, and West Lebanon. Washed and screened material accounted for 87 percent of the output. All sand and gravel was delivered by truck. Ruggles Mining Co., Inc., Grafton, produced potash feldspar from pegmatite. Hand picked material was delivered by truck to a feldspar grinding mill at West Paris, Maine. Densmore Brick Co. produced miscellaneous clay from a pit near Lebanon for use in manufacturing building brick.

Hillsboro.—This county continued to lead the State in mineral production, accounting for 29 percent of the State's total

Table 5.—Value of mineral production in New Hampshire, by counties

County	1965	1966	Minerals produced in 1966 in order of value
Belknap	W	W	Sand and gravel, stone, peat.
Carroll	W	W	Sand and gravel, stone.
Cheshire	$657,700	W	Do.
Coos	W	W	Sand and gravel.
Grafton	947,734	$932,960	Sand and gravel, stone, feldspar, clays.
Hillsboro	1,767,869	2,035,305	Stone, sand and gravel.
Merrimack	W	1,242,472	Sand and gravel, stone.
Rockingham	1,273,567	W	Sand and gravel, stone, clays.
Strafford	253,250	208,290	Do.
Sullivan	188,625	W	Sand and gravel, stone.
Undistributed [1]	2,576,011	2,581,465	
Total	7,665,000	7,000,000	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes value of sand and gravel and gem stones not assigned to specific counties and values indicated by symbol W.

value. Block granite was produced at the Kitledge Granite Corp. quarry near Milford. All of the stone was finished by the Barretto Granite Corp. Curbing, monuments, and architectural stone accounted for most of the total value with construction stone, paving, and durax blocks the remainder. Five sand and gravel operators produced aggregate used principally in building construction and paving. J. J. Cronin Co., Manchester, was the largest producer with 42 percent of the county's tonnage. North Country Aggregates, Inc., South Lyndeboro, produced crushed quartz for use in precast decorative concrete.

Merrimack.—The county ranked second in the State for value of mineral production. Manchester Sand, Gravel & Cement Co., Inc., Hooksett, was a large producer of building and paving material. Weaver Brothers Construction Co., Inc., Concord, also produced a large volume of sand and gravel for paving. Of the total tonnage, 91 percent was washed and screened; 4 percent was shipped by rail and the remainder by truck. Rough granite blocks from the Swenson Gray quarry were processed at the finishing plant of the John Swenson Granite Co., Inc., Concord. Principal products were curbing and architectural stone.

Rockingham.—Manchester Sand, Gravel, & Cement Co., Inc., processed sand and gravel at their Raymond plant for shipment by rail to Boston. The product was used primarily in ready-mix concrete. Iafolla Crushed Stone Co., Inc., Portsmouth, produced sand and gravel for paving and fill, and also produced crushed stone for riprap and roadstone. Two other pits in Exeter and Londonderry produced unprocessed sand and gravel used primarily for fill. The Eno Brick Corp. suspended operations at its clay pit during the year; W. S. Goodrich, Inc., Epping, continued to produce clay for use in manufacturing building brick.

Strafford.—Iafolla Crushed Stone Co., Inc., produced sand and gravel from a pit near Madbury; the product was used in paving material and fill. Dover Sand & Gravel, Inc., produced sand and gravel from pits in Dover and Farmington for use as aggregate in concrete. James S. Pike, Durham, produced bank run sand and gravel. The Kane-Gonic Brick Corp. produced clay for building brick from a pit near Gonic.

Sullivan.—Eaton Jones Sand & Gravel Co., Inc., Newport, produced sand and gravel for building and paving. Most of the production was processed and all was delivered by truck. Quartz, Inc., produced white quartz from a quarry near South Acworth. The material was crushed for use as exposed aggregate in precast concrete. The Globe mine near New London previously operated by Mineral Materials, Inc., as a source of crushed quartz, was closed.

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 Joseph Krickich [1]

Value of mineral production in New Jersey decreased 6 percent below the record high value of $80.2 million established in 1965. Major contributing factors for the decline were the cessation of iron ore mining and decreased output of zinc ore. Slight to moderate increases in value of stone, sand and gravel, peat, manganiferous residuum, greensand marl, and ilmenite were recorded.

[1] Mineral specialist, Bureau of Mines, Pittsburgh, Pa.

Table 1.—Mineral production in New Jersey [1]

	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	506	$1,388	488	$1,319
Gem stones	NA	10	NA	10
Peat—short tons	40,480	431	36,312	489
Sand and gravel—thousand short tons	17,389	28,646	17,782	29,322
Stone—do	12,232	27,247	12,453	28,056
Zinc [2] (recoverable content of ores, etc.) short tons	38,297	11,106	25,237	7,319
Value of items that cannot be disclosed: Iron ore, lime, magnesium compounds, manganiferous residuum, greensand marl, and titanium concentrate (ilmenite)	XX	11,330	XX	9,080
Total	XX	80,158	XX	75,595

NA Not available.
XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] 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 constant 1957–59 dollars
(Thousands)

Year	Value [1]	Year	Value [1]
1957	$65,231	1962	$64,002
1958	50,588	1963	71,564
1959	58,597	1964	75,396
1960	54,881	1965	76,998
1961	57,746	1966	[p] 72,701

[p] Preliminary.
[1] Data for 1957-65 revised.

Table 3.—Employment 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
1965:								
Metal	463	253	117	941	---	55	58.44	5,706
Nonmetal	395	280	111	886	---	27	30.46	1,173
Sand and gravel	976	250	244	2,104	---	39	18.54	395
Stone	1,111	249	276	2,282	---	57	24.98	602
Peat	16	259	4	33	---	---	---	---
Total	2,961	254	752	6,246	---	178	28.50	1,379
1966: p								
Metal	455	149	68	548	---	27	49.27	1,228
Nonmetal	400	281	113	904	---	16	17.70	497
Sand and gravel	1,045	264	275	2,274	---	55	24.19	663
Stone	1,035	243	252	2,124	1	49	23.54	3,381
Peat	19	203	4	31	---	---	---	---
Total	2,954	241	712	5,881	1	147	25.17	1,668

p Preliminary.

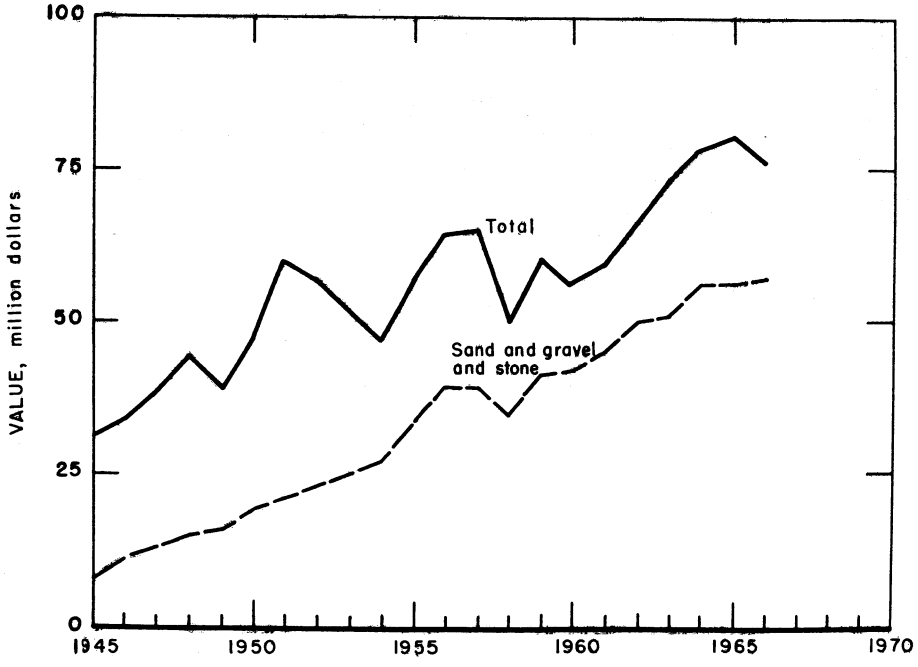

Figure 1.—Value of sand and gravel and stone, and total value of mineral production in New Jersey.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Portland cement shipments into New Jersey totaled 9.8 million barrels; nearly 670,000 barrels of masonry cement were distributed within the State. Most of the portland and masonry cement came from plants in Pennsylvania and New York, but some portland cement was shipped from Maryland and Texas and some masonry cement from Virginia and West Virginia. Cement distribution terminals were operated at Bayonne, Elizabethport, Jersey City, and Newark.

Clays.—Fire and miscellaneous clay and shale production decreased 4 percent in total tonnage and 5 percent in value compared with that of 1965. Miscellaneous clay and shale accounted for most of the quantity but fire clay contributed most of the value. Nearly all of the fire clay was of the plastic variety and was recovered from pits in Cumberland and Middlesex Counties. Output was used chiefly for manufacturing refractory products but some went into pottery and stoneware, floor and wall tile, and architectural terra cotta. Quantities also were used as filler material in insecticides and linoleum and as rotary drilling mud. Miscellaneous clay and shale was produced mainly in Middlesex and Somerset Counties, with some quantities coming from Bergen, Burlington, and Camden Counties. Production was primarily for manufacturing heavy clay products such as building brick and sewer pipe.

Gem Stones.—Various mineral specimens continued to be collected from stone quarries and old mine dumps throughout the State. Mineral collectors were particularly active at the mine dumps at Franklin, Sussex County, acquiring specimens of fluorescent calcite, franklinite, willemite, and zincite. Value of the minerals collected was estimated at the same level as that of 1965.

Gypsum.—Calcined gypsum was produced at four plants, two in Burlington County and one each in Bergen and Camden Counties. Calcined gypsum was used in manufacturing plaster, lath, sheathing, wallboard, and other building products. Companies processed crude materials shipped from other States as well as that imported from Newfoundland, Canada.

Iodine.—Chemical and pharmaceutical companies reported consumption of 573,000 pounds of organic and inorganic iodine. Consumption was 4 percent below that of 1965. Mostly imported crude iodine was used for manufacturing medicines and sanitation products and other iodine-based chemicals.

Lime.—Production and value of hydrated lime produced in Sussex County was below that of 1965. However, an increase in the average unit price was reported. Hydrated lime was sold for use in construction, agricultural applications, sewage treatment, and water purification.

Magnesium Compounds.—Compared with that of 1965, refractory magnesia production and value was lower but a higher average unit value was reported. Production was centered in Cape May County and was from out-of-State dolomite and seawater. Various magnesium compounds were refined from purchased materials at a plant in Warren County.

Marl, Greensand.—Production and value of greensand marl increased above that of 1965. Output of the material (natural zeolite) was limited to one operation in Gloucester County and was used for softening water.

Mica.—Synthetic flake mica used in glass-bonded ceramic materials was produced by Molecular Dielectrics, Inc., Clifton, and Synthetic Mica Co., Division of Mycalex Corp. of America. Molecular Dielectrics also continued production of high-quality synthetic mica crystals for splitting and punching. Four plants in the State fabricated sheet mica (muscovite block and film) mainly for consumption by the electrical and electronic industries.

Perlite.—Production and value of expanded perlite increased 22 percent above that of 1965 and was reported from four plants. Production was discontinued at a Passaic County plant but a new plant began operations in Burlington County. Other plants operated in Middlesex, Somerset, and Union Counties. Crude perlite shipped from other States was processed for manufacturing acoustical plaster, ultralightweight concrete aggregate, loose-fill insulation, shingles, and other uses.

Pigments.—Iron oxide pigments were produced by E. I. du Pont de Nemours &

Co., Inc., Newark; Columbian Carbon Co., Trenton and Monmouth Junction; and Stabilized Pigments, Inc., New Brunswick. New Jersey Zinc Co., Gloucester City, and National Lead Co., Perth Amboy produced titanium dioxide. National Lead also manufactured lead pigments at Perth Amboy, Royce Chemical Co., Carlton Hill, manufactured zinc oxide and leaded-zinc oxide pigments.

Sand and Gravel.—Greater activity in highway and building construction resulted in higher output of sand and gravel. Production increased 2 percent in quantity and value compared with that of 1965. The output was virtually all commercial production; limited quantities were produced by Government-and-contractor operations in Atlantic County. Over 12.4 million tons of the commercial output was used in construction as a building and paving material. Demand for most industrial sand, including ground sand, decreased but higher average prices were recorded. Most of the industrial sand was sold to the glass industry and to foundries. Ground sand production in Cumberland, Middlesex, and Ocean Counties was marketed principally for use in foundries and for glass ceramic manufacturing. Some was sold as abrasive and filler material.

As in previous years, sand and gravel was produced in 14 counties. Cumberland County continued to rank first in value because of higher priced industrial sand production; Morris County led in tonnage with production of 4.1 million tons. Other important areas with production exceeding 1 million tons were Bergen, Burlington, Camden, Middlesex, and Ocean Counties. Production was reported from 105 operations, (104 commercial and 1 Govern-

Table 4.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	4,940	$5,911	5,182	$5,485
Paving	2,906	2,790	2,923	2,825
Fill	720	354	597	315
Glass	843	3,139	W	W
Molding	1,740	5,454	1,817	5,918
Blast	151	699	141	748
Engine	W	W	24	81
Ground	191	1,513	157	1,481
Other [1]	907	1,579	1,259	4,704
Total	12,398	21,439	12,100	21,557
Gravel:				
Building	2,868	5,090	2,879	5,280
Paving	1,416	1,533	1,456	1,707
Fill	485	325	W	W
Other [2]	220	258	1,327	767
Total	4,989	7,206	5,662	7,754
Total sand and gravel	17,387	28,645	17,762	29,311
Government-and-contractor operations:				
Sand: Other	2	1	1	[3]
Gravel:				
Paving	---	---	12	7
Fill	---	---	7	4
Total	---	---	19	11
Total sand and gravel	2	1	20	11
All operations:				
Sand	12,400	21,440	12,101	21,557
Gravel	4,989	7,206	5,681	7,765
Total	17,389	28,646	17,782	29,322

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes fire or furnace, filtration and other sand.
[2] Includes miscellaneous (1965) and other gravel.
[3] Less than ½ unit.

ment-and-contractor) compared with 97 the previous year. Production exceeding 900,000 tons was reported by two commercial producers, and six operators produced between 500,000 and 900,000 tons. The majority of the State's commercial producers had tonnages ranging from 25,000 to 300,000 tons; output below 25,000 tons was reported at only 16 operations. Over 15.4 million tons were shipped to consumers by truck and 1.9 million tons by rail. Nearly 15.1 million tons of the commercial output was processed by washing, crushing, sizing, or screening.

Stone.—Total stone output and value increased 2 and 3 percent, respectively, compared with that of 1965. The higher output reflected greater building and highway construction activity. Stone was produced in 11 counties and included basalt, granite, limestone, marble, miscellaneous stone, oystershell, and sandstone. Leading producing areas were Somerset, Passaic, Hudson, and Sussex Counties, in decreasing order of value. As in 1965, basalt (traprock) was quarried in seven counties and accounted for 86 percent of the tonnage and 81 percent of the total value of all stone produced in the State. In terms of both production and value, the most important use of basalt was as a construction aggregate. Output and value of basalt for concrete aggregate and roadstone were less than that of 1965, but the average value increased $0.05 to $2.10 per ton. Other uses for basalt included riprap, roofing granules and railroad ballast. Limestone, produced at two quarries in Sussex County, ranked second in value. Principal uses of limestone were as agricultural stone (agstone), concrete aggregate, filler material, livestock feed additive, and as a raw material for lime manufacturing.

Granite was quarried and crushed in Hunterdon and Morris Counties; output and value increased moderately but the average value was slightly less than the $1.96 per ton reported in 1965. Virtually the entire output was processed for concrete aggregate and roadstone. Other uses were for riprap and fill. Miscellaneous stone was produced in two counties. Crushed gneiss from Passaic County and crushed argillite from Hunterdon County was used in construction applications. Output and value decreased compared with that of 1965. Crushed marble used exclusively as terrazzo was produced in Warren County, and dimension sandstone was produced in Hunterdon County. Oystershell was used in Gloucester County for lime manufacture and poultry grit.

Sulfur.—Although byproduct sulfur shipments decreased 2 percent below that of 1965, value was greater because of higher unit prices. Shipments totaled 45,000 long tons valued at $1.4 million; average unit value increased $25.86 to $29.93 per ton. Four plants recovered elemental sulfur as a byproduct of gas purification, two in Gloucester County and one each in Middlesex and Union Counties. Most of the sulfur was sold for manufacturing sulfuric acid but part of the output was retained for captive use for various chemical processes. A refinery in Union County recovered hydrogen sulfide. Freeport Sulphur Co., Warners, Pan American Sulphur Co., at Newark; and Texas Gulf Sulphur Co., Carteret and Paulsboro, operated liquid sulfur storage and transhipment terminals. Total capacity at the terminals was 72,500 long tons per year.

Vermiculite.—Crude vermiculite imported and shipped from other States was exfoliated at plants in Essex and Mercer Counties. The processed material was used as loosefill insulation, plaster and concrete aggregate, and for agricultural and miscellaneous uses. Total output and value of exfoliated vermiculite was greater than that of 1965.

METALS

Ferroalloys.—Shieldalloy Corp., Newfield, Gloucester County, produced chiefly ferroalloys of titanium, vanadium, boron, columbium, and columbium-tantalum. The company utilized a thermite furnace for ferroalloy production.

Iron Ore.—An era of iron ore mining extending back to Colonial times came to an end in February when the State's last active mine ceased operation. The Scrub Oaks mine in Morris County was shut down due to increasing costs. Buildings and equipment at the site were dismantled and sold. The final inventory of crude ore was beneficiated and shipped to company-owned blast furnaces at Conshohocken, Pa. Some concentrates were sold to other steel producers. Also in Morris County the entire stockpile of iron ore concentrates from the Mt. Hope mine was sold for consump-

tion at a Pennsylvania steel plant. The ore was mined and beneficiated in previous years. The State's total shipment and value of iron ore, however, were below that of 1965.

Titanium.—Production and value of ilmenite concentrate continued to increase but the average value was below that of 1965. Output from a titanium-bearing sand deposit in Ocean County was processed and concentrated for shipment to Baltimore, Md. The concentrate was further processed into titanium dioxide for use as a white paint pigment.

Zinc.—Production and value of manganiferous zinc ore from the underground Sterling Hill Mine in Sussex County was below that of 1965. Average unit value was the same as that of the previous year but monthly production levels at the mine were lower. Ore from the mine was crushed and shipped without processing to a company-owned smelter at Palmerton, Pa., for recovery of zinc and manganiferous residuum.

MINERAL FUELS

Coke and Coal Chemicals.—Coke and coal chemicals were produced by Koppers Co., Inc., at its merchant ovencoke plant at Kearney, Hudson County. Coal chemical products recovered included crude coal tar and crude light oil.

Natural Gas.—Underground natural gas (LP gas) storage facilities were operated by Humble Oil & Refining Co. and Transcontinental Gas Pipe Line Corp. The former company operated two facilities, one propane, and one butane in Union County; the latter company operated a frozen earth facility for liquefied natural gas in Bergen County. Total capacity of the three operations was 803,000 barrels.

Peat.—Production of peat declined but value was greater compared with that of 1965. Higher unit values were recorded for some producers resulting in higher total value for 1966. Producers recovered both humus and reed-sedge peat from bogs in Passaic, Sussex, and Warren Counties. The material was processed and sold mostly for soil conditioning, in both bulk and packages.

Petroleum.—Total crude oil capacity at active petroleum refineries as of January 1, 1966, was 488,500 barrels per day, compared with 508,900 barrels the previous year. Gasoline output capacity per day decreased from 155,600 barrels to 150,100. Other materials recovered at the State's refineries included asphalt, coke, lubricants, and paraffin. Refineries were operated by Chevron Oil Co., (formerly California Oil Co.), Perth Amboy; Cities Service Oil Co., Linden; Hess Oil & Chemical Co., Sewaren; Humble Oil & Refining Co., Bayonne and Linden; Mobile Oil Co., Paulsboro; and Texaco, Inc., Westville.

REVIEW BY COUNTIES

Production of minerals was reported in all counties except Salem. Compared with that of 1965, value increases were reported for eight counties; the greatest increase was in Somerset County because of higher demand for stone. The county also replaced Sussex County as the State's leading mineral-producing area. Other leading areas, in decreasing order of value, were Cumberland, Morris, Passaic, and Ocean Counties. Sand and gravel production by Government-and-contractor operation was limited to Atlantic County. Value of mineral specimens (gem stones) was not assigned to the specific counties.

Atlantic.—Production of commercial sand and gravel was above that of 1965. Output consisted chiefly of construction material; quantities of molding sand were produced. Commercial operations were active near Mays Landing, Bargaintown, Folsom, Hammonton, Cedar Lake, and Somers Point. The Atlantic County Road Department near Pleasantville produced gravel for road repair and sand for controlling icy highways. Most of the county output was processed material and shipped mainly to consumers by truck. Some rail shipments were made.

Bergen.—Sand and gravel production increased 14 percent above that of 1965 and totaled 1.1 million tons. Output was mostly processed sand and gravel used in construction and in manufacturing concrete pipe and block. Producers were Braen Sand & Gravel Co., Wyckoff; Samuel Braen & Co., Mahwah; and McKee Bros., Inc., Ramsey. Clay for manufacturing building brick was produced near Moonachie. Barrett Division, Allied Chemical Corp. produced cal-

Table 5.—Value of mineral production in New Jersey by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Atlantic	$858,000	$361,000	Sand and gravel.
Bergen	1,712,565	1,946,000	Sand and gravel, clays.
Burlington	2,265,000	1,500,725	Do.
Camden	1,805,000	1,930,500	Do.
Cape May	W	W	Magnesium compounds, sand and gravel.
Cumberland	9,998,696	11,026,796	Sand and gravel, clays.
Essex	W	W	Stone.
Gloucester	475,500	499,500	Sand and gravel, greensand marl stone.
Hudson	W	W	Stone.
Hunterdon	1,394,573	1,309,760	Do.
Mercer	W	W	Do.
Middlesex	2,588,033	2,567,748	Sand and gravel, clays.
Monmouth	915,000	885,000	Sand and gravel.
Morris	9,738,676	8,866,093	Sand and gravel, iron ore, stone.
Ocean	4,945,546	4,721,270	Sand and gravel, ilmenite.
Passaic	5,760,267	5,118,959	Stone, sand and gravel, peat.
Somerset	11,563,844	12,715,273	Stone, clays.
Sussex	15,463,277	W	Zinc, stone, manganiferous residuum, lime, sand and gravel, peat.
Union	W	W	Stone.
Warren	617,627	791,420	Sand and gravel, peat, stone.
Undistributed [2]	10,056,474	21,355,376	
Total	80,158,000	75,595,000	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] No production reported in Salem County.
[2] Includes value of gem stones and values indicated by symbol W.

cined gypsum and fabricated gypsum building products at its South Kearney Plant.

Burlington.—Output of sand and gravel totaled 1.4 million tons, a sharp decline compared with 1965 output of nearly 2 million tons. Principal producers were Amico Sand & Gravel Co., Riverside; American Dredging Co., Burlington; Lockhart, Inc., Riverton; Asphtar, Inc., Hainesport; and George F. Pettinos, Inc., Mt. Holly. The Franklin dredge of Warner Co. did not operate. Church Brick Co., Fieldsboro, produced miscellaneous clay for manufacturing building brick. Kaiser Gypsum Co. produced calcined gypsum and finished building products at its newly constructed plant near Delanco. Calcined gypsum and expanded perlite were produced at the Burlington plant of National Gypsum Co.

Camden.—Although sand and gravel production was slightly below that of 1965, value increased 6 percent. The increased value in 1966 was due chiefly to higher unit prices for most uses including molding sand. Construction material was produced by Tri-Borough Sand & Stone, Inc., Gibbsboro; Con.-Agg., Inc., Chews Landing; and Ward Sand & Materials Co., Pennsauken Township. Molding sand was produced by George F. Pettinos, Inc., with plants at Grenloch, Penbryn, Williamstown Junction; and Taggart Brimfield Co., Hayville. The Pine Hill plant of Triangle Silica Sand Corp. was idle. The Alliance Clay Product Co. produced miscellaneous clay for building brick at Winslow Junction. Crude gypsum imported from Newfoundland, Canada was calcined and processed into plaster and gypsum building products by The Flintkote Co., Camden.

Cape May.—Northwest Magnesite Co. produced refractory magnesia from a combination of seawater and purchased dolomite at its Cape May plant. Output of sand and gravel was below that of 1965 and consisted chiefly of processed construction material. Tuckahoe Sand & Gravel, Tuckahoe, was the principal producer. Other producers were John F. Gandy, Ocean View; Matalucci Brothers, Dennisville; and Curtland Sand & Gravel Co., Cape May Court House.

Cumberland.—The county continued to rank first in terms of value, and second in tonnage as a sand-and-gravel producing area. Production increased 8 percent above that of 1965 and totaled 3.2 million tons; value was 11 percent greater than that of 1965. Output was chiefly industrial sand used for manufacturing glass and molding purposes. Quantities of blast, furnace, engine, and filtration sand as well as con-

struction sand and gravel also were produced. Ground industrial sand for special applications was produced by Pennsylvania Glass Sand Corp. and National Glass Sand Corp., both near Millville. Other industrial sand producers were Millville Silica Sand & Gravel Co., Inc., George F. Pettinos, Inc., and Port Silica Sand Co., Inc., all near Port Elizabeth; Whitehead Brothers Co., Dividing Creek; Jesse S. Morie & Son, Inc., Vineland and Mauricetown; and New Jersey Silica Sand Co. and Tri-State Co., both near Millville. Construction sand and gravel was produced by Whitehead Brothers Co., Dorchester; Mays Landing Sand & Gravel Co., Inc., Cedarville; Ricci Brothers Washed Sand & Stone Co., Port Norris; and Brunetti Brothers, Vineland. All of the county output was processed material. Plastic fire clay used as a bond for molding sand was produced at Vineland by Daniel Goff Division, Jesse S. Morie & Son, Inc.

Essex.—Crushed basalt (traprock) was produced by M. L. Kernan Quarry, South Orange, and Orange Quarry Co., West Orange, chiefly for use as concrete aggregate and roadstone. Vermiculite Industrial Corp. produced exfoliated vermiculite at Port Newark. Output was used mainly in insulation applications and as an ultralightweight aggregate.

Gloucester.—Sand and gravel production totaled 290,000 tons, 5 percent greater than that of 1965. Mostly construction sand was produced by Crown Point Sand Co., Inc., Bridgeport; L. R. Curtis Son, Bridgeport; and Wenonah Sand & Gravel Co., Inc., Repaupo. Industrial sand was produced by Downer Silica Co., Downer, and William Thorn & Son, Grenloch. Inversand Co., Sewell, produced greensand marl for use in water treating equipment manufacture, and for water softening purposes. Oystershell was processed for poultry grit and lime at Franklinville by Joseph Bauder & Sons. Mobil Oil Corp. used the Claus process for recovering sulfur at its Paulsboro refinery. Freeport Sulphur Co. recovered byproduct sulfur in the liquid purification of gas at its Eagle Point (Westfield) plant. The company used the modified Baehr process for recovering sulfur.

Hudson.—Callanan Traprock Corp., at its Laurel Hill plant near Secaucus, quarried and processed basalt for use as concrete aggregate, roadstone, and riprap.

Hunterdon.—Basalt was quarried and processed mainly for use as concrete aggregate and roadstone by Houdaille Construction Materials, Inc., Oldwick, and Lambertville Quarry Co. with operations near Lambertville and Pennington. A sizable tonnage of basalt was also marketed for railroad ballast by the latter company. Traprock Industries, Inc., Kingston, purchased Lambertville Quarry Co. late in 1966. The Clinton granite quarry of Somerset Crushed Stone Division, Anthony Ferrante & Sons, was inactive during 1966 while the company's newly reporting Pattenburg quarry produced granite for concrete aggregate and roadstone. Dimension miscellaneous stone (argillite) was produced by Delaware Quarries. Dimension sandstone for construction and flagging was produced by H. W. Lindblad near Lambertville.

Mercer.—Pennington Quarry Co., Pennington, produced diabase (traprock) for concrete aggregate, roadstone, railroad ballast, and riprap. The company was purchased by Traprock Industries, Inc., Kingston, late in 1966. Basalt was produced for riprap by inmates of the Mercer County Workhouse, Trenton. Exfoliated vermiculite used for insulation, aggregate, and agricultural purposes was produced by Zonolite Division, W. R. Grace & Co., Trenton.

Middlesex.—Sand and gravel output increased slightly above that of 1965 and totaled 1.7 million tons. Output was mainly processed material for building and highway construction and maintenance. South River Sand Co. produced industrial and ground sand at its Old Bridge plant. Principal producers of construction sand and gravel were Crossman Co. and Sayre & Fisher Co., both near Sayreville; Herbert Sand Co., Inc., and Buck Brothers, Inc., both near East Brunswick; Raritan River Sand Co., Nixon; and Dallenbach Sand Co., Inc., Milltown.

The county continued as the leading clay-producing area accounting for nearly 50 percent of the State's total output. Production was 231,000 tons, 7 percent below that of 1965. Fire clay output increased slightly but miscellaneous clay production declined. The miscellaneous clay was used for manufacturing building brick and other heavy clay products. Most of the fire clay was used for manufacturing refractory products, but quantities also were used for pottery and stoneware, floor and wall tile, architectural terra cotta, rotary-drilling

mud, and as a filler material. Sayre & Fisher Co. produced plastic fire clay and miscellaneous clay at Sayreville. Miscellaneous clay was produced by Natco Corp., Perth Amboy, and Oschwald Brick Works, Cliffwood. Fire clay producers were A. P. Green Refractories Co., Perth Amboy and Woodbridge; Almasi Clay Co., Woodbridge; Crossman Co., South Amboy; McHose Clay Co., Edison; and Such Clay Co., Sayreville. H. C. Perrine & Son, Inc., discontinued its clay operation at Matawan. The State has taken over the property for development of a park. Marcus S. Wright, Inc., Milltown, discontinued business at the end of 1965. Sulfur was recovered by the Amine gas purification and the modified Claus processes by The Anlin Co. of New Jersey, Perth Amboy. Coralux Perlite Corp. of New Jersey produced expanded perlite used mainly as an aggregate for plaster and concrete at Metuchen.

Monmouth.—Sand and gravel production continued to decline; output was 645,000 tons, 7 percent below that of 1965. Eight operations were active producing mainly processed construction sand and gravel. Bennett Sand & Gravel Co., Manasquan, was the leading producer. Other leading producers were Hause Gravel Co., Asbury Park; Hoffman Sand & Gravel, Belmar; and New Jersey Gravel & Sand Co., Farmingdale. Production also was reported at operations near Hazlet, Wayside, New Shrewsbury, and Wall Township.

Morris.—The Scrub Oaks iron ore mine of Alan Wood Steel Co. was closed and the installation dismantled in February. It had been the State's last remaining active iron ore mine. Stocks of magnetite iron ore concentrate were liquidated, mostly by shipment to the company's steel plant at Conshohocken, Pa. The inventory of stone (granite) resulting from processing of mine wastes and mill tailings was sold for use as concrete aggregate and roadstone. No production of iron ore was reported from the Mt. Hope mine of Shahmoon Industries Inc., but the company sold its entire stockpile of concentrated ore in 1966. The company, however, continued to quarry granite at Mt. Hope for use as concrete aggregate, stone sand, fill, and riprap. Substantial tonnages of granite were also produced for concrete aggregate and roadstone by Braen Industries Inc., near Riverdale; a limited quantity was also produced for riprap.

Over 4.1 million tons of sand and gravel was recovered from operations in the county. Value totaled $5.1 million, compared with 3.4 million tons and $4.1 million in 1965. The increase was attributed to greater construction activity and to the addition of two new operations. New plants were operated by Houdaille Construction Materials, Inc., Morristown; and Flanders Sand & Gravel Co., Flanders. Houdaille Construction Materials, Inc., also operated plants at Kenvil and Riverdale and continued as the county's largest producer. Other leading producers were Conklin Brothers, Montville; Wharton Sand & Stone Co., Inc., Montville Township; T. Landi & Sons, Inc., Morristown; Pequannock Sand & Gravel Division, Union Building & Construction Corp., Pequannock; Certified Aggregates Co., Inc., Mount Olive Township; and Berkshire Sand & Stone Co., Inc., Jefferson Township. Other operations were active near Stanhope, Whippany, and Pequannock. Most of the material was processed for building and highway construction.

Ocean.—Sand and gravel output totaled 2.3 million tons valued at $3.0 million and was slightly below that of 1965. Houdaille Construction Materials, Inc., Lakewood, was the leading producer of construction sand and gravel. New Jersey Pulverizing Co., Pinewald, produced industrial sands, both ground and unground. Other construction sand and gravel producers were Brick-Wall Corp., Lakehurst; Clayton's Sand & Gravel Corp., Barnegat; Ralph Clayton & Sons, Lakewood; Robert E. Kalach, Staffordville; and Lacey Materials, Inc., Forked River. Ilmenite concentrate was produced by The Glidden Co., at its Lakehurst mine and concentrating plant near Jackson. The material was shipped to the company-owned plant in Baltimore, Md., for conversion to titanium dioxide for use in manufacturing paint.

Passaic.—Production of crushed stone declined moderately but the county continued to rank second in output and value among the State's stone-producing areas. Output was basalt and miscellaneous stone, used mostly for concrete aggregate and roadstone. A sizeable tonnage also was produced for riprap and limited quantities were marketed for roofing granules and railroad ballast. Basalt producers were Samuel Braen's Sons, Haledon and North Haledon; Great Notch Corp., Little Falls;

Houdaille Construction Materials, Inc., Montclair; Sowerbutt Quarries, Inc., Prospect Park; and The Union Building and Construction Corp., Clifton. Passaic Crushed Stone Co., Inc., quarried miscellaneous stone (gneiss) near Pompton Lakes. Sand and gravel production was below that of 1965 and totaled 365,000 tons valued at $610,000. Output consisted chiefly of processed material for building construction. Producers were Herbert J. Hinchman & Son, Inc., Van Orden Sand & Gravel Co., Inc., and Van Decker Bros., Inc., all near Wayne, and Van Orden Sand & Gravel, Ringwood. Humus peat was produced by Horticultural Products, Inc., from a bog near Newfoundland. The material was shredded and sold in packages. The production of expanded perlite at the Patterson plant of Peralex of New Jersey, Inc., was discontinued and the corporation dissolved.

Somerset.—Somerset County continued as the leading stone-producing area with basalt production of 5.4 million tons valued at $12.6 million. Output and value were 4 and 10 percent respectively, higher than that of 1965. The average value per ton increased 6 percent. Uses for crushed stone included concrete aggregate, roadstone, riprap, railroad ballast, roofing granules, and filler material. Producers were Dock Watch Quarry Pit, Inc., Martinsville; Fanwood Stone Crushing & Quarry Co., Watchung; Houdaille Construction Materials, Inc., Millington and Bound Brook; Somerset Crushed Stone Division, Anthony Ferrante & Sons, Inc., Bernardsville; Traprock Industries, Inc., (formerly Kingston Traprock Co.,) Kingston; and Minnesota Mining & Manufacturing Co., Belle Mead. Production of miscellaneous shale used for manufacturing heavy clay products was slightly above that of 1965. Producers were Natco Corp., New Brunswick; New Jersey Shale Brick & Tile Corp., and American Vitrified Products Co., both near Somerville. Expanded perlite for roofing and siding shingles was produced at the Manville plant of Johns-Manville Products Corp., Building Products Division.

Sussex.—The underground Sterling Hill mine near Ogdenburg continued active the entire year and shipped crushed crude manganiferous zinc ore to Palmerton, Pa. for smelting. Manganiferous zinc residuum also was recovered from the ore. Limestone was quarried and crushed by Farber White Limestone Co., Franklin, and Limestone Products Corp. of America, Newton, for varied uses. The latter company calcined limestone at its Lime Crest plant and produced hydrated lime for construction, agricultural, and chemical applications. Sand and gravel production was above that of 1965. Output was reported from operations near Andover and Sparta. P. Michelotti & Sons, Inc., and Sparta Sand & Gravel Co., Inc., both near Sparta, were the leading producers. Hyper-Humus Co., Newton, and Netcong Natural Products, Stanhope, produced reed-sedge peat. Hyper-Humus Co. sold peat in bulk and in packages; Natural Products marketed its material in bulk form only.

Union.—Houdaille Construction Materials, Inc., Summit, produced granite for concrete aggregate and roadstone. Industrial Chemicals Division, Allied Chemical Corp., (formerly General Chemical Division) recovered sulfur by the modified Claus process at its Bayway plant. Hydrogen sulfide was recovered by hydrofining and sour gas scrubbing at the Bayway petroleum refinery of Humble Oil & Refining Co. Expanded perlite used mainly as an aggregate in concrete and plaster was produced at the Hillside plant of Certified Industrial Products, Inc.

Warren.—Production of sand and gravel was greater than that of 1965. Steckel Concrete Co., Phillipsburg, was the leading producer. Other producers were Houdaille Construction Materials, Inc., Carpenterville; Warren Paving Co., Inc., Stewartsville; and Van Horn Sand & Gravel Co., Belvidere. Most of the material was processed for use in construction. The Royal Green Marble Co., Phillipsburg; produced marble for terrazzo. Humus peat was recovered from bogs near Great Meadows by Kelsey Humus Co. and Partac Peat Co. The material was shredded for sale in bulk and in packaged form. J. T. Baker Chemical Co., Phillipsburg, produced a variety of refined magnesium compounds, including chloride, sulfate, and trisilicate.

The Mineral Industry of New Mexico

By R. B. Stotelmeyer [1] and William C. Henkes [2]

Mineral production in New Mexico was valued at $820.3 million, a new high. The State again led the Nation in the production of perlite, potassium salts, and uranium ore.

Multimillion-dollar projects, announced or brought into production, were to increase substantially the output of copper, coal, and molybdenum. Announcements of private sales of uranium concentrate assured steady growth in output of this commodity.

Mineral fuels production was valued at $541.0 million, a 7-percent increase. Output amounted to 66 percent of the total value of mineral yield. Production value of metals ($141.2 million) was slightly more than that of nonmetals ($138.1 million)—the reverse of the order in 1965. Start of operations at a new molybdenum mine, and increased copper production, were mainly responsible for a 15-percent increase in value of metals output. Lower potash prices were mainly the cause of a 4-percent decline in value of nonmetals production.

[1] Mining engineer, Bureau of Mines, Socorro, N. Mex.
[2] Petroleum engineer, Bureau of Mines, Denver, Colo.

Table 1.—Mineral production in New Mexico [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Barite—short tons	200	$2	-----	-----
Carbon dioxide (natural)—thousand cubic feet	833,819	62	795,885	$58
Clays—thousand short tons	60	101	W	W
Coal (bituminous)—do	3,212	10,710	2,755	9,110
Copper (recoverable content of ores, etc.)—short tons	98,658	69,850	108,614	78,571
Gem stones	NA	45	NA	45
Gold (recoverable content of ores, etc.)—troy ounces	9,641	337	9,295	325
Gypsum—thousand short tons	W	W	146	545
Helium—thousand cubic feet	80,583	r 2,821	95,900	3,357
Lead (recoverable content of ores, etc.)—short tons	3,387	1,057	1,596	482
Lime—thousand short tons	33	465	34	472
Manganese ore and concentrate (35 percent or more Mn)—short tons, gross weight	5,637	156	W	W
Manganiferous ore (5 to 35 percent Mn)—do	50,090	328	47,590	324
Mica (scrap)—short tons	4,263	45	W	W
Natural gas (marketed)—million cubic feet	937,205	110,590	998,076	124,760
Natural gas liquids:				
LP gases—thousand gallons	759,311	25,817	816,202	31,832
Natural gasoline and cycle products—do	358,487	20,824	338,732	19,736
Perlite—short tons	331,011	2,905	343,334	3,423
Petroleum (crude)—thousand 42-gallon barrels	119,166	334,977	124,154	352,101
Potassium salts thousand short tons, K_2O equivalent	2,848	117,771	2,953	108,653
Pumice—thousand short tons	264	915	245	787
Salt—do	64	572	66	716
Sand and gravel—do	11,763	12,130	15,503	13,029
Silver (recoverable content of ores, etc.) thousand troy ounces	288	372	243	314
Stone—thousand short tons	1,911	3,020	2,652	4,056
Uranium ore—short tons	2,013,861	38,311	2,080,481	38,754
Vanadium—do	W	221	W	53
Zinc (recoverable content of ores, etc.)—do	36,460	10,646	29,296	8,496
Value of items that cannot be disclosed: Cement, iron ore, molybdenum, tin, and values indicated by symbol W	XX	8,070	XX	20,328
Total	XX	r 773,120	XX	820,327

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

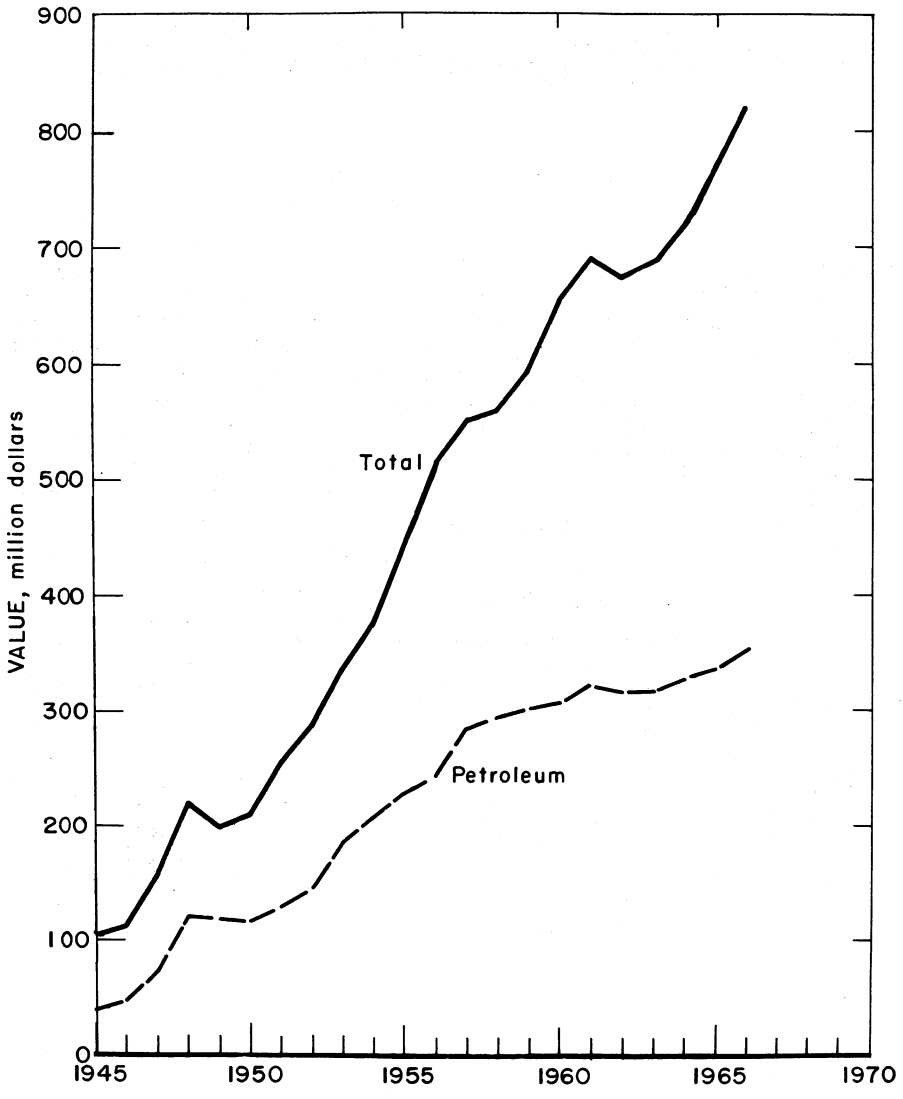

Figure 1.—Value of petroleum, and total value of all mineral production in New Mexico.

Employment and Injuries.—Final data for 1965 and preliminary data covering 1966 compiled by the Federal Bureau of Mines for employment and injuries in the New Mexico mineral industries, excluding all mineral fuels except coal, are reported in table 3.

Legislation and Government Programs.—Substantial progress was made at the two major water-diversion projects in the northern part of the State, both under the direction of the Federal Bureau of Reclamation. At the Navajo irrigation project, east of Farmington, the first of six proposed tunnels was holed through. The tunnel, 2 miles long, was more than 20 feet in diameter. The six tunnels were to have a combined length of 13 miles when com-

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]
1957	$542,993
1958	561,557
1959	600,707
1960	656,616
1961	694,092
1962	672,499
1963	683,646
1964	711,306
1965	752,954
1966	789,619

[1] 1957–65 figures revised.

pleted in 1971. At the San Juan-Chama diversion project in northern Rio Arriba County and southern Colorado, work continued on the 13-mile-long Azotea tunnel.

The New Mexico Bureau of Mines and Mineral Resources in cooperation with the Office of the State Inspector of Mines published a directory listing active and inactive mines and mining companies. Other State Bureau of Mines' publications included a bibliography of New Mexico geology and mineral technology for 1961–65 (Bulletin 90) and a listing of mining districts by legal subdivisions (Circular 84).

A new geologic map of the State was issued by the U.S. Geological Survey. The map replaced one published 40 years ago.

The Federal Bureau of Mines published a report [3] on fluorspar deposits in New Mexico.

[3] Williams, Frank E. Fluorspar Deposits of New Mexico. BuMines Inf. Circ. 8307, 1966, 143 pp.

Table 3.—Employment 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
1965:								
Coal	284	233	66	530	1	15	30.20	12,206
Metal	3,279	278	912	7,308	5	392	54.33	5,427
Nonmetal	2,889	345	997	7,974	---	255	31.98	2,341
Sand and gravel	1,109	176	195	1,572	---	33	21.00	503
Stone	219	255	56	526	1	13	26.60	11,955
Total	7,780	286	2,226	17,910	7	708	39.92	4,013
1966: [p]								
Coal	285	223	64	504	1	14	29.76	12,766
Metal	3,290	280	923	7,386	4	361	49.42	6,285
Nonmetal	2,905	340	989	8,069	2	222	27.76	3,141
Sand and gravel	1,650	178	294	2,360	---	56	23.73	602
Stone	210	233	49	380	---	13	34.21	566
Total	8,340	278	2,319	18,699	7	666	35.99	4,270

[p] Preliminary.

REVIEW OF MINERAL COMMODITIES

MINERAL FUELS

Mineral fuels, accounting for 66 percent of the value of mineral production, increased $35.2 million, or 7 percent.

Carbon Black.—The annual report [4] of the New Mexico Oil & Gas Engineering Committee stated that United Carbon Co. and Continental Carbon Co. used 15.2 billion cubic feet of natural gas to produce 52.1 million pounds of carbon black, 8 percent less than in 1965. United Carbon Co. produced 54 percent of the output.

Carbon Dioxide.—Emerald Carbonic Division of Frick Co., Union County, expanded its dry ice (carbon dioxide) plant near Des Moines early in the year; daily capacity was increased from 20 to 100 tons. Production by the three Harding County operators declined 7 percent, to 772.6 million cubic feet.

Coal (Bituminous).—Coal output in the State declined 14 percent. Coal from the Kaiser Steel Corp. mines (Koehler and York Canyon), The Pittsburg & Midway Coal Mining Co. (McKinley), and Utah Construction & Mining Co. (Navajo), comprised most of the production. Other

[4] New Mexico Oil & Gas Engineering Committee. Annual Report, V. 1, 1966, p. 397.

operators were Julius Seidel in Colfax County, Sundance Coal Co. in McKinley County, and Hogback Coal Co. in San Juan County. Output decreases were reported from all three producing counties: Colfax County production declined 9 percent, as did that of McKinley County; production from San Juan County declined 16 percent. The Colfax County decrease was principally due to curtailment of activities at the Koehler mine of Kaiser Steel Corp.; main operations were transferred to the new York Canyon mine nearby. Production at the latter mine, begun in August, was expected to reach an annual rate of 700,000 tons. Coal from the new mine was shipped by unit train to the company steel plant at Fontana, Calif.

Upon completion of a $150 million expansion program at the Four Corners powerplant, production at the Navajo mine of Utah Construction & Mining Co. near Farmington will increase substantially. The addition of two 755,000-kilowatt generating units, to be completed by July 1969 and July 1970, respectively, would result in a total generating capacity of 2,085,000 kilowatts for the plant. The firm has contracted to supply coal for these units and expects coal output to reach 8.5 million tons per year by 1970. The open-pit mine was to be the largest coal mine in the United States. Treatment of coal, other than by crushing, included the use of washing plants at the Kaiser Steel Corp. operations. Output from the Navajo mine was treated with a dust supression detergent; Sundance Coal Co. used oil to treat most of the production. Coal from the McKinley mine was treated with a chemical and water.

Helium [5].—The Federal Bureau of Mines Navajo helium plant at Shiprock, San Juan County, was the only helium producing facility in the State. During 1966, the plant produced 95.9 million cubic feet of grade-A helium (99.995 percent purity), a significant increase over the 80.5 million cubic feet produced in 1965. At the Bureau of Mines established sales price of $35 per 1,000 cubic feet (f.o.b. plant), the 1966 production was valued at $3.4 million.

Rail shipments of gaseous helium were made from the Gallup shipping terminal, connected by pipeline to the Navajo plant. Highway semitrailers were loaded either from the plant or from the Gallup terminal. About 40 persons were employed at the plant and terminal.

Natural Gas.—Production of marketed natural gas increased 6 percent, most of the increase coming from wells in the San Juan basin. As in the past, however, slightly more than half of the gas was produced from the southeastern part of the State.

At yearend, according to the Oil Conservation Commission, 8,325 gas wells were in production in 164 gas pools; casinghead gas was also produced from many of the 624 oil pools.

Annual estimates by American Petroleum Institute (API) and American Gas Association (AGA) [6] indicated a 4-percent decline in gas reserves to 14.8 trillion cubic feet; the State was ranked fifth in the Nation in these reserves. New discoveries added 31.1 billion cubic feet to the reserves; revisions and extensions in existing fields added 337.2 billion cubic feet.

On July 26, the Federal Power Commission (FPC) settled a long-standing dispute over supplying gas to the southern California market. By a 4 to 1 decision, it approved plans of El Paso Natural Gas Co. and Transwestern Pipeline Co. to provide an additional 600 million cubic feet of gas per day from the Permian and San Juan basins to this market; with the decision, the FPC rejected a counterproposal to supply the market with gulf coast gas. El Paso and Transwestern were to spend a total of $94.6 million to build 259 miles of pipeline and to add compressor stations; the expansion was to boost deliveries to 2 billion cubic feet per day.

In other legal action, the Court of Appeals for the Tenth Circuit extended its stay of the August 1965 order of FPC fixing Permian basin gas prices. At yearend, the Court had reached no decision.

Project Gasbuggy, the proposed experiment to use a nuclear explosion to fracture low-permeability, gas-bearing sandstone in the San Juan basin, neared reality during the year. Government funds for the project —jointly sponsored by the U.S. Atomic Energy Commission (AEC), the Federal Bureau of Mines, and El Paso Natural Gas Co.—were rejected by the Bureau of the Budget early in the year, but were later restored by Congress. El Paso increased its

[5] Prepared by Office of Assistant Director—Helium, Washington, D.C.

[6] The Oil and Gas Journal, V. 65, No. 14, Apr. 3, 1967, pp. 128–131.

share of the cost to $2 million; total cost was estimated to be $5 million. Revised plans called for using a 20-kiloton device instead of the 10 kilotons originally proposed. The tentative explosion date was set for late 1967.

The large Indian basin gasfield in Eddy County had virtually reached completion of its development drilling; 12 dry holes defined the field limits. Gas production in the field during 1966 was 39.9 billion cubic feet.

In May, a very significant gas discovery was completed in southwestern Lea County. The discovery well—Texaco Inc.-Pauley Petroleum, Inc., Cotton Draw Unit No. 64, sec 18, T25S, R32E—was completed for a calculated absolute open flow gage of 92 million cubic feet of gas per day from a Devonian formation at a depth of 16,492 to 16,537 feet. The test, in the deep part of the north end of the Delaware basin, attracted wide attention. The completion gage was significant because the gas had to rise through 4,769 feet of debris in the hole: Junked 3½-inch drill pipe and drill-collars, milled packers, fishing tools, and other equipment lost in the hole and not recovered. More than 350,000 barrels of mud and lost circulation materials were pumped into the producing formation when high pressures threatened a blowout during the fishing job. Part of the gas from the well was sold to New Mexico Electric Co. for its 109,000-kilowatt electric-generating plant west of Hobbs. At year-end, the first development well was being drilled about 2½ miles northwest of the discovery.

Natural Gas Liquids.—The New Mexico Oil & Gas Engineering Committee annual report [7] listed production at the 42 natural gas liquids extraction plants as 29.8 million barrels. The plants processed 918.7 billion cubic feet of raw gas and returned 812.7 billion cubic feet to pipelines for marketing. Products included 11.7 million barrels of natural gasoline, 4.1 million barrels of butane, 4.4 million barrels of propane, and 9.6 million barrels of composite liquids. As in the past, most of the production (71 percent) was from the 34 plants in southeastern New Mexico; the rest was from the northwestern counties. The State had facilities for underground storage of 1.4 million barrels of LP gases.

API and AGA reported reserves of natural gas liquids as 559.8 million barrels, 3 percent higher than at the end of 1965; the State again was ranked third in the Nation.

The Indian basin gas plant of Marathon Oil Co. was completed in January. The plant, with a daily capacity of 180 million cubic feet of gas, extracted liquids from the gas produced at Indian basin; the dry gas was then delivered to Natural Gas Pipeline Co. for shipment to markets in the Chicago area. The Indian Hills Gas System, Ltd., built a liquids extraction plant just north of Carlsbad to process Indian basin gas. The plant had a daily capacity of 30 million cubic feet of gas which was received from a desulfurization unit in the field; the dry gas was then sold through the Southern Union Gas Co. system.

In September, plans were announced for $3 million in new facilities and improvements at the Hobbs gas plant of Northern Natural Gas Co. The expansion would increase daily gas capacity of the plant by 5.5 million cubic feet.

Warren Petroleum Corp. expanded gas-processing facilities at its Euncie plant. In the latter part of the year, Cities Service Oil Co. took over operation of the Bluitt plant, Roosevelt County, formerly owned by Capitan Petroleum, Inc.

A fire on December 16 destroyed the processing area of the Tatum gas plant of Sinclair Oil & Gas Co. Damage was estimated at $1 million to $1.5 million.

Petroleum.—For the fourth successive year, crude oil production increased and, for the third time, reached a new high. Output was 4 percent higher than in 1965 and the State again ranked sixth in the Nation in oil and condensate production.

The New Mexico Oil Conservation Commission reported that, at yearend, 16,504 oil wells were producing from 624 reservoirs; 14,981 of the wells and 574 of the pools were in the Permian basin; the remainder were in the San Juan basin. Lea County again yielded 68 percent of the State production.

Overall drilling activity was slightly higher than during the previous year: 1,236 wells compared with 1,137 in 1965. Total footage drilled was slightly less than the 6,726,431 feet drilled in 1965. Explora-

[7] Reference cited in footnote 4, v. I, p. 397, and v. II, p. 124.

Table 4.—Crude petroleum production by counties
(Thousand 42-gallon barrels)

County	1965	1966	Principal fields (those producing more than 1 million barrels) in 1966, in order of production
Chaves	7,579	5,883	Caprock.
Eddy	16,663	18,380	Empire, Lusk, Loco Hills, Grayburg.
Lea	80,999	84,064	Vacuum, Justis, Monument, Hobbs, Denton, Maljamar, Lusk, Lovington, Bagley, Crossroads, Eunice, Tobac, Pearl, Blinebry.
McKinley	179	204	
Rio Arriba	1,409	1,365	Tocito.
Roosevelt	2,343	4,508	Chaveroo, Milnesand.
Sandoval	10	7	
San Juan	9,984	9,743	Horseshoe, Bisti.
Total	119,166	124,154	

Source: New Mexico Oil & Gas Engineering Committee. Annual Report 1966. V. 1–2, 1966, 651 pp.

Table 5.—Drilling for petroleum in 1966, by counties

County	Oil	Gas	Dry	Total	Footage
Exploratory completions:					
Catron	---	---	1	1	12,284
Chaves	5	3	30	38	167,177
Colfax	---	---	2	2	3,634
Dona Ana	---	---	1	1	6,620
Eddy	7	3	27	37	255,702
Guadalupe	---	---	4	4	5,186
Lea	6	5	42	53	475,245
McKinley	---	---	39	39	75,761
Rio Arriba	---	---	1	1	3,519
Roosevelt	2	---	28	30	144,901
Sandoval	---	---	8	8	10,215
San Juan	2	5	31	38	116,810
Union	---	---	2	2	2,220
Total	22	16	216	254	1,279,274
Development completions:					
Chaves	78	---	15	93	338,433
Eddy	71	22	31	124	537,812
Lea	175	12	44	231	1,745,086
McKinley	7	---	3	10	17,142
Rio Arriba	6	47	7	60	334,790
Roosevelt	198	2	6	206	913,705
Sandoval	---	3	3	6	13,276
San Juan	6	240	6	252	1,322,218
Total	541	326	115	982	5,222,462
Total all drilling	563	342	331	1,236	6,501,736

Source: Committee on Statistics of Drilling, American Association of Petroleum Geologists.

tory drilling accounted for 21 percent of the wells; this activity resulted in 22 oil and 16 gas discoveries for a success ratio of 15 percent.

The Chaveroo field, discovered in March 1965, continued to be the area of greatest petroleum activity. Development drilling, on 40-acre spacing, proceeded at a fast pace. At yearend, the field had an average daily production of 12,492 barrels of oil from 300 wells. Depth to the main producing horizon—the San Andres formation (Permian)—was about 4,400 feet; well costs were about $55,000 to $65,000 for a pumping well and $27,000 for a dry hole. Exploratory drilling southwest of the field was aimed at establishing further production from the stratigraphic-trap-type sandstones of the San Andres formation; at least one discovery had been made about 20 miles west of Chaveroo.

A significant oil discovery was the Winchester field, Eddy County. The discovery well, J. C. Williamson, State No. 1–A, sec 36, T19S, R28E, was completed in February with a flow gage of 605 barrels of 49° API oil per day from the Wolfcamp formation (Permian) at 9,112 feet.

Eddy County also had an important new pay discovery in the Big Eddy Wolfcamp (Permian) gasfield. Pan American Petroleum Corp., Big Eddy Unit No. 7 well, sec 19, T20S, R31E, was completed in the Strawn formation (Pennsylvanian) at 11,402 feet for a flow gage of 579 barrels of 50° API oil per day. The field reportedly

had 50 feet of net pay and, at yearend, had four producing wells.

A significant wildcat failure was drilled in the southwestern part of the State, an area of little previous petroleum interest. Sun Oil Co. drilled the San Augustin Plains Unit No. 1, sec 29, T3S, R9W, Catron County, on a unitized block of 404,293 acres at a cost of $500,000. The well, drilled to 12,284 feet into Precambrian granite, found no significant shows of oil or gas. The presence in this well of some of the producing formations found in the Permian basin may encourage further drilling. The dry hole was presented to the New Mexico Institute of Mining and Technology, Socorro, to be used for experiments involving heat flow, rock mechanics, and seismic research.

Six petroleum refineries in the State processed 12.3 million barrels of crude oil. Shipments of crude oil out of the State amounted to 111.6 million barrels, most of which went to Texas (40.2 million barrels) and Illinois (34.7 million).

METALS

Output value of metals ($141.2 million) exceeded that of nonmetals ($138.1 million) for the first time since 1962, and accounted for 17.4 percent of the State mineral-output value. Although decreases of 76 and 54 percent, respectively, were noted for vanadium and lead plus smaller declines for other metals, the dollar value of these declines was not significant compared with increases in other metals, particularly molybdenum and copper. Output of copper was the largest recorded and exceeded 100,000 tons.

Copper.—Increased production was reported for the Chino Mines Division of Kennecott Copper Corp. at Hurley. The increase was the result of expansion of the precipitation section where mine-dump leach solutions were treated to recover dissolved copper. Output from this operation is expected to increase to a total of more than 100,000 tons of copper per year.

A major development in the New Mexico copper industry was the announcement that Phelps Dodge Corp. was to open a large mine at Tyrone in Grant County. Annual production from the open-pit mine was to be about 55,000 tons of copper. An initial investment of about $100 million was expected.

Table 6.—Mine production of gold, silver, copper, lead, and zinc in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1957–61 (average)	36	-----	6,835	4,274	$149	243	$221
1962	22	-----	7,687	7,529	264	302	327
1963	25	-----	7,404	7,805	273	256	328
1964	41	1	7,882	6,110	214	242	313
1965	34	2	9,006	9,641	337	288	372
1966	36	-----	9,438	9,295	325	243	314
1848–1966	NA	NA	NA	2,276,060	52,996	73,954	59,010

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1957–61 (average)	61,919	$37,033	2,314	$583	16,604	$3,862	$41,848
1962	82,683	50,933	1,134	209	22,015	5,063	56,796
1963	83,037	51,151	1,014	219	12,938	2,976	54,947
1964	86,104	56,140	1,626	426	29,833	8,115	65,208
1965	98,658	69,850	3,387	1,057	36,460	10,646	82,262
1966	108,614	78,571	1,596	482	29,296	8,496	88,189
1848–1966	2,798,936	1,259,853	344,039	49,208	1,362,776	267,820	1,688,888

NA Not available.

[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings or slimes retreated, and ore, old tailings, old slag, or copper precipitates shipped to smelters during the calendar year indicated.

[2] Does not include gravel washed or tonnage of precipitates shipped.

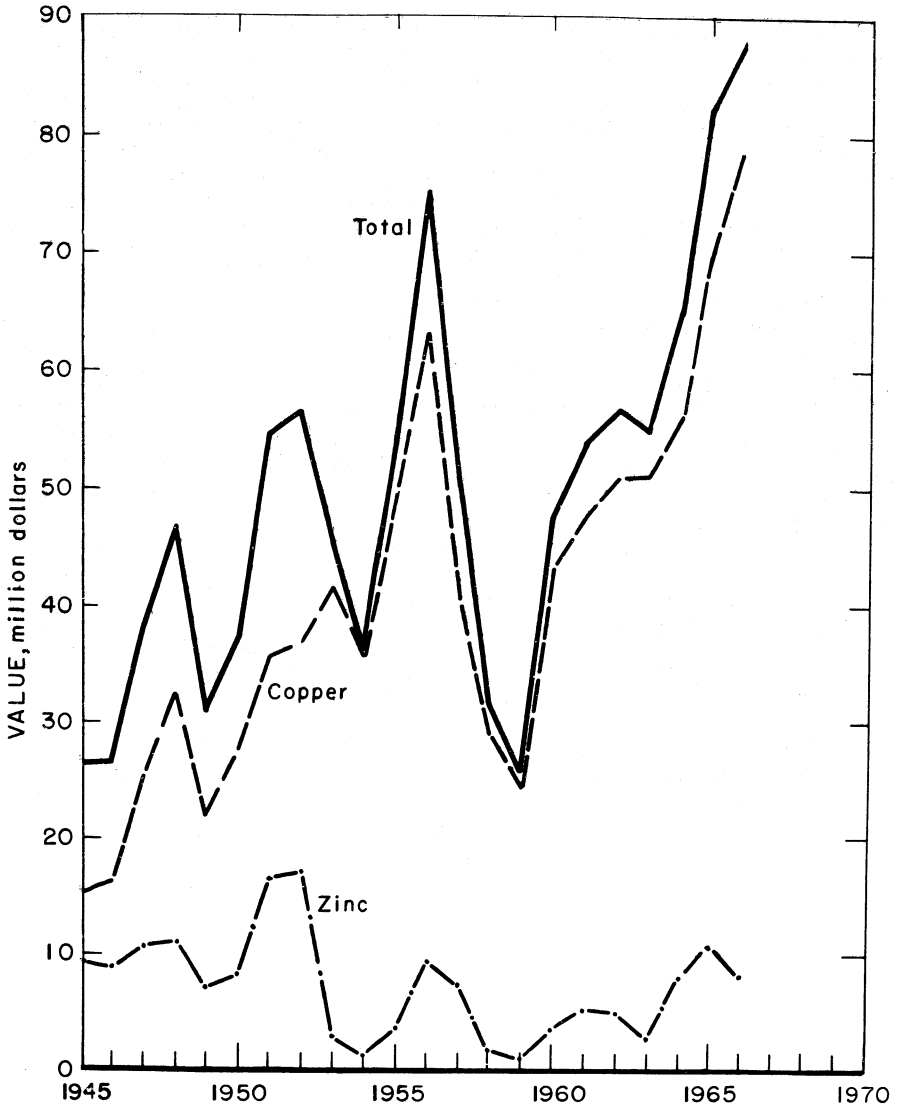

Figure 2.—Value of mine production of copper and zinc and total value of gold, silver, copper, lead, and zinc in New Mexico. The value of gold, silver, and lead produced annually has been relatively small.

Table 7.—Mine production of gold, silver, copper, lead, and zinc in 1966, by counties, in terms of recoverable metals

County	Mines producing[1]		Lode material sold or treated[2] (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
Grant	13	-----	9,277,455	3,760	$131,600	136,520	$176,520
Hidalgo	4	-----	139,620	5,420	189,700	70,263	90,850
Lincoln	2	-----	260	1	35	1,111	1,437
Luna	3	-----	13	-----	-----	12	16
Otero	1	-----	288	-----	-----	76	98
Rio Arriba	1	-----	46	-----	-----	12	16
Santa Fe	1	-----	800	23	805	592	765
Sierra	1	-----	1	-----	-----	31	40
Socorro	9	-----	19,228	91	3,185	34,000	43,962
Taos	1	-----	4	-----	-----	3	4
Total:							
1966	36	-----	9,437,715	9,295	325,325	242,620	313,708
1965	34	2	8,966,349	9,641	337,435	287,509	371,749

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Grant	106,021	$76,695,302	633	$191,265	27,865	$8,081,010	$85,275,697
Hidalgo	2,535	1,833,638	156	47,114	138	39,962	2,201,264
Lincoln	[3]	72	2	574	[3]	29	2,147
Luna	[3]	145	[3]	106	-----	-----	267
Otero	5	3,617	-----	-----	-----	-----	3,715
Rio Arriba	2	1,339	-----	-----	-----	-----	1,355
Santa Fe	24	17,362	-----	-----	-----	-----	18,932
Sierra	-----	-----	-----	-----	-----	-----	40
Socorro	27	19,821	805	243,412	1,293	374,839	685,219
Taos	[3]	72	-----	-----	-----	-----	76
Total:							
1966	108,614	78,571,368	1,596	482,471	29,296	8,495,840	88,188,712
1965	98,658	69,849,864	3,387	1,056,744	36,460	10,646,320	82,262,112

[1] Operations at plants leaching runoff water and old mill or miscellaneous cleanups not counted as producing mines.
[2] Does not include tonnage of precipitates shipped or gravel washed.
[3] Less than ½ unit.

Table 8.—Mine production of gold, silver, copper, lead, and zinc in 1966, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines[1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Dry gold-silver	4	61,543	4,076	39,183	2,538,900	3,700	14,000
Dry silver	8	2,202	6	7,816	13,200	5,800	5,500
Total	12	63,745	4,082	46,999	2,552,100	9,500	19,500
Copper	10	8,842,366	3,725	69,912	126,222,700	-----	9,200
Copper-zinc and lead zinc[2]	6	100,846	572	49,538	2,923,700	1,806,400	4,565,100
Lead and lead tailings[2]	6	1,755	6	793	700	114,700	2,000
Zinc	4	376,907	804	75,354	781,000	1,261,400	53,996,200
Total	26	9,321,874	5,107	195,597	129,928,100	3,182,500	58,572,500
Other "lode" material:							
Gold cleanup	[3]	[4]	106	24	-----	-----	-----
Copper precipitates	[5] 1	52,096	-----	-----	84,747,800	-----	-----
Total	1	52,096	106	24	84,747,800	-----	-----
Total "lode" material	36	9,437,715	9,295	242,620	217,228,000	3,192,000	58,592,000

[1] Detail will not necessarily add to total because some mines produce more than one class of material.
[2] Combined to avoid disclosing individual company confidential data.
[3] From property not classed as a mine.
[4] Less than ½ unit.
[5] Operations at plants leaching runoff water not counted as producing mines.

Table 9.—Mine production of gold, silver, copper, lead, and zinc in 1966, 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 (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Concentration and smelting of concentrates:					
Ore	5,102	196,233	129,415,100	3,128,200	58,571,800
Direct-smelting:					
Ore	4,087	46,363	2,625,500	63,800	20,200
Cleanup	106	24	-----	-----	-----
Copper precipitates	-----	-----	84,747,800	-----	-----
Total	4,193	46,387	87,373,300	63,800	20,200
Leaching of copper ore	-----	-----	439,600	-----	-----
Grand total	9,295	242,620	217,228,000	3,192,000	58,592,000

The $14 million construction project of United States Smelting Refining and Mining Co. (USSR&M Co.) at the Continental mine near Fierro continued. Expected to be the largest underground copper mine in the State, production was to begin in 1967. The old section of the Continental continued to be mined by lessees L. A. Patten & Associates.

Development and construction continued at the John H. Trigg Co. copper-leaching site near Tyrone; a small amount of precipitates was produced. Construction was begun at the Elena Mining Co. copper-leaching plant south of Cuba in Sandoval County.

Banner Mining Co. closed the Bonney-Miser's Chest operation in late December. However, an exploration-option agreement was signed with Federal Resources Corp. of Salt Lake City, Utah.

Copper was produced at 40 operations, including 16 leaching operations. In addition to the Banner Mining Co. operations, other major underground mines were the "85", operated by Diversified Mines, Inc., and the Continental No. 1, leased to L. A. Patten & Associates by USSR&M Co.

Gold.—Gold production declined 4 percent. Although output from the major producer, the Diversified Mines, Inc., "85" mine increased, decreases were noted at the other principal sources; the copper mines of Kennecott Copper Corp. (Chino mine) and Banner Mining Co. (Bonney-Miser's Chest mine). Gold was recovered from 20 mining operations, including 9 in Grant County, 3 in Hidalgo, 1 each in Lincoln and Santa Fe Counties, and 6 in Socorro County. Most of the mines were classified as copper, lead, or zinc mines.

Iron Ore.—Magnetite iron ore, about the same quantity as in 1965, was produced by Dotson Minerals Corp. of Socorro. Output was from the Jones mine in Socorro County, the Scholle mine in Torrance County, and the Yellow Jacket mine in Lincoln County. All of the mines were open pit. Before shipment, the ore was concentrated by magnetic separation at Coyote in Lincoln County. Most of the production was used in cement manufacture. The remainder was used as a heavy aggregate to increase density of atomic-radiation shielding.

Lead.—Shutdown of the Ground Hog mine in Grant County was the main cause for the 53 percent decrease in lead production and the 54 percent decrease in value. The Ground Hog mine, owned by American Smelting and Refining Co. (Asarco), had been shut down following a labor strike in July 1965. When in operation, the mine yielded much of the State lead output. Lower lead prices contributed somewhat to decreased value of production.

Lead ore was produced at 17 mines. The major production was from the Linchburg mine near Magdalena in Socorro County. L. A. Patten & Associates leased the mine from The New Jersey Zinc Co. The other major production was from the Hanover mine of The New Jersey Zinc Co. and the Kearney mine of American Zinc, Lead and Smelting Co. The Kearney mine was to be closed early in 1967.

Manganese Concentrate.—Manganese ore, mined from the Black Canyon under-

ground mines in Socorro County, was upgraded for shipment to out-of-state users. Late in the year, operations were transferred to a nearby leased property. In Grant County, Luck Mining Co. produced ferruginous manganese ore for direct shipment to the CF&I Steel Corp. plant at Pueblo, Colo. The ore, mined by open-pit methods, contained 36.01 percent iron and 11.78 percent manganese.

Shipments of manganese ore began from the Government stockpile at Deming in Luna County; the ore was used for blending by private consumers.

Molybdenum. — Continuous production began at the new Molybdenum Corporation of America (Molycorp) mine-mill complex near Questa in Taos County. Ore was processed at the recently completed concentrator; the concentrates were trucked to the railhead at Fort Garland, Colo., a distance of 76 miles.

Molybdenite concentrate continued to be recovered as a byproduct at the Chino mine of Kennecott Copper Corp. in Grant County. Beginning March 1, the concentrate was shipped to a company plant near Salt Lake City, Utah, for further processing.

The Utah plant processed the molybdenite to molybdic oxide and ammonium perrhenate. The oxide was sold to steel plants, and the perrhenate was shipped to a consumer for conversion to rhenium metal for high temperature uses in electronics.

Byproduct molybdenum was also recovered during the processing of uranium ores by Kerr-McGee Corp. at the company plant in McKinley County. Uranium-bearing lignite ash from South Dakota was treated at the plant. Because the ash contained molybdenum in excess of permissable limits allowed in uranium concentrates, the molybdenum was removed along with small amounts contained in New Mexico sandstone ores.

Silver.—Silver continued to be produced mainly as a byproduct of the treatment of copper, lead, and zinc ores. Output decreased 16 percent principally because of the shutdown of the Ground Hog mine of Asarco in Grant County. Major producing mines were Chino, Continental, Hanover, Kearney, and Princess, all in Grant County; Bonney-Miser's Chest and "85" in Hidalgo County; and Linchburg in Socorro County.

Tin.—Tin from placer deposits was recovered at a jig plant operated by Tinco, Inc., in Catron County. The plant was dismantled during the year, and all production activities ceased after the final clean-up. Stockpiled concentrates were shipped by Anommco, Inc., from the company property in Sierra County. Output from both counties was shipped to Texas City, Tex.

Uranium Ore.—There were 57 uranium mining operations in 1966 compared with 50 in 1965. Although the number of operations increased, the amount and value of ore produced were essentially unchanged. The six largest producing mines, in order or rank, were the Section 25 mine of Homestake-Sapin Partners, the Section 30 mine of Kerr-McGee Corp., the Section 23 mine of Homestake-Sapin Partners, the Section 22 mine of Kerr-McGee Corp., the Black Jack No. 1 mine of Homestake-Sapin Partners, and the Paguate open-pit mine of The Anaconda Company.

Four uranium mills were active during the year, with some concentrates stockpiled for future sales. Claim-staking and exploration activities increased in all uranium mining districts. Ranchers Exploration and Development Corp. announced that company uranium-claim holdings in the northwestern part of the State had been increased to approximately 40,000 acres, more than double the size of previous holdings. The company reportedly received royalties on about half of the producing properties in the Ambrosia Lake district. Preparations were under way to begin again large-scale stripping at the Paguate open-pit mine of The Anaconda Company in Valencia County. The principal new developments in State uranium-producing activities were the announcements of contracts for sale of uranium concentrates to electric utility firms. A contract totaling more than $70 million, negotiated between The Anaconda Company and Westinghouse Electric Corp. provided for delivery of U_3O_8 concentrate over a 7-year period beginning in 1968. Reportedly, a contract also had been negotiated with a Swiss firm for concentrate deliveries to begin in 1968. Homestake-Sapin Partners concluded a contract to sell 628,000 pounds of U_3O_8 concentrate to a West German electric utility company; shipments were scheduled for 1966 and 1967. Kerr-McGee Corp. contracted to sell

concentrate valued at $15 to $20 million to Commonwealth Edison Co. in the period 1968 through 1970, and to sell about $50 million worth to Philadelphia Electric Co. in the period 1968 through 1973. Commonwealth Edison Co. also arranged a purchase of about $15 million worth of concentrates from United Nuclear Corp.

Vanadium.—Vanadium output declined 81 percent, and value declined 76 percent. All of the vanadium was recovered as a byproduct of uranium-ore milling. The decrease in production was mainly the result of a large drop in the amount of vanadium-rich solutions shipped from uranium mills not having vanadium recovery circuits. At mills having vanadium recovery circuits—the Shiprock mill of Vanadium Corporation of America (VCA); the Grand Junction, Colo., mill of Climax Uranium Co., Climax Molybdenum Co. Division, American Metals Climax, Inc.; and the Rifle, Colo., mill of Union Carbide Corp.—uranium ores containing vanadium were processed from four operations in McKinley County and five in San Juan County. The VCA mill also processed the vanadium-rich solutions.

Zinc.—Zinc production, which previously had been ranked third in value of metals output, declined 20 percent, and dropped to fourth place behind copper, uranium ore, and molybdenum. Declines in output from three of the principal mines were large enough to offset a slight increase from the Hanover mine, the major producer. Output was reported from 17 mines: 8 in Grant County, 4 in Hidalgo, 1 in Lincoln, and 4 in Socorro. The principal mines were the Hanover, Princess, Oswaldo, and Kearney in Grant County and the Linchburg in Socorro County.

Zinc concentrates were recovered from ores treated at the Peru mill of American Zinc, Lead and Smelting Co., near Deming, the Hanover mill of The New Jersey Zinc Co., and the Bayard mill of USSR&M Co.

NONMETALS

Output of nonmetals, declining 4 percent in value of production—from $144.3 million to $138.1 million—accounted for 17 percent of the State mineral production. Most of the decline was because of lower prices for potassium salts (potash). The amount of potash produced increased, however. Substantial increases in dollar value of portland cement, perlite, sand and gravel, and stone were not great enough to offset the decline in potash production value.

Barite.—No output of barite was reported; a small amount had been produced in 1965.

Cement.—The Tijeras plant of Ideal Cement Co. produced both portland and masonry cements. Output of portland cement, the principal product, increased 9 percent, whereas masonry cement output declined 10 percent.

Kaiser Cement & Gypsum Corp. announced plans for construction of a new cement plant at Scholle in Socorro County, 55 miles south of Albuquerque. The plant was to have a rated capacity of 1.7 million barrels of cement per year.

Clay.—Production of clay was about the same as in 1965. Most of the output was miscellaneous clay used in manufacturing cement at the Ideal Cement Co. plant and shale for manufacturing building brick at the Albuquerque plant of Kinney Brick Co., Inc. Other miscellaneous clay was produced by Louis O. Romero, in Taos County, for use in building brick, and shale by U.S. Mining Corp., in McKinley County, for use as rotary-drilling mud.

Fire clay produced by Phelps Dodge Corp. in Hidalgo County was used as furnace stoppers—a refractory use. In addition, Mathis & Mathis produced refractory fire clay in Luna County.

Gypsum.—Production of gypsum increased slightly and was used mostly in manufacturing wallboard at the Rosario plant of Kaiser Gypsum Co., Inc., and the Albuquerque plant of American Gypsum Co., a division of The Susquehanna Corp. Kaiser Gypsum obtained crude material from its plant quarry. American Gypsum Co. purchased material from White Mesa Gypsum Co., which operated a mine about 30 miles northwest of Albuquerque.

Ideal Cement Co. obtained gypsum from Duke City Gravel Products Co. for use in cement manufacture. The gypsum was added to portland cement to retard the rate of setting. Associated Materials Co., Sierra County, began producing gypsum for agricultural use.

Lime.—All of the lime output, about the same as in 1965, was by Kennecott Copper

Corp. for use in treating copper ores and for water purification.

Mica.—Scrap mica (sericite) was mined by Mineral Industrial Commodities of America (M.I.C.A.) from the leased To-Jo mine in Taos County. Processed at its Pojoaque dry-grinding plant north of Santa Fe, all of the output was sold to paint manufacturers. A large decrease in output value was reported. M.I.C.A. had discontinued production of muscovite mica in December 1965. A small amount of mica was purchased by M.I.C.A. from independent producers.

Perlite.—The State continued to lead the Nation in perlite production. Increases of 18 percent in value and 4 percent in output indicated continued growth of the industry. (Production increased 13 percent in value and 16 percent in output in 1965.) Most of the output was from deposits in northern Taos County. Grefco, Inc., Johns-Manville Perlite Corp., and United Perlite Corp. were the producers in this area. Grefco, Inc., a new subsidiary of General Refractories Co., was formed in April when the latter firm acquired the Mining and Mineral Products Division, including the New Mexico perlite operations, of Great Lakes Carbon Corp. United States Gypsum Co. continued to produce perlite at the Grants operation in Valencia County. All of the output was used by the company; the other producers shipped sized material to out-of-State expanding plants before sale on the open market.

Table 10.—Crude perlite sold or used by producers

Year	Short tons	Value (thousands)
1962	258,164	$2,143
1963	259,113	2,212
1964	286,329	2,568
1965	331,011	2,905
1966	343,334	3,423

Potash.—New Mexico with 10 mines and 7 refineries continued to lead the Nation in the production of potassium salts. Output reached a new high, increasing by 4 percent; value of output declined 8 percent because of lower prices. Stocks of crude salts on hand declined 37 percent to 49,428 tons containing 7,741 tons of K_2O equivalent. Average grade of ore mined was 17.5 percent, compared with 18.1 percent in 1965.

United States Borax & Chemical Corp. (U.S. Borax) announced that it would dispose of its New Mexico operations in 1968 and concentrate on its Canadian potash holdings. A group of Carlsbad investors obtained options on the properties and planned to continue operations. U.S. Borax was the first to operate in the Carlsbad area, having started in 1931.

The new operation of Kermac Potash Co. completed its first full year of production. The 500,000-ton-per-year plant was brought into production in November 1965.

National Potash Co. came under the sole ownership of Freeport Sulphur Co. Formerly, Consolidation Coal Co. had been a partner.

Pumice.—Output of volcanic rock—pumice, scoria, and volcanic cinders—declined 7 percent. Most of the production was used as concrete aggregate or in other construction products. The decrease in output reflected a general decline in construction activities. Five companies were engaged in producing or processing pumice; five companies produced scoria; and two produced volcanic cinders. Average value of sales, including crude and prepared material,

Table 11.—Potassium salts production and sales
(Thousand short tons and thousand dollars)

Year	Crude salts, mine production		Marketable potassium salts					
			Production			Sales		
	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Value	Gross weight	K_2O equivalent	Value
1962	14,115	2,619	3,758	2,208	$85,124	4,206	2,476	$95,851
1963	16,414	3,083	4,504	2,643	101,458	4,213	2,484	94,925
1964	17,356	3,122	4,585	2,675	104,861	4,815	2,814	110,772
1965	18,557	3,363	4,919	2,848	117,771	4,607	2,677	110,424
1966	20,105	3,528	5,096	2,953	108,653	4,872	2,827	104,668

ranged form $1.65 to $50.28 per ton for pumice, $1 to $5.83 per ton for scoria, and $1.60 to $1.83 for volcanic cinders.

In addition to that used for concrete aggregate, pumice was used mainly in scouring and cleansing compounds. Scoria was principally used as railroad ballast, concrete aggregate, and as a roofing and landscaping material. Nearly all of the volcanic cinders was used as concrete aggregate.

Salt.—Although production of salt rose only 3 percent, the value of production increased 25 percent. Substantial increases were noted in the salt produced for use as livestock feed. All of the output was from Eddy County. With the exception of brine produced by Pioneer Water Co., Inc., from open lakes, and used in oil refining, salt was obtained from tailings resulting from the refining of potash minerals. Most of the output by the salt companies was rock salt or pressed blocks used mainly as livestock feed. The Salt Supply Co., Inc., was the only producer of solar-evaporated salt.

Southwest Salt Products Co. acquired the Salt Lake properties of Curtis Salt Co. near Quemado in western Catron County in May. No shipments were made during the year; development of the property was to be completed about April 1967. Most of the output was to be sold for use in uranium-ore milling.

Sand and Gravel.—Total production of sand and gravel from 177 operations in 31 counties increased 32 percent in quantity and 7 percent in value. Only Harding County had no reported production. Government-and-contractor operations constituted 78 percent of output and 69 percent of value; commercial operations accounted for the remainder. Bernalillo, Dona Ana, San Juan, and Valencia Counties were the only ones to have production valued in excess of $1 million.

Sixty percent of the sand and gravel was crushed, screened, washed, or otherwise treated. Thirty operators reported having stationary plants; 70 reported having portable plants; 7 had both types; and 1 operator reported using a dredge. Material classified as gravel comprised 90 percent of the sand and gravel output. Sand and gravel used for paving was 87 percent of the total output. Building construction accounted for 12 percent; the remainder was used as railroad ballast and fill. The only industrial sand output was produced by Hites Sand and Gravel, of Chavez County, for use in sand blasting. At four commercial operations, production was between 100,000 and 300,000 tons of sand and gravel; in addition, two operations produced more than 500,000 tons.

As of December 31, 76 miles of Interstate highway was under construction. Of the 1,003 miles designated for the State, 517 miles had been completed to full or acceptable standards.[8]

Stone.—Stone produced in 24 counties, compared with 19 in 1965, increased more than $1 million in value or 34 percent. San Miguel County with an output valued at more than $1.4 million led the State and was the only county having production valued in excess of $1 million. State output, in order of value, consisted of the following crushed and broken stone: Limestone, miscellaneous stone, sandstone, and basalt. Following crushed and broken stone in value of production were dimension stones

[8] Bureau of Public Roads. Quarterly Report on The Federal-Aid Highway Program, Dec. 31, 1966. Press Release BPR 67-5, Feb. 1, 1967.

Table 12.—Sand and gravel production in 1966, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value
Bernalillo	1,619	$1,800
Catron	287	367
Chaves	429	452
Colfax	195	195
Curry	30	38
De Baca	32	41
Dona Ana	4,562	2,832
Eddy	73	63
Grant	W	W
Guadalupe	262	265
Hidalgo	72	72
Lea	57	64
Lincoln	W	W
Los Alamos	75	75
Luna	131	118
McKinley	437	455
Mora	197	194
Otero	346	328
Quay	291	364
Rio Arriba	453	362
Roosevelt	6	7
Sandoval	531	508
San Juan	1,193	1,069
San Miguel	111	110
Santa Fe	566	529
Sierra	388	386
Socorro	323	216
Taos	150	120
Torrance	328	212
Union	163	164
Valencia	1,969	1,431
Undistributed	227	192
Total	15,503	13,029

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

Table 13.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	949	$1,105	899	$1,021
Paving	480	556	135	157
Railroad ballast	48	16	-----	-----
Fill	40	34	52	26
Industrial:				
Blast	-----	-----	1	1
Other (unground sand only)	2	1	-----	-----
Total	1,519	1,712	1,087	1,205
Gravel:				
Construction:				
Building	1,106	1,397	1,009	1,298
Paving	2,963	3,246	1,280	1,433
Railroad ballast	20	24	(1)	(1)
Fill	88	66	64	49
Miscellaneous	-----	-----	[1] 14	[1] 9
Total	4,177	4,733	2,367	2,789
Total sand and gravel	5,696	6,445	3,454	3,994
Government-and-contractor operations:				
Sand:				
Building	-----	-----	3	4
Paving	682	679	488	381
Fill	60	41	-----	-----
Other	6	6	-----	-----
Total	748	726	491	385
Gravel:				
Paving	5,282	4,924	11,550	8,646
Fill	37	35	8	4
Total	5,319	4,959	11,558	8,650
Total sand and gravel	6,067	5,685	12,049	9,035
All operations:				
Sand	2,267	2,438	1,578	1,590
Gravel	9,496	9,692	13,925	11,439
Total	11,763	12,130	15,503	13,029

[1] Railroad ballast and "Miscellaneous" gravel combined to avoid disclosing individual company confidential data.

of granite, marble, miscellaneous stone, basalt, sandstone, and limestone. Dimension marble and crushed granite were the only classifications to show declines; no crushed granite was produced in 1966. Dimension limestone was produced in 1966, but not in 1965.

The largest increases were for crushed and broken sandstone and miscellaneous stone. Most of the sandstone was quarried for the State highway department in San Miguel County. The miscellaneous stone was also used mainly in highway construction in various counties. Crushed and broken limestone, accounting for 51 percent of the value of all stone produced, was used principally in highway construction.

Twin Peaks Products Co., in Lincoln County, was the only commercial producer of basalt. The output was for dimension building stone and for landscaping. Dimension granite produced by New Mexico Granite Co. in San Miguel County was used as monumental stone. The only dimension-limestone producer was Mathis & Mathis in Grant County. Dimension marble, both rough and dressed building stone, was produced by Ultra Marbles, Inc., in Valencia County and processed at the company's Albuquerque plant. William H. Thomas Stone Quarries produced dimension sandstone in Luna County; dimension sandstone was also produced by Sandeno Stone Co. in four other counties. The

sandstone was used as rubble and as dressed building stone.

Sulfur.—Sulfur was recovered as a by-product from two natural gas processing plants in Eddy County and from two in Lea County. Production was 12,450 long tons of sulfur. Shipments were 13,022 tons valued at $273,776. Value of shipments increased 38 percent, reflecting higher prices; the quantity of shipments increased 24 percent. The modified Claus process was used at the plants of Pan American Petroleum Corp., Climax Chemical Co., and Sinclair Oil & Gas Co. Phillips Petroleum Co. used the standard Claus process.

Vermiculite.—Vermiculite from Montana was exfoliated, sized, and bagged at the Albuquerque plant of Southwest Vermiculite Co. Five sizes of vermiculite were sold. Most of the product was used as an aggregate; the remainder was used for insulation.

Table 14.—Stone production in 1966, by counties

County	Short tons	Value
Bernalillo	W	W
Catron	201	$302
Chaves	143,075	214,614
Colfax	10,928	16,392
De Baca	8,650	12,975
Dona Ana	16,879	22,833
Eddy	414,408	598,400
Grant	80,404	126,408
Lea	233,247	349,870
Lincoln	79,777	123,590
Luna	40	1,200
McKinley	41,219	41,335
Otero	W	W
Rio Arriba	2,124	6,470
Roosevelt	36,437	54,656
Sandoval	7,590	12,635
San Juan	W	W
San Miguel	911,001	1,460,630
Santa Fe	2,080	3,120
Sierra	861	1,292
Socorro	16,233	24,562
Taos	25	250
Torrance	28	42
Valencia	1,184	42,351
Undistributed	645,354	941,705
Total	2,651,745	4,055,632

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

Table 15.—Stone sold or used by producers, by kinds

Year	Short tons	Value	Short tons	Value	Short tons	Value
	Basalt and related rocks (traprock)		Granite		Limestone	
1962	148,858	$201,758	-----	-----	918,483	$1,298,410
1963	6,716	8,211	996	$25,997	1,264,243	2,017,667
1964	42,941	81,376	190	4,140	1,260,898	1,936,041
1965	84,490	248,500	3,445	17,130	1,452,401	2,084,281
1966	135,635	274,627	W	W	1,478,686	2,088,792
	Sandstone		Other stone [1]		Total	
1962	95	1,125	936,336	1,280,947	2,003,772	2,782,240
1963	W	W	1,236,783	2,184,264	2,508,738	4,236,139
1964	[2] 6,724	[2] 10,086	[3] 1,449,331	[3] 2,212,383	2,760,084	4,244,026
1965	[4] 88	[4] 2,036	[5] 370,739	[5] 667,616	1,911,163	3,019,563
1966	325,079	492,765	712,345	1,199,448	2,651,745	4,055,632

W Withheld to avoid disclosing individual company confidential data; included with "Other stone."
[1] Includes marble.
[2] Excludes dimension sandstone; included with "Other stone."
[3] Includes dimension sandstone.
[4] Excludes crushed sandstone; included with "Other stone."
[5] Includes crushed sandstone.

REVIEW BY COUNTIES

Mineral production, recorded for all 32 counties, ranged in value from $38,000 for Curry County, where a small amount of sand and gravel was produced, to more than $325 million for Lea County, where production of mineral fuels predominated. Counties having significant mineral production activities are discussed in detail.

Bernalillo.—All mineral commodities produced in the county were used in construction and road building. Value of mineral output increased 5 percent. Clay and crushed limestone were produced mainly for use in manufacturing portland and masonry cements at the Tijeras plant of Ideal Cement Co. A direct digital-control system, reported to be the first installation of its kind at a cement plant in the United States, was installed at the plant. Use of the system enabled highly automated

operation for maximum production and quality control.

Sand and gravel was produced at 17 operations. Output, 1.6 million tons, about the same as in 1965, was used for building construction (62 percent), paving (35 percent), and fill (3 percent). Albuquerque Gravel Products Co. and Springer Transfer Co. were the principal commercial producers.

Crego Block Co., Inc., mined volcanic cinder in Santa Fe County for use in manufacturing building block at the company's Albuquerque plant. Ultra Marbles, Inc., operated a stone finishing plant near Albuquerque; travertine, quarried in Valencia County, was cut by a gangsaw before being finished or shipped as rough stone. Sandeno Stone Co. quarried a small amount of dimension sandstone, and Edgar D. Otto & Son, Inc., produced pumice for use as concrete aggregate. Basalt and limestone were produced for the U.S. Army Corps of Engineers and the State highway department, respectively, for use as riprap. In addition to that used in cement manufacture, clay produced by Kinney Brick Co., Inc., was used to manufacture building brick.

Catron.—Sand and gravel production accounted for most of the mineral output

Table 16.—Value of mineral production in New Mexico, by counties

County	1965	1966	Minerals produced in 1966 in order of value
Bernalillo	$8,614,631	$9,087,986	Cement, sand and gravel, stone, clays, pumice.
Catron	102,931	W	Sand and gravel, tin, stone.
Chaves	22,062,923	17,793,614	Petroleum, sand and gravel, natural gas, stone.
Colfax	W	W	Coal, sand and gravel, stone.
Curry	-----	38,000	Sand and gravel.
De Baca	W	53,975	Sand and gravel, stone.
Dona Ana	W	2,943,681	Sand and gravel, pumice, stone.
Eddy	171,633,511	173,901,121	Potassium salts, petroleum, natural gas, LP gases, natural gasoline, salt, stone, sand and gravel.
Grant	82,809,703	87,928,094	Copper, zinc, molybdenum, lime, manganiferous ore, lead, sand and gravel, silver, gold, stone.
Guadalupe	W	265,000	Sand and gravel.
Harding	61,562	56,481	Carbon dioxide.
Hidalgo	2,069,024	W	Copper, gold, silver, sand and gravel, lead, zinc, clays.
Lea	309,517,995	325,292,906	Petroleum, natural gas, LP gases, natural gasoline, potassium salts, stone, sand and gravel.
Lincoln	W	150,236	Stone, iron ore, silver, sand and gravel, lead, copper, gold, zinc.
Los Alamos	100,000	75,000	Sand and gravel.
Luna	793,795	122,067	Sand and gravel, clays, stone, copper, lead, silver.
McKinley	33,090,084	33,225,984	Uranium ore, coal, petroleum, sand and gravel, molybdenum, stone, clays, vanadium.
Mora	W	194,000	Sand and gravel.
Otero	W	W	Sand and gravel, stone, copper, silver.
Quay	352,588	364,000	Sand and gravel.
Rio Arriba	13,898,172	12,339,210	Natural gas, petroleum, LP gases, sand and gravel, natural gasoline, pumice, stone, copper, mica (scrap), silver.
Roosevelt	8,351,000	14,459,656	Petroleum, natural gas, LP gases, natural gasoline, stone, sand and gravel.
Sandoval	782,121	1,033,734	Sand and gravel, gypsum, pumice, petroleum, stone, natural gas.
San Juan	r 95,471,454	105,119,044	Natural gas, petroleum, LP gases, coal, helium, natural gasoline, sand and gravel, uranium ore, vanadium, stone.
San Miguel	810,483	1,570,630	Stone, sand and gravel.
Santa Fe	860,912	925,351	Sand and gravel, pumice, gypsum, copper, uranium ore, stone, gold, silver.
Sierra	W	392,314	Sand and gravel, tin, stone, gypsum, silver.
Socorro	W	1,155,269	Zinc, lead, sand and gravel, manganese concentrate, iron ore, silver, stone, copper, gold.
Taos	2,787,611	15,161,423	Molybdenum, perlite, sand and gravel, mica (scrap), stone, clays, copper, silver.
Torrance	172,000	W	Sand and gravel, iron ore, stone.
Union	W	W	Pumice, sand and gravel, carbon dioxide.
Valencia	W	W	Uranium ore, sand and gravel, perlite, stone.
Undistributed [1]	r 18,777,866	16,678,556	
Total	r 773,120,000	820,327,000	

r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Includes gem stones that cannot be assigned to specific counties, and values indicated by symbol W.

value. Output from five operations was used for paving.

Production of tin was discontinued; the jig plant of Tinco, Inc., was dismantled and sold. A small shipment of tin concentrates resulted from cleanup operations.

No salt was sold by Curtis Salt Co. before the property, near Quemado, was sold to Southwest Salt Products Co. in May. The new company began constructing facilities to mine the salt directly from the bottom of a lake that occupies the crater of an extinct volcano. A barge was to move slowly across the lake carrying apparatus for cutting the salt and for pumping it by means of a floating pipeline to screen and washing operations on the shore. Most of the output was to be used by uranium-processing companies; some was to be used by water-softening companies. Salt also was to be recovered by solar evaporation, mainly for use as livestock feed and in highway deicing.

No production of copper, gold, or silver was reported. Ores of these metals had been produced from the Bearup mine in the Mogollon district in 1965.

Chaves.—A decline of $4.3 million (19 percent) in the value of mineral production was the result of a decrease in petroleum output; the slight increase in marketed natural gas failed to offset in value the 1.7-million-barrel decrease in output of crude oil. Success ratio for the 38 exploratory wells in the county was 21 percent. A significant discovery was that of Pan American Petroleum Corp., D.C. Baskett No. 1 well, sec 11,T8S, R30E, which was completed for a flow gage of 322 barrels of 27° API oil per day from the San Andres formation; the discovery was believed to be on trend with the Chaveroo field to the east. Development drilling in the county was successful with 78 oil wells resulting from a total of 93 wells drilled; this was up markedly from the 36 successes out of 56 wells for 1965.

Other than petroleum and natural gas, which accounted for 96 percent of the mineral output value of more than $17 million, only sand and gravel and stone were produced. Sand and gravel, produced at 10 operations, the same number as in 1965, was used in building and road construction. Armstrong & Armstrong was the principal commercial producer. Crushed limestone and miscellaneous stone were produced for use in concrete or as roadstone.

Colfax.—Operations began at the York Canyon coal mine of Kaiser Steel Corp., 36 miles southwest of Raton. Annual production from the new underground mine was to reach 700,000 tons, compared with previous output of about 400,000 tons per year from the company's nearby Koehler mine. The high-grade coking coal from the York Canyon mine was shipped by unit train, in custom-built, 100-ton railroad cars, to the company steel mill at Fontana, Calif. The mine was being developed by driving four adits into the 84-inch York seam. Operations were highly automated; continuous miners were used, and the coal transported by conveyor to the mine mouth for crushing. The new 400-ton-per-hour-capacity washing plant provided a sized, washed, and dewatered product. Coal, discharged from the plant, was dropped from a 160-foot tower to form a cone-shaped stockpile directly over a loading tunnel.

Julius Seidel produced coal from the Franks No. 1 mine. Output of about 4,000 tons was from the 36-inch Yankee seam. Sand and gravel and stone were produced from three operations. The sand and gravel was used in highway construction. Limestone was quarried for use as riprap and as roadstone or concrete aggregate.

Dona Ana.—Sand and gravel from 15 operations amounted to 96 percent of the mineral output value; most of the output was by Government-and-contractor producers. Material used for paving constituted 97 percent of the tonnage produced.

Volcanic cinders, used mainly as concrete aggregate, were produced by Volcanic Cinder Co. and Builders Block & Supply Co., Inc., which also sold cinders for use in asphalt and for landscaping and roofing aggregate. Coconino Stone Co. produced pumice for use as concrete aggregate.

Output of stone decreased 93 percent in value, to $23,000. The U.S. Army Corps of Engineers and the State highway department used 68 percent of the output—crushed limestone—for riprap and for concrete or roadstone. Builders Block & Stone and Robert & Juan Singh produced crushed and dimension miscellaneous stone.

Eddy.—Value of production increased for all mineral commodities except potassium salts (potash). The county was ranked second in total value of mineral production.

Output of potash increased 2 percent, but value of production declined 9 percent. Production by Duval Corp. was from the Nash Draw, Saunders, and Wills-Weaver mines. Products of the refinery, located at the Saunders mine, were muriate of potash, sulfate of potash-magnesia, and sulfate of potash. Output from the Saunders and Wills-Weaver mines was mainly the potash mineral sylvite (KCl), and output from the Nash Draw mine was langbeinite (a potassium-magnesium sulfate). The sylvite was refiined by standard flotation methods, but the langbeinite was refined by a crystallization process utilizing the different rates of solution between chlorides and sulfates. Facilities at the recently developed Nash Draw mine, which was the southernmost operating mine in the area, included separate storage bins for the langbeinite, which occurred on the 1,075-foot level, and for sylvite, which occurred mainly on the 900-foot level. Ore mined on the lower level was transported by inclined conveyor belt to the 900-foot level where the crusher was located.

International Minerals & Chemical Corp. (IMC) mined sylvite-langbeinite from the 800-foot level, langbeinite from the 850-foot level, and sylvite from the 900-foot level of its mine. The IMC mine was the only one in the area where production was from several levels. Products were muriate of potash, potassium sulfate, and potassium magnesium sulfate.

Kermac Potash Co. completed the first full year of production. Sylvinite ore, which is a combination of sylvite (KCl) and halite (NaCl), was mined by both continuous mining and conventional mining methods from a depth of 1,625 feet. White crystallized muriate of potash was produced at the refinery.

National Potash Co. continued operations at its Eddy mine; output was shipped by rail 15 miles to its refinery in Lea County. Freeport Sulphur Co. assumed full ownership of National Potash upon acquiring the Consolidation Coal Co. 50-percent share of the operations.

Potash Corporation of America produced muriate of potash from ore occurring 1,000 to 1,400 feet deep. Continuous miners, developed by the company, removed the ore in an advance-retreat method that resulted in an extraction rate of about 90 percent. Flotation was used to process the ore.

Southwest Potash Corp., Amax Chemical and Petroleum Division, American Metal Climax, Inc., continued to produce red muriate of potash by the flotation process. The company used the room-and-pillar method of advance and retreat by undercutting, drilling, and blasting. Principal haulage was by rail, as contrasted with the more common conveyor haulage at other operations.

U.S. Borax granted a 2-year option to a group of Carlsbad investors to purchase the company potash operations in New Mexico. Reportedly, high-grade reserves were nearing exhaustion, and new facilities would have to be constructed to process the large low-grade reserves. U.S. Borax was the first company to begin operations in the Carlsbad area; production began in 1931 when the company was called U.S. Potash. The company was to concentrate activities at its Canadian potash holdings.

Salt production increased and the county accounted for all of the State output. The production was obtained from tailings at potash refineries, except for some brine obtained from open lakes by Pioneer Water Co., Inc. Pioneer Salt Co. resumed rock salt production in July, following completion of a new drying, screening, and bagging plant, which replaced the one destroyed by fire. Other producers were The Great Salt Lick, Inc., and Williams Salt Co., producers of rock salt, and New Mexico Salt Co. and The Salt Supply Co., Inc., producers of rock salt and pressed blocks. The Salt Supply Co. also produced solar-evaporated salt used for oil refining. Livestock feed accounted for the major part of the total salt output. Other uses were for ice manufacture or cold storage, paper manufacture, water softening, and highway deicing.

Sand and gravel and stone were produced at five and six operations, respectively. The sand and gravel was used for highway construction, as was most of the crushed limestone and miscellaneous stone. A small amount of stone sand was produced.

Output of all the hydrocarbons was higher than during the previous year: Petroleum was up 10 percent, marketed natural gas more than doubled, and natural gas liquids increased 39 percent. Value of production was $51 million, $10 million, and

$4 million, respectively, for the three commodities. The increase in natural gas and natural gas liquids was attributed to development of the Indian basin gasfield.

Overall drilling was down slightly from that in 1965; the decrease was in development drilling: 124 wells compared with 143. Wildcat drilling was up by nine wells and resulted in seven oil and three gas discoveries. The discoveries included the new pay discovery at the Big Eddy oilfield, the Winchester oilfield (J. C. Williamson, State No. 1-A well), and the Hackberry Hills Unit gas discovery by Sinclair Oil & Gas Co. (initial flow gage 14 million cubic feet per day).

Two men were burned critically in a gas-well fire about 15 miles northeast of Carlsbad. The well, Stoltz Oil Co., No. 1 Hudson-Federal, blew out and caught fire; after burning for a week at an estimated rate of 30 to 40 million cubic feet of gas per day, the fire was brought under control and extinguished. Cost of extinguishing the fire was about $750,000.

Grant.—Value of mineral production increased $5 million, or 6 percent, due to expanded outputs of copper, molybdenum, and lime. Kennecott Copper Corp. produced all of the molybdenum, lime, and most of the copper.

Except for copper, which increased 12 percent, output value declined for gold to $131,600 (a decrease of 19 percent), silver to $176,520 (30 percent), lead to $191,265 (76 percent), and zinc to $8.1 million (21 percent). The declines were mainly the result of two factors. The first was the continued shutdown of the Ground Hog mine of Asarco. This mine, idled by a labor dispute in mid-1965, was a major source of lead, silver, and zinc. The second factor was the decline in output from the Kearney mine, scheduled to be closed early in 1967.

The major new development affecting county mineral production was the announcement by Phelps Dodge Corp. of a $100 million copper-mine project. The company planned to open a large open pit at the old mining camp of Tyrone. Annual output of 55,000 tons of copper was expected, with full operation in 3 to 4 years. A rail spur to the mine site was to be completed by March 1967, and removal of overburden expected to begin in April 1967. Fifty million tons of over-burden were to be removed. Construction of shops, a rail haulage system, and a 25,000-ton-per-day concentrator were to be undertaken before the start of mining. Concentrates were to be shipped to the company smelter at Douglas, Ariz., and thence to the company electrolytic refinery at El Paso, Tex.

At the Kennecott Copper Corp. Chino Mines Division operations near Santa Rita, increased copper-precipitate recovery was accomplished by changes in the precipitation process. A pressurized system was installed to obtain greater efficiencies in recovery of copper dissolved in solutions percolated through low-grade mine dumps. Another improvement was the installation of a faster method for drying the precipitated copper. Changes at the company mill, smelter, and refinery complex near Hurley included start of construction on a 625-foot smokestack, augmenting the existing 500-foot stack. The project, including repairs on the old stack, was to take 2 years.

According to the company annual report, Kennecott Copper mined and milled 8.1 million tons of 1.02 percent copper ore and produced, from flotation and precipitation, 105.3 million pounds of copper. These figures compare with 7.9 million tons of 1.04 percent ore mined and milled, and 90.9 million pounds of copper produced in 1965. As of March 1, molybdenite, recovered as a byproduct, was shipped to the company plant near Salt Lake City, Utah, for further treatment. Previously, it had been sold to steel plants for use in making alloy steel.

Construction and development neared completion at the John H. Trigg copper leaching sites near Tyrone. Leaching plants at the Copper Leach and Copper Mountain properties were virtually completed. Full-scale production was to begin in 1967.

Other than at the Kennecott Copper Corp. operations, copper was produced from 8 lode mines and 15 leaching operations. The underground mines also were the source of gold, silver, lead, or zinc.

These mines, and the metals produced in order of value, were the Continental mine of USSR&M Co. (partly leased)—copper, zinc, gold, and silver; the Hanover mine of The New Jersey Zinc Co.—zinc, lead, silver, copper, and gold; the Jim Crow mine operated by Grant County Mining Co. in the Steeple Rock district—silver, gold, and

copper; the Kearney mine of American Zinc, Lead and Smelting Co.—zinc, lead, copper, silver, and gold; the Oswaldo mine operated by The New Jersey Zinc Co.—zinc, lead, silver, copper, and gold; the Princess mine of USSR&M Co. (leased to Frank Van Cleave)—zinc, copper, silver, gold, and lead; the Royal John mine operated by West America Mining & Milling, Inc., in the Swartz district—zinc, lead, and silver; and the Silver King mine of Silver King Mining Co.—silver, zinc, copper, lead, and gold. The major underground copper production was from a part of the USSR&M Co. Continental mine, leased to L. A. Patten & Associates. The ore was treated at the USSR&M Co. flotation mill near Vanadium, as was zinc ore from the Princess mine. Reportedly, this mill was to be closed upon completion of the Continental mine-mill project.

USSR&M Co. continued development at its Continental mine copper-zinc project near Fierro. During the year, the No. 3 shaft was completed to a final depth of 1,468 feet; a 3,300-foot crosscut between the No. 2 and No. 3 shafts and another crosscut between the No. 3 and No. 4 shafts were completed. Shaft stations were cut on the 850-, 1,000-, 1,150-, and 1,300-foot levels. Surface facilities were completed at the No. 3 shaft, and construction began on the concentrator that was to have a daily capacity of 3,000 tons of ore. Consideration was being given to recover magnetite from the ore, in addition to copper and zinc. Production was to begin in 1967.

Ore processing mills operated in the county, other than that of Kennecott Copper Corp., were the Hanover mill of The New Jersey Zinc Co. and the Bayard mill of USSR&M Co. Ore from the Kearney mine was treated at the Peru mill of American Zinc, Lead and Smelting Co. at Deming in Luna County.

Luck Mining Co. continued to produce ferruginous manganese ore from open pits at Silver City. All output was shipped to the CF&I steel plant at Pueblo, Colo.

Limestone was quarried by Kennecott Copper Corp. for use as a smelter flux and for manufacturing lime used in the flotation circuits and for water purification. Other limestone was produced mainly for use in road building. Mathis & Mathis produced some rough-dimension dolomite. Sand and gravel output was used for road and building construction. There were three stone and four sand and gravel operations.

Harding.—The only mineral production, carbon dioxide declined 7 percent and was from wells operated by R. W. Adams, Carbonic Chemicals Corp., and Schwartz Carbonic Co.

Hidalgo.—Value of mineral output increased. The county was ranked first in value of gold production ($189,700), and second in silver ($90,850) and copper ($1.8 million). Output of these commodities increased.

In late December, Banner Mining Co. closed its Bonney-Miser's Chest mine and mill near Lordsburg, which the company had operated since 1935. More than 2 million tons of ore containing copper, silver, and gold had been mined during the 31-year period. Increased costs and controlled prices caused the shutdown. About 100 persons were employed at the operation. Federal Resources Corp., Salt Lake City, Utah, negotiated with the company for an exploration-option agreement to resume operation of the properties. According to the company annual report, from 74,702 tons of ore, concentrates containing 2.6 million pounds of copper, 1,384 ounces of gold, and 28,911 ounces of silver were produced.

Diversified Mines, Inc., operated the "85" mine under lease from Phelps Dodge Corp. The mine was the major source of gold produced in the State and was exceeded only by the Kennecott Copper Corp. Chino mine in output of silver. The ore, also containing some copper, was shipped to the El Paso, Tex., copper smelter as flux ore.

Don Still operated the Crystal mine in the San Simon district. Lead-zinc ore containing gold, silver, and copper was shipped for custom milling. Herbert Johnson mined ore containing silver, lead, and zinc from the Red Hill mine in the Gillespie district.

Sand and gravel from two operations was used for paving and building construction. Phelps Dodge Corp. produced clay for use as a furnace stop.

Lea.—Mineral production valued at $325.3 million, ranked the county first in the State in total mineral output as well as in production of petroleum, marketed natural gas, and natural gas liquids. Crude oil

output was valued at $238.4 million, up nearly 5 percent from 1965. Marketed natural gas declined slightly as did natural gasoline, but output of LP gases was 1 percent higher.

Total drilling in the county accounted for 23 percent of the Statewide drilling. Both exploratory and development drilling, however, were much less than in 1965; down 26 percent and 35 percent, respectively. One of the two gas discoveries was the very significant Cotton Draw gas field.

National Potash Co. continued to operate the Lea potash mine and refinery. Output of the mine was mixed with ore from the company Eddy mine (Eddy County). At the refinery, flotation accounted for about 84 percent of production, and crystallization the remainder. "Red" and "white" muriate of potash were the products of flotation and crystallization, respectively.

Miscellaneous stone, valued at $350,000, was produced by the county and State highway departments. Sand and gravel output from two commercial operations was used for paving and building construction.

Lincoln.—Value of mineral production declined. Stone from three operations comprised 82 percent of mineral output value. Twin Peaks Products Co. quarried basalt for use as dimension stone and for landscaping. Two companies produced crushed limestone used in concrete or as road metal.

Other minerals produced included magnetite iron ore mined from the Yellow Jacket mine by Dotson Minerals Corp. The ore, after being upgraded by magnetic separation, was sold for use in cement manufacture and as a heavy aggregate to increase density of atomic shielding. Silver Bar Mining Co. produced ore containing gold, silver, copper, lead, and zinc from the Bird mine in the Nogal district. Little Idaho Mining Co. also produced ore containing silver and lead. Ruidoso Gravel Service mined building gravel.

Exploration and development were undertaken at various old mining districts including the Jicarilla placer district and the White Oaks gold-tungsten district.

Luna.—Total output value declined; however, clay increased slightly. Most of the decline was the result of decreased output of sand and gravel and crushed limestone used in highway construction. William H. Thomas Stone Quarries produced some dimension sandstone. Mathis & Mathis produced clay for use as "Sagger Pins"—a refractory use.

Los Angeles By-Products Co. completed construction of a tin-can shredding plant at Deming. Most of the output of shredded metal was used by Phelps Dodge Corp. at copper-precipitation operations in Arizona. Raw material, shipped to the plant by railroad from out of State, consisted of detinned metal, mainly in the form of can stampings. The metal was shredded to enable optimum contact by copper-bearing solutions.

McKinley.—Mineral-output value was about the same as in 1965. The county again was the source of most of the uranium ore mined in the State; value of production was $30.9 million. Approximately 1.8 million tons of uranium ore was produced at 47 operations, compared with 1.7 million tons of ore from 41 operations in 1965. Activities continued at the uranium processing mill of Kerr-McGee Corp. Claim staking, exploration, and development activities increased as favorable market indications began to appear. Scattered tracts of Navajo Indian land, which possibly contained significant uranium-ore occurrences, were leased late in the year. The 193 tracts consisted of more than 30,000 acres. Annual rentals and royalties from any future uranium production were to be paid to the 250 Navajo families who owned the land.

Along with other mining methods, "jack stoping," a modified form of longwall mining, was used at Kerr-McGee mines for ore bodies less than 8 feet thick. The method was more efficient than the standard open stoping in general use. Three rows of hydraulic jacks were placed parallel to the ore face to be mined. Six-foot-deep cuts across the face, parallel to the development crosscuts, were drilled and blasted; the ore was slushed out. The rear line of jacks was then advanced to within 6 feet of the new ore face, and the mined-out area was allowed to cave.

Kerr-McGee Corp. again recovered byproduct molybdenum at its processing operations. The molybdenum occurred in small amounts in sandstone uranium ores from McKinley County.

Liquids resulting from uranium processing, containing significant vanadium, were shipped to processing plants having vana-

dium-recovery circuits. Output of vanadium declined somewhat.

Coal was mined mainly at the McKinley mine of The Pittsburg & Midway Coal Mining Co. northwest of Gallup; coal was also produced at the Sundance Coal Co. operations southeast of Gallup. The coal at the McKinley mine occurred as a series of seams varying in number and in individual seam thickness. The parting members also varied in thickness. Coal seams as thin as 12 inches were mined by stripping methods. A 33-cubic-yard stripping shovel was used to remove the 20 to 50 feet of overburden. Loading of coal into 30-ton, bottom-dump trucks was by a front-end loader and a 6-cubic-yard shovel. Output was sold to Arizona Public Service Co. at Joseph City, Ariz. The coal at the Sundance strip mine occured as a single 5- to 8-foot thick seam covered by 20 to 40 feet of overburden. Output was used locally.

Sand and gravel, valued at $455,000, was produced at eight operations; output was used principally for paving. Sandstone was produced for the State highway department for use as riprap, and miscellaneous stone for the Federal Bureau of Indian Affairs for concrete or roadstone. Value of stone output was $41,000. U.S. Mining Corp. produced clay for use as rotary-drilling mud.

Crude oil production from the Red Mountain field decreased by 7,400 barrels, but yield from the Hospah field was up 32,700 barrels to give the county a net increase of 14 percent. The county had 39 wildcat wells (all unsuccessful), exceeded only by Lea County with 53. The seven successful development wells were drilled in the Hospah field.

Otero.—Mineral-production value decreased 47 percent because of a decline in sand and gravel output, particularly that used for paving. There were nine sand and gravel operations; one less than in 1965. Stone produced at two operations was used in road construction.

Frazier Enterprises produced ore containing a small amount of silver and copper from the Shay mine about 10 miles north of Orogrande. Construction began on the Cameron Mineral Corp. copper flotation mill. Ore for the mill was to come from the Shay mine initially at about 125 tons per day. Some gold and silver was recovered. Open-pit mining of the 2.75 percent copper ore from the limestone-replacement ore body was to begin in 1967.

Rio Arriba.—Value of mineral production was 11 percent lower than the 1965 figure. Output of petroleum and natural gas declined from that of 1965, but natural gas liquids increased slightly. Marketed natural gas was valued at $6.9 million compared with $8.3 million for the previous year; this remained, however, the most valuable mineral commodity in the county. Value of LP gases was 21 percent greater than in 1965.

Output of sand and gravel, pumice, stone, and mica decreased. Ninety percent of the sand and gravel, produced at eight operations, was used in highway construction and the remainder for building construction. Pumice was mined by General Pumice Corp. and sold for use in cleansing or scouring materials and for concrete aggregate. Crushed decorative sandstone was produced by Petaca Mining Corp. and by John W. Moran. The latter also mined scrap mica, which was sold for use in paint manufacture. Miscellaneous stone, used to check erosion, was produced for the State highway department.

Construction was a year ahead of schedule on the $89 million San Juan-Chama diversion project. Excavation of the 13-mile-long Azotea tunnel was expected to be essentially completed by the end of 1967. The diversion project is in the northern part of the county, and in southern Colorado.

Roosevelt.—Value of mineral production increased $6 million, and was 1.7 times the 1965 figure. As was expected from the rapid development of the Chaveroo field, oil production in the county jumped 92 percent. Output of natural gas and natural gas liquids, however, declined. Higher unit prices for LP gas caused an increase in output value of this commodity even though quantity decreased. Largely because of development of the Chaveroo field, development drilling in the county totaled 206 wells compared with 84 in 1965; 200 of the wells were successful (97 percent). Exploratory drilling, also influenced by the Chaveroo successes, amounted to 30 wells compared with 13 the previous year; only 2 of the 30 wells were successful.

Sand and gravel and stone were pro-

duced at one operation each. Output of sand and gravel was used for building construction, and the miscellaneous stone was produced for the State highway department for use as concrete aggregate and road metal.

Sandoval.—Except for petroleum output, production increased for all mineral commodities. Stone was produced; no production had been reported in 1965. The net result was an increase in production value of 32 percent to a total of more than $1 million.

Gypsum was mined at the San Ysidro open-pit mine by White Mesa Gypsum Co. The crude gypsum was crushed and screened, and the coarse size, constituting most of the production, was trucked to the American Gypsum Co. wallboard plant at Albuquerque. Some of the fine-screen material was sold locally as a soil conditioner. Gypsum mined by Duke City Gravel Products Co. was used at the Ideal Cement Co. plant near Albuquerque.

Sand and gravel, all for paving, was produced at seven operations. Stone output used as riprap consisted of basalt produced for the U.S. Army Corps of Engineers, limestone produced for the State highway department, and miscellaneous stone produced for the Federal Bureau of Public Roads.

Construction began at the Elena Mining Corp. copper leaching plant south of Cuba. Output of sponge copper was expected to begin in 1967. Copper ore, containing some silver, was to be mined from the San Miguel property, about 8 miles east of the plant site.

Output of crude oil continued to decline —down 30 percent from that of 1965. Drilling activity was 14 wells compared with 8 the previous year, but results were the same, 3 gas development wells.

San Juan.—Mineral production value exceeded $100 million for the first time, and was greater in only two other counties—Lea and Eddy. The county continued to rank second in the State in natural gas and third in crude oil production. Output of petroleum, valued at $27.6 million, declined slightly, probably as a result of reduced drilling in previous years. Marketed natural gas, valued at $53.0 million, and LP gases, valued at $12 million, had higher production (9 and 11 percent, respectively) than during 1965. It was anticipated that the FPC decision opening the southern California gas market to gas from the San Juan and Permian basins would result in an even larger yield of these commodities in future years.

Overall drilling in the county was 29 percent higher than in the previous year, with exploratory drilling up 9 wells and development drilling up 56. The wildcat activity was more successful than during 1965 (18 percent compared with 7 percent); the development drilling resulted in 240 new gas wells—plus 6 oil wells—which was reflected in increased gas production.

Utah Construction & Mining Co. contracted to supply coal for additional generating units to be constructed at the Four Corners powerplant. Two 755,000-kilowatt units, to be completed by 1969 and 1970, would bring total generating capacity to 2,085,000 kilowatts, at the plant of the six member Western Energy Supply and Transmission Associates (WEST). Arizona Public Service Co. was to operate the plant and take 15 percent of the power; Southern California Edison Co. was to receive 48 percent of the power. Other members were to be Public Service Company of New Mexico (13 percent), Tucson Gas and Electric Co. (7 percent), El Paso Electric Co. (7 percent), and the Salt River Power District (10 percent). Cost of new investment in the plant and mine was expected to be about $191 million.

The coal agreement called for deliveries over a 35-year period and a 15-year extension option. Coal was to be supplied from the Navajo strip mine just east of the powerplant. Current output of about 2.5 million tons per year was to be increased to 8.5 million tons. The mine would become the largest coal mine in the United States. Royalty to the Navajo Indians, on whose land the coal occurs, was to be 15 cents per ton of coal mined from the first 25,000 acres that were leased.

Operations continued at the VCA uranium-vanadium ore processing plant near Shiprock. Feed for the mill consisted of uranium ores, some of which contained vanadium, and vanadium-rich solutions from uranium mills not having vanadium recovery circuits. Raw material for the plant came from New Mexico, Arizona, Colorado, and Utah. Production value of vanadium decreased 73 percent. Uranium

production value increased 46 percent. Ores were produced at five operations, one more than in 1965.

Sand and gravel production, from 11 operations, was valued at more than $1 million, more than double the 1965 value. Eighty-nine percent of the 1.2 million tons produced was used for paving. Production for the New Mexico State Highway Commission accounted for most of the output. Allison & Haney, Inc., was the major commercial producer. Sandstone was produced for the State highway department, and miscellaneous dimension stone was quarried by J. W. Jones Construction Co.

San Miguel.—Stone production valued at $1.5 million, compared with only $40,000 in 1965, came from seven operations, an increase of three. Sand and gravel, the only other mineral commodity produced, declined in value from $770,000 to $110,000 and came from eight operations. Eighty-nine percent of the sand and gravel output was used for paving, the remainder for construction and fill. The New Mexico State Highway Commission used crushed limestone and sandstone valued at $866,000 and $472,000, respectively, accounting for most of the production increase. New Mexico Granite Co. produced granite for dressed monumental stone. Output of crushed and broken sandstone, used for riprap, was reported by Atchison, Topeka & Santa Fe Railway Co. Vegas Ready Mix Concrete Co. produced crushed limestone for use in concrete or as roadstone.

Santa Fe.—Total value of mineral production increased 7 percent. Sand and gravel output value, from 10 operations, was $529,000, 57 percent of the total. Paving utilized 86 percent of the sand and gravel output. Atowi Materials, Kauffman Trucking Co., and Santa Fe Sand & Gravel Co. were the commercial producers. Miscellaneous stone production, valued at $3,000, was used by the State highway department for plating and erosion control.

Output of pumice and scoria was valued at $294,000. Copar Pumice Co., Inc., at the company plant near Pojoaque, crushed and screened pumice from its open pit mine near Los Alamos. A carload of pumice was used for testing as firewall brick, and reportedly excellent results were obtained. James H. Rhodes & Co. purchased pumice and dried, crushed, and screened it at its plant south of Santa Fe. The product was bagged and sold mainly for use in soaps and cleansers. Kauffman Trucking Co. also produced pumice for landscaping and roofing material. Crego Block Co., Inc., mined scoria and shipped it to its building-block plant in Albuquerque.

Production of wallboard continued at the Rosario plant of Kaiser Gypsum Co., Inc. Crude gypsum was obtained from a quarry located at the plant.

M.I.C.A. mined scrap mica (sericite) in Taos County, and processed it at its dry grinding plant near Pojoaque. All of the production was sold to paint manufacturers.

Silver Bar Mining Co. produced ore containing copper, gold, and silver from the San Pedro mine in the Cedar Crest district; output was valued at about $19,000. Lone Star Mining & Development Co. produced uranium ore at the La Bajada No. 1 mine.

Sierra.—Sand and gravel from four operations accounted for most of the total mineral output value. Paving gravel produced for the State highway department represented 98 percent of the output. The only stone produced was a small amount of limestone quarried for the State highway department for use as riprap. Associated Materials Co. produced gypsum for agricultural use.

Output of metals included a small amount of tin produced by Anommco, Inc. The company operated a jig plant at placer properties about 25 miles west of Winston. Jimmy Zook produced ore containing a small amount of silver from the Little Boy Blue mine in the Chloride district. Barefoot Mining Co. began construction of a mill to treat gold ore from a proposed open pit near the old Rattlesnake mine east of Hillsboro. Daily capacity of the mill was to be 200 tons of ore.

Socorro.—Value of mineral output, $1.2 million, was less than that for 1965. Gold, silver, copper, lead, and zinc produced from the Magdalena district was the source of 59 percent of the value of mineral yield. The principal producer in the district was L. A. Patten & Associates who operated the Linchburg mine leased from The New Jersey Zinc Co. The ore was shipped to the Hanover mill in Grant County. The major source of lead produced in the State, the mine was ranked fourth in silver and fifth

in value of zinc production. Eight mines were operated in the Magdalena district.

Manganese ore was produced at the Black Canyon underground mine operated by L. A. Goret & Valente Aguilar. Output was crushed, screened, and graded at the partnership plant near Socorro. Late in the year, mining operations were transferred to the adjacent leased properties of Tower Mining Co. Access to the ore body was through the Nancy mine tunnel. Iron ore produced by Dotson Minerals Corp. from the Jones mine was used in cement manufacture.

Sand and gravel and stone—five and four operations, respectively—were the nonmetal mineral commodities produced. Paving gravel produced for the State highway department was 296,000 tons of the total sand and gravel output of 323,000 tons. Most of the stone produced was crushed and broken limestone and miscellaneous stone used in road construction. Sandeno Stone Co. produced a small amount of sandstone for use as rubble.

Taos.—Mineral production increased more than fourfold to a total value of more than $15 million. The increase was attributed mostly to start of operations at the Questa open-pit molybdenum mine of Molycorp. According to the company annual report, full-scale, continuous operations began in April, and the concentrating mill maintained an average ore processing rate of 10,735 tons per day for the remainder of the year. The latter part of the year, mill throughput averaged more than 11,000 tons per day and mill recovery improved. Annual recovery of 10 million pounds of molybdenum was expected.

Molybdenum had been mined previously at the Questa mine site, with more than 18 million pounds of molybdenite produced between 1923 and 1956. In 1954, an underground exploration program was begun to determine the extent of the large low-grade ore occurence, and in the 1957–60 period, extensive underground exploration was undertaken by the company and the Federal Government as part of the Defense Minerals Exploration Administration program. Metallurgical testing began in 1963, a surface drilling program was started, and a 100-ton-per-day pilot plant was constructed. Contract stripping of waste and construction of the mill began in 1964. Overburden of 9.5 million tons was removed before mining started. In addition to this capping, more than 62 million tons of waste was to be moved. The overall stripping ratio was expected to be 3.49 tons of waste for every ton of ore.

Perlite accounted for most of the value of other minerals produced; output increased 6 percent. General Refractories Co. acquired the Mining & Mineral Products Division of Great Lakes Carbon Corp., one of the three perlite producers in the No Agua area. The others were Johns-Manville Perlite Corp. and United Perlite Corp. The companies operated crushing, drying, and screening plants near the open-pit mines. The output was shipped to out-of-State expanding plants.

The To-Jo mica mine was leased by M.I.C.A. Ripping by a bulldozer was the only mining procedure required. The scrap mica (sericite) was screened before being shipped to the company grinding plant in Santa Fe County. Sand and gravel output, valued at $120,000, was used for paving, building, and for fill. Sandeno Stone Co. produced a small amount of dimension sandstone used as rubble. Louis O. Romero produced clay for building brick.

Torrance.—Mineral production increased slightly. Paving sand and gravel, a small amount of miscellaneous stone for erosion control, and iron ore were the only commodities produced. Dotson Minerals Corp. mined magnetite from the Scholle mine. The upgraded output was sold for use in cement manufacture.

Union.—Mineral output, in order of production value, consisted of pumice (scoria), sand and gravel, and carbon dioxide. Pumice produced by Patterson Mining Co. and Twin Mountain Rock Co., was sold for use as concrete aggregate, railroad ballast roofing material, and for use on running tracks. Most of the sand and gravel was used for paving by the State highway department.

Emerald Carbonic Division of Frick Co. manufactured dry ice (carbon dioxide) at the company plant near Des Moines. Daily capacity of the plant was increased from 20 to 100 tons.

Valencia.—Mineral production value increased 12 percent; the county was second in the value of uranium ore output. Ores from the Ambrosia Lake district in McKinley County were treated at the Homestake-

Sapin Partners mill. The mill was operated at maximum capacity; some uranium concentrates were stockpiled in anticipation of private-purchase contracts. The Anaconda Company continued to ship ore from the Jackpile-Paguate open-pit mines to the company mill near Grants. United Nuclear Corp. made shipments of ore from the San Mateo mine.

United States Gypsum Co. mined perlite from a mine 9 miles northeast of Grants. The material was crushed and sized at the company plant at Grants and shipped to company-owned plants in other States. Because of the proximity of the plant to residential and business areas, tailings or rejects were trucked 4½ miles for disposal on leased land.

Sand and gravel was produced at eight operations. Nearly all of the output of 2 million tons was used for paving by the State highway department. Belen Sand & Gravel Co. and Tabet Lumber Co. were the commercial producers. Marbleized travertine quarried by Ultra Marbles, Inc., was shipped to the company Albuquerque finishing plant. Dimension sandstone was quarried by Sandeno Stone Co.; limestone and sandstone were produced for the State highway department.

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 James R. Kerr [1]

The value of New York's mineral output exceeded $300 million for the first time, increasing $11 million over that of 1965. A high level of construction activity, particularly in the early months of the year, was responsible for the strong markets for stone, sand and gravel, and lightweight aggregate produced from clay and shale. Residential construction decreased slightly from that of 1965 but there were strong increases in nonresidential building and highway construction. An active chemical industry was reflected in increased consumption of lime and salt. Output of zinc was at a record high and recovery of by-product lead and silver sharply increased over that of 1965. The State continued to lead the Nation in production of talc and wollastonite and to be a major producer of zinc, cement, salt, sand and gravel, and stone.

Trends and Developments.—Top priority was given to programs to study the State's water resources, with special emphasis on water pollution control. The State Water Resources Commission completed a 6-month reconnaissance survey to determine, by river basin, statewide water supply

[1] Supervisory mining engineer, Bureau of Mines, Pittsburgh, Pa.

Table 1.—Mineral production in New York [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	1,354	$1,717	1,464	$1,726
Emery—short tons	10,720	204	11,102	210
Gem stones	NA	10	NA	10
Gypsum—thousand short tons	662	3,511	559	2,998
Lead (recoverable content of ores, etc.)—short tons	601	188	1,097	332
Lime—thousand short tons	W	W	1,096	9,870
Natural gas—million cubic feet	3,340	1,029	2,699	837
Peat—short tons	25,098	232	27,211	250
Petroleum (crude)—thousand 42-gallon barrels	1,632	7,246	1,735	7,925
Salt—thousand short tons	5,002	35,771	4,980	36,203
Sand and gravel—do	39,225	40,370	41,903	43,091
Silver (recoverable content of ores, etc.) thousand troy ounces	11	15	22	28
Stone—thousand short tons	30,801	48,675	34,130	54,543
Zinc (recoverable content of ores, etc.)—short tons	69,880	20,405	73,454	21,302
Value of items that cannot be disclosed: Abrasive garnet, cement, iron ore, talc, titanium concentrate, wollastonite, and values indicated by symbol W	XX	130,684	XX	121,939
Total	XX	290,057	XX	301,264

W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed."
NA Not available. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

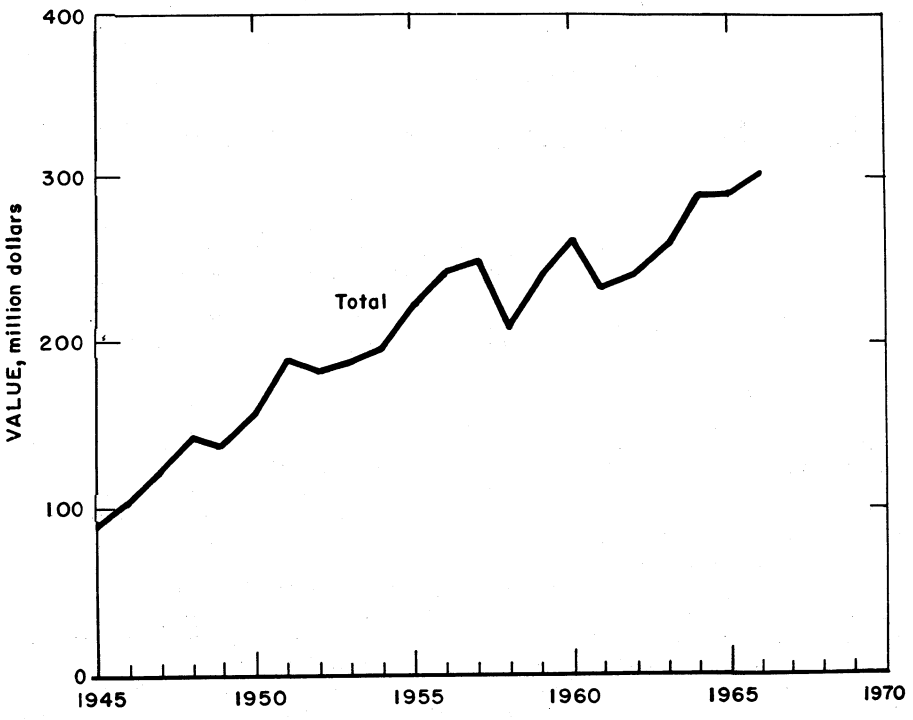

Figure 1.—Total value of mineral production in New York.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Millions)

Year	Value [1]
1957	$245
1958	207
1959	237
1960	254
1961	228
1962	236
1963	254
1964	278
1965	280
1966	[p] 287

[p] Preliminary.
[1] Data for 1957, 1959–65 revised.

needs. Many other State, interstate, and Federal water resource programs were underway. Federal Water Pollution Control Administration studies on The Hudson-Mohawk River Basin-Long Island-New Jersey coastal water region were aimed at preventing water quality degradation. The same agency was conducting Great Lakes pollution control studies. The U.S. Geological Survey and the U.S. Army Corps of Engineers carried out continuing studies on water resources, water flow, and pollution abatement.

Work advanced on Niagara Mohawk Power Corp.'s Nine Mile Point nuclear power plant. Cooling water intake-discharge tunnels 1,780 feet in length were completed. The tunnels, which extend 500 feet from shore into Lake Ontario, will have the capacity to carry 250,000 gallons per minute of lake water to condense steam from the turbine before its return to the nuclear reactor.

Corning Glass Works announced plans to build a plant about 8 miles southwest of Canton in St. Lawrence County for the manufacture of fused silica products. Manufacturing operations were expected to start by the end of 1966.

National Lead Co. announced plans to expand operations at its Albany Nuclear Metals Division plant. The company purchased and transported to Albany the equipment of Sylvania's Sylco Division at Hicksville. The newly equipped plant will fabricate aluminum and stainless steel-clad metallic uranium fuel.

Table 3.—Employment 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
1965:								
Metal	1,732	265	459	3,671	1	59	16.34	4,114
Nonmetal	2,375	258	614	5,019	---	139	27.70	1,268
Sand and gravel	1,672	196	328	2,709	3	48	18.82	7,278
Stone	3,603	256	921	7,547	---	88	11.66	1,246
Peat	19	149	3	23	---	---	---	---
Total	9,401	247	2,325	18,969	4	334	17.82	2,667
1966: p								
Metal	1,675	279	467	3,743	4	48	13.89	9,479
Nonmetal	2,475	256	635	5,134	2	128	25.32	3,079
Sand and gravel	1,625	203	330	2,727	2	57	21.64	4,893
Stone	3,725	266	991	8,141	2	131	16.34	2,411
Peat	11	191	2	17	---	---	---	---
Total	9,511	255	2,425	19,762	10	364	18.93	4,264

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—New York continued to rank fifth in the Nation in shipments of cement, and the commodity continued to rank first among the State's mineral industries with valuation in excess of $75 million. Combined shipments of all types of cement increased slightly over those of 1965, but total value decreased because of lower prices for portland and masonry cements. The average price of portland cement dropped $0.05 to $2.63 per barrel. As recently as 5 years ago (1961) the average value of portland cement in New York was $3.39 per barrel. Portland cement was the leading type of cement produced, accounting for 97 percent of the cement value. Shipments of masonry cement decreased slightly and the average price declined $0.10 per barrel to $2.36. Natural cement shipments declined 17 percent but the average selling prices remained at the 1965 level. Thirteen cement plants were in operation of which 11 were in eastern and 2 in western New York. Seven of these plants produced both portland and masonry cement, four produced portland cement exclusively, and one produced natural and masonry cement. Eight counties had cement production; Albany County ranked first, followed by Greene, Columbia, and Ulster counties.

The principal raw materials for manufacturing portland cement were cement rock and limestone; a total of 8.2 million tons was used. Other raw materials included clay and shale (275,000 tons), gypsum (220,000 tons), sand and slag (57,000 tons), and iron-bearing materials (20,000 tons). Grinding aids, air-entraining compounds, fly ash, bauxite, and other materials also were used. Cement plants consumed 680 million kilowatt hours of electrical energy of which 97 percent was purchased; the balance was generated by the cement companies.

Of the combined portland and masonry cement shipped, 43 percent was consumed within the State. New England received 33 percent of the shipments. Nineteen States purchased New York cement and more than 25,000 barrels were exported. Ready-mixed concrete companies were the leading customers, purchasing 70 percent of the portland cement shipped. Other large consumers included highway and other contractors, concrete product manufacturers, and building material dealers. Cement was shipped by truck (69 percent), by railroad (21 percent), and by boat (10 percent). Bulk shipments composed 94 percent of the total; the balance was shipped in packaged containers.

Most of the portland cement produced was the non-air-entrained, general-use type; however, almost 3 million barrels of air-entrained general-use type and more than 1 million barrels of high-early-

strength portland cement was produced. About three-fourths of the State's cement capacity was at wet-process plants. Yearend stocks of portland cement were 31 percent higher than those of 1965.

Marquette Cement Manufacturing Co.'s new 3.3 million barrel capacity plant at Catskill went onstream in 1966. The heart of the new plant is a 550- by 18-feet rotary kiln, which replaced five smaller kilns. The plant features electronic control of the kiln, monitoring of the burning operation by closed circuit television, and quality control by X-ray analyzers. Universal Atlas Cement, division of U.S. Steel Corp. announced plans for construction of a new dust-controlled 535 foot rotary kiln to replace three small kilns at its Hudson plant. Lake Ontario Cement Co., Ltd., and its subsidiary, the Rochester Portland Cement Corp., announced the awarding of contracts for constructing an $11 million cement plant and dock facilities at Stoney Point, N.Y.

Clays.—A strong market for lightweight aggregate led to a sharp increase in production of miscellaneous clay and shale as raw material. Other large clay users, the building brick and portland cement industries, consumed 4 percent and 11 percent less clay, respectively, than in 1965. Overall clay production increased 8 percent mainly because of the increased output from Ulster County, the center of the State's lightweight aggregate industry. Albany slip clay mined in Albany County was used extensively in the ceramic mix for bonded abrasive wheels and shapes. Some of the slip clay was exported. About the same quantity of clay was used for pottery and other uses, as in 1965. The leading counties in decreasing order of tonnage of clay and shale produced were Ulster and Albany in the eastern part of the State and Erie in the West.

Emery.—The entire U.S. production of emery continued to be recovered from three open pit mines in Westchester County. Production destined for use as an aggregate for heavy-duty, non-slip floors and pavements increased 41 percent and raised the total output 4 percent over that of 1965. The quantity used for general abrasive purposes decreased sharply as the Peekskill Emery mine was closed more than half of the year because of litigation concerning a zoning conflict.

Garnet.—Production and value of garnet increased compared with that of 1965. Garnet mined in Warren County as a primary product was precisely ground and sized for use in coated abrasives and as a polishing agent for glass and metal. In Essex County, garnet was recovered as a byproduct of wollastonite mining and was sold for sandblasting, wire sawing, and coated abrasives.

Gem Stones.—Amateur gem collectors and lapidarists recovered garnet, beryl, hematite, magnetite, graphite, and quartz from many localities. The garnet mining area near North Creek in Warren County was popular with collectors.

Graphite (Manufactured).—Petroleum coke was used as raw material to produce manufactured graphite at Niagara Falls. Baked carbon was converted to graphite products such as powder, shapes, cloth, and fiber.

Gypsum.—Production of crude gypsum declined 16 percent below that of 1965. The average price per ton increased $0.07 to $5.37. Gypsum was recovered from five underground mines, three in Erie County and one each in Genesee and Monroe Counties. Most of the crude gypsum was calcined at company-owned plants for use in manufacturing wallboard and lath and in the formulation of various types of plasters. Other uses for calcined gypsum were in manufacturing plate glass, pottery plasters, industrial molding, and art and casting plasters. Some crude gypsum was used as a retarder in portland cement.

Table 4.—Crude gypsum production
(Thousand short tons and thousand dollars)

Year	Active mines	Quantity	Value
1957–61 (average)	5	807	$3,930
1962	5	601	3,122
1963	5	647	3,339
1964	5	653	3,321
1965	5	662	3,511
1966	5	559	2,998

Lime.—Production of lime increased considerably over that of 1965 as Bethlehem Steel Corp. began operating a lime plant in Erie County to supply quicklime for its basic oxygen furnaces at Lackawanna. The balance of the quicklime output was captive production by chemical companies. Quicklime accounted for about nine-tenths of the lime output. Most of the hydrated

lime was used in chemical manufacture; some was used for construction. The leading lime-producing counties were Onondaga, Niagara, and Erie. New York ranked sixth among the lime-producing States.

Nitrogen Compounds.—Atmospheric nitrogen, recovered by two companies at Niagara Falls, was used to prepare anhydrous ammonia which in turn was used in fertilizers, explosives, and other chemical and industrial applications.

Perlite.—Crude perlite mined in Colorado and Nevada was expanded at five plants; three in Erie County and one each in Genesee and Bronx Counties. The most important use for expanded perlite was in acoustical building plaster; other uses included loose fill insulation, soil conditioning, ultra-lightweight concrete aggregate, and filter aid.

Salt.—Production of salt decreased slightly from that of 1965, but its value was greater mainly because of a $0.72 per ton increase in the price of evaporated salt and a $0.23 increase in the price of rock salt. The State ranked fourth in production and third in value among the salt-producing States. There was less production of rock salt and evaporated salt; only salt in brine had a greater output than in 1965. Rock salt was used in manufacturing chemicals and for highway ice control. Evaporated salt was an important chemical raw material and was used for a wide variety of industrial and food processes. Most of the salt in brine was used in manufacturing soda ash and other chemicals. Rock salt was mined in Livingston and Tompkins Counties and salt was produced from wells in Onondaga, Schuyler, and Wyoming Counties. Output was shipped to most States in the East and Midwest.

Table 5.—Salt sold or used by producers
(Thousand short tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	3,951	$30,219
1962	4,456	32,236
1963	4,782	34,228
1964	4,816	34,216
1965	5,002	35,771
1966	4,980	36,203

Sand and Gravel.—Production of sand and gravel increased 7 percent over that of 1965. Average prices remained unchanged at $1.03 per ton. Most of the increased output was sand as more than 2 million more tons was produced to meet the increased demands chiefly of the building and fill markets. Commercial producers operated 293 pits and in addition many other locations yielded sand and gravel to highway construction companies working under contract on State and Interstate highway projects and to the crews of State and local highway departments. Three operations produced more than 1 million tons, and a total of nine operations had production in excess of 500,000 tons. Output of these nine large operators comprised 30 percent of the commercial production. Many small pits were in operation; 132 pits, each producing less than 25,000 tons, accounted for only 5 percent of the commercial output. Of the total output 83 percent was washed and screened or otherwise prepared. Nassau and Suffolk Counties ranked first and second in sand and gravel production; output was reported from 52 of the 62 counties in the State.

Stone.—The value of stone production increased by $5.9 million as 11 percent more stone was produced than in 1965. Most of the increase was attributed to greater production of crushed limestone but all types of stone, with the exception of miscellaneous stone, had increased value of production. Dutchess County ranked first among the State's 38 stone-producing counties followed by Rockland, Onondaga, and Erie. Sixteen counties had stone industries with output valued in excess of $1 million.

Crushed limestone was the leading stone produced, accounting for 90 percent of stone production and 84 percent of the value. The chief uses for crushed limestone were as an aggregate material and for the manufacture of cement and lime. A small quantity of dimension limestone was quarried for rubble in Onondaga County.

Basalt, the second-ranking stone, was produced only in Rockland County. Output increased 13 percent over that of 1965 as a larger quantity was consumed for concrete aggregate and roadstone and a greatly expanded market for riprap was developed. Both dimension and crushed sandstone were quarried. Production was reported from seven counties; the leading ones were Delaware and Sullivan. More than $1.5 million worth of dimension sandstone, used principally for flagging and sawed and dressed construction stone, was produced.

Table 6.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	8,418	$10,073	10,253	$11,774
Paving	4,644	5,004	4,003	4,331
Fill	649	356	1,441	1,167
Molding	187	762	187	768
Engine	23	34	W	W
Filtration	9	15	19	45
Other	644	561	566	556
Undistributed	-------	-------	[1] 39	[1] 57
Total	14,574	16,805	16,508	18,698
Gravel:				
Building	4,512	6,507	4,755	6,905
Paving	3,476	4,239	3,659	4,706
Fill	1,920	1,175	1,670	973
Undistributed [2]	582	446	561	487
Total	10,490	12,367	10,645	13,071
Total sand and gravel	25,064	29,172	27,153	31,769
Government-and-contractor operations: [3]				
Sand:				
Building	92	138	90	135
Paving	618	433	679	449
Fill	2,851	1,177	2,766	1,151
Other	502	243	617	332
Total	4,063	1,991	4,152	2,067
Gravel:				
Paving	5,672	6,373	5,819	6,334
Fill	4,390	2,816	4,705	2,892
Other	36	18	74	29
Total	10,098	9,207	10,598	9,255
Total sand and gravel	14,161	11,198	14,750	11,322
All operations:				
Sand	18,637	18,796	20,660	20,765
Gravel	20,588	21,574	21,243	22,326
Total	39,225	40,370	41,903	43,091

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes railroad ballast and foundry sand.
[2] Includes railroad ballast and other gravel.
[3] Includes data for State, counties, municipalities, and other Government agencies.

Production of crushed granite more than doubled in response to the strong demand for stone aggregates. Less dimension granite was quarried but higher prices for architectural stone brought value of production to a higher level than in 1965. Westchester County led in output of dimension granite; Warren County led in output of crushed granite. Marble was quarried in Dutchess, Westchester, and St. Lawrence Counties. Output was crushed and ground for a variety of uses, including terrazzo.

Production of dimension slate was lower than in 1965 but higher prices, particularly for roofing slate, caused a higher value of production. The entire slate output was from Washington County. Output of miscellaneous stone was reported from Rensselaer and Clinton Counties for use solely as concrete aggregate and roadstone; production was 36 percent less than in 1965.

Talc.—New York continued to be the leading talc-producing State, with output more than 100,000 tons above that of the second-ranking State. Production was 5 percent less than that of 1965 as both producers reported decreased mining activity. Higher prices were reported for the product so value of output was only slightly less than that of 1965. Three underground mines and one opencut mine were in operation in Gouverneur district of St. Lawrence County. The crude talc was

Table 7.—Sand and gravel production by Government-and-contractor operations, by counties

(Thousand short tons)

County	1965	1966	County	1965	1966
Allegany	-----	10	Oneida	94	161
Broome	13	23	Onondaga	36	468
Cattaraugus	22	73	Ontario	86	56
Cayuga	15	3	Orange	104	56
Chautauqua	W	190	Orleans	16	12
Chemung	16	11	Oswego	62	83
Chenango	64	30	Otsego	54	68
Clinton	20	31	St. Lawrence	163	133
Columbia	16	9	Saratoga	82	47
Delaware	21	33	Schuyler	48	39
Dutchess	88	58	Steuben	116	122
Essex	3	137	Suffolk	50	------
Franklin	W	150	Sullivan	W	-----
Fulton	------	19	Tioga	-----	3
Genesee	35	17	Washington	W	------
Herkimer	W	21	Wayne	117	100
Jefferson	140	142	Yates	------	19
Lewis	24	27	Undistributed [1]	12,643	12,381
Livingston	8	8			
Monroe	2	4	Total	14,161	14,750
Montgomery	3	6			

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes data unspecified by counties and data indicated by symbol W.

Table 8.—Crushed and broken limestone sold or used by producers by uses

(Thousand short tons and thousand dollars)

Use	1965		1966	
	Quantity	Value	Quantity	Value
Riprap	87	$175	234	$352
Concrete aggregate and roadstone	17,026	29,514	19,311	33,049
Agricultural	379	1,353	515	1,857
Railroad ballast	557	910	540	863
Cement	7,299	5,994	7,926	6,712
Miscellaneous uses, including fluxing stone and lime	2,177	3,008	2,134	2,926
Total	27,525	40,954	30,660	45,759

ground in company-owned mills and marketed principally for use in ceramics and as a mineral filler in paint. Both of these outlets were depressed in 1966 as was the floor and wall covering market. Some of the ground material was exported.

Vermiculite.—Crude vermiculite mined in other States was exfoliated at a plant in Weedsport, Cayuga County. Principal uses for the expanded material was for loose fill insulation, agriculture, ultralightweight concrete aggregate, and acoustical and other plasters.

Wollastonite.—Crude wollastonite was mined and beneficiated in Essex County. The quantity of refined material used as a filler in paints and plastics and as an ingredient in ceramic products increased by almost one-third over that of 1965. The Lewis mine of Adirondack Minerals Corporation, which produced a small tonnage of crude material for experimental uses in 1965, did not operate in 1966.

METALS

Aluminum.—Production of primary aluminum increased slightly in both tonnage and value over that of 1965. Two plants were in operation at Massena. The State dropped from third to fourth rank in aluminum production, being replaced by Louisiana.

Iron Ore.—Mine production of magnetite iron ore decreased slightly from that of 1965. Underground mines in Essex and Clinton Counties had increased production but combined output from the open pit mines in Essex and St. Lawrence Counties decreased. Strip-mined production composed 79 percent of the crude output. Production of concentrates decreased 20 percent to narrow the difference between production and shipments, but another large increment was added to the mounting stocks of mill concentrates. All of the ore was beneficiated, and most of the con-

centrates were agglomerated before shipment. Most was consumed in blast furnaces or steelmaking-furnaces but some was used in manufacturing cement and some was sold for use as heavy media in mineral preparation.

Iron and Steel.—According to the American Iron and Steel Institute, production of steel, most of which came from open hearth and basic oxygen furnaces increased 10 percent over that of 1965, to 7.7 million tons. Pig iron production was 6.5 million tons, an increase of 7 percent over that of 1965. Average production of pig iron per blast furnace day was 1,432.6 tons, 3 percent more than in 1965 and 60 percent more than 10 years ago. Shipments, which were valued at $365 million, consisted mainly of basic and malleable grades. Year-end stocks of pig iron at 363,000 tons were 27 percent above those of 1965. Pig iron was made at three plants in Erie County and one each in Niagara and Rensselaer Counties; 14 blast furnaces were in operation.

Most of the iron ore used in manufacturing pig iron was of domestic origin, but some was imported, mostly from Canada and Chile, with a small quantity from Brazil. In addition to the iron ore, sinter and pellets, other materials consumed in the blast furnace included limestone, dolomite, coke, mill cinder and roll scale, flue dust, open hearth and basic oxygen slag, scrap iron and steel, and slag scrap.

Bethlehm Steel Corp. announced the installation of a vacuum degassing unit in its No. 2 open hearth shop at the Lackawanna plant. The degassing process removes oxygen and other gases frrom the molten steel enhancing its metallurgical characteristics and enabling its use in making higher alloy steels for certain specialty products.

Lead.—Sharply increased quantities of lead were recovered as a byproduct of zinc mining at the Balmat mine in St. Lawrence County. Production and value increased 83 percent and 77 percent, respectively, compared with 1965. According to the company, a greater proportion of the 1966 zinc ore production was mined from a section of the Balmat mine where the vein has a higher lead content. Recovery of lead has varied from year to year, depending upon the proportion of ore coming from that section of the mine in the total feed to the concentrator. The lead concentrate was shipped to the company's lead smelter at Herculaneum, Mo. National Lead Co. converted lead to red lead and litharge at its Brooklyn plant. Electric Auto-Lite Battery Corp., Niagara Falls, manufactured black lead oxide.

Silver.—The quantity of silver recovered from the lead concentrates shipped from the Balmat mine was almost double that of 1965, reflecting the increased recovery of lead concentrates. Silver recovery, however, usually reflects the demand for silver-free lead rather than the silver content of the concentrate.

Titanium Concentrate (Ilmenite).—Ilmenite concentrate was recovered as a coproduct of magnetite from an opencut titaniferous-magnetite deposit near Tahawus, Essex County. Mine production, shipments, and total value were 3 percent less than in 1965. Ilmenite concentrate was used principally in the manufacture of titanium dioxide pigment.

Zinc.—New York ranked second to Tennessee in U.S. zinc production. Output was at a record high, exceeding the previous high of 1965 by 5 percent. It was the first full year of production at the renovated Edwards mine and mill and, in addi-

Table 9.—Mine production of silver, lead, and zinc, in terms of recoverable metals

Year	Mines producing	Material sold or treated (short tons)	Silver		Lead		Zinc		Total value (thousands)
			Troy ounces	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1957–61 (average)	2	591,337	54,407	$49	876	$217	56,453	$13,106	$13,372
1962	3	596,452	19,451	21	1,063	196	53,654	12,340	12,557
1963	3	594,245	19,544	25	1,009	218	53,495	12,304	12,547
1964	2	683,494	13,306	17	732	192	60,754	16,525	16,734
1965	2	788,961	11,441	15	601	188	69,880	20,405	[1] 20,607
1966	2	818,408	21,590	28	1,097	332	73,454	21,302	[1] 21,661

[1] Data do not add to total due to rounding.

Table 10.—Mine production of silver, lead, and zinc, in 1966, by months, in terms of recoverable metals

Month	Silver (troy ounces)	Lead (short tons)	Zinc (short tons)
January	1,231	69	5,449
February	1,471	80	5,914
March	2,387	128	6,822
April	1,926	98	6,516
May	1,550	83	6,551
June	1,920	95	6,090
July	1,971	93	6,330
August	1,845	95	6,499
September	1,932	93	5,742
October	2,031	94	6,017
November	1,564	77	5,827
December	1,762	92	5,697
Total	21,590	1,097	73,454

tion, there was increased output from the Balmat mine. St. Joseph Lead Co. announced that construction work had started on a new shaft at the Balmat zinc mine aimed for completion in 1969. In addition to increasing the efficiency of the existing mine, the shaft will open a new ore body, containing a large tonnage of good grade zinc ore for development. Reportedly sufficient additional ore will be made available to virtually double Balmat's milling capacity by the early 1970's.

Zirconium.—No zirconium ore was mined in the State, but zirconium ingot was produced at Akron from zirconium sponge; alloys of zirconium were produced at Niagara Falls; and zircon refractories were produced at Niagara Falls and Corning.

MINERAL FUELS

Natural Gas.—According to the Geological Survey—New York State Museum and Science Service, the production of natural gas decreased 25 percent, to 2.7 billion cubic feet. The Federal Bureau of Mines preliminary estimate of marketed production was 2.3 billion cubic feet. The value of the 1966 well production was $809,577 priced at $0.30 per thousand cubic feet at the wellhead. According to the American Gas Association, estimated recoverable reserves of natural gas at yearend were 121 billion cubic feet, of which 93 billion cubic feet were in underground storage reservoirs. This was a decline of 14.8 billion cubic feet from the total reserves at the end of 1965. During the year, 20 exploratory and 23 development or extension wells were drilled to the Oriskany sandstone or deeper. This is six wells less than were drilled in 1965. Most of the drillers were interested in drilling to the Oriskany formation (Devonian) and Medina group (Silurian), but 14 wells were drilled to test Cambrian and Ordovician formations. Three wildcat wells discovered gas in the Queenstown (Ordovician) in Yates County.

The State Geological Survey estimated that of the 7,400 gas wells drilled in the State (1821–1965), 1,200 were productive at the beginning of 1966. The Oil and Gas Journal [2] reported that Mobil Oil Co. had capacity to store 616,000 barrels of liquefied petroleum gas (propane, 418,000 barrels; butane, 198,000 barrels) in Steuben County; Suburban Propane Gas Corp. had capacity to store 400,000 barrels of propane in Cortland County. These storage facilities were in underground caverns mined in salt. Brooklyn Union Gas Co. was constructing aboveground tank facilities to store 175,000 barrels of liquefied natural gas.

Table 11.—Marketed production of natural gas

(Million cubic feet and thousand dollars)

Year	Quantity	Value	Average value (cents per thousand cubic feet)
1957–61 (average)	3,865	$1,160	$30.0
1962	4,262	1,198	28.1
1963	3,962	1,169	29.5
1964	3,108	963	31.0
1965	3,340	1,029	30.8
1966	2,699	837	31.0

Peat.—Sales of peat increased 8 percent over those of 1965, but the average value decreased slightly to $9.17 per ton. Orange County was the leading producing area; output also was reported from Cattaraugus, Westchester, and Seneca Counties. Most of the output was used for general soil improvement; some was used for potting soils, in packing flowers and plants, etc.

Petroleum.—An expanded program of secondary recovery by waterflooding led to a 6-percent increase in production of crude oil compared with 1965. Of the total production, 62 percent came from the Cattaraugus field in Cattaraugus County; the bal-

[2] Oil and Gas Journal. V. 64, No. 42, Oct. 17, 1966, p. 102.

ance came from the Allegany field in Allegany and Steuben Counties. Value of production increased at a greater rate than quantity because of higher average prices for crude oil at the wellhead—from $4.38 to $4.53 per barrel for Allegany crude and from $4.48 to $4.63 per barrel for Cattaraugus crude.

According to the American Petroleum Institute, reserves of crude oil at the end of the year were 10.2 million barrels, a decrease of 1.8 million barrels compared with 1965. Geophysical exploration consisting of seismic reflection work and gravity work was conducted during the year.

The Geological Survey—New York State Museum and Science Service, estimated that of the 26,332 oil wells drilled in the State in the past 100 years, 12,500 were operating at the start of 1966.

Mobil Oil Co. operated a refinery at Buffalo with a crude oil capacity of 37,500 barrels per day. Using catalytic cracking and reforming, the refinery had a daily gasoline output of 15,800 barrels. The Frontier Oil Refining Corp., Division of Ashland Oil and Refining Co., operated a 30,000-barrel-per-day crude capacity refinery at Tonawanda with cracking and reforming capacities of 12,000 and 7,000 barrels per day, respectively. The Mobil Oil Co. refinery at Brooklyn was shutdown at the start of 1966. Acording to the Oil and Gas Journal, 1.1 billion gallons of gasoline were consumed in New York in 1966.

Table 12.—Petroleum production

(Thousand 42-gallon barrels and thousand dollars)

Year	Quantity	Value	Average value per barrel
1957–61 (average)	1,976	$8,955	$4.53
1962	1,589	7,309	4.60
1963	1,679	7,707	4.59
1964	1,874	8,321	4.44
1965	1,632	7,246	4.44
1966	1,735	7,925	4.57

Table 13.—Well completions and drilling footage for field wells and wildcats in 1966

Type of well	Field wells		Wildcats		Total	
	Well completions	Footage drilled	Well completions	Footage drilled	Well completions	Footage drilled
Oil	6	NA	-------	NA	6	NA
Gas	15	NA	4	NA	19	NA
Dry	12	NA	29	NA	41	NA
Total	33	62,640	33	99,459	66	162,099

NA Not available.
Source: American Association of Petroleum Geologists.

REVIEW BY COUNTIES

Sand and gravel produced by Government-and-contractor operations is shown in table 7 and is not included under the individual county reports that follow.

Albany.—Even though the value of cement shipments decreased $1 million below that of 1965, the county continued to rank second in value of minerals produced. Atlantic Cement Co., Inc., Ravena, manufactured portland cement for delivery by ship to company-owned distribution centers along the Atlantic Coast. The company quarried limestone for raw material at a nearby quarry but purchased all other raw materials.

Limestone was quarried and crushed by the Callanan Road Improvement Co. at South Bethlehem for use mainly as concrete aggregate and roadstone. Other uses included riprap, railroad ballast, and blast furnace flux. The company received a citation from the National Safety Competition for working the year without a disabling work injury. Heldeburg Bluestone, Inc., quarried bluestone (graywacke) at East Berne and produced dressed stone for architectural use.

Powell & Minnock Brick Works, Inc., mined miscellaneous clay at its S.&S. pit and shale at Coeymans Hollow for manufacturing building brick. Shale for lightweight aggregate manufacture was mined near Cohoes by Northern Lightweight Aggregate, Inc. Industrial Mineral Products, Inc., mined Albany slip clay for pottery, as a bonding material for abrasives and for export.

Table 14.—Value of mineral production in New York, by counties [1,2]

County	1965	1966	Minerals produced in 1966 in order of value
Albany	$22,071,114	W	Cement, stone, clays, sand and gravel.
Allegany	W	W	Sand and gravel.
Broome	1,294,001	$1,348,617	Sand and gravel, stone, clays.
Cattaraugus	735,000	1,393,400	Sand and gravel, peat.
Cayuga	868,859	861,866	Stone, sand and gravel.
Chautauqua	96,000	227,000	Sand and gravel.
Chemung	W	W	Do.
Chenango	304,000	335,000	Do.
Clinton	W	W	Iron ore, stone, sand and gravel.
Columbia	W	W	Cement, stone, sand and gravel, clays.
Cortland	W	784,000	Sand and gravel.
Delaware	1,239,743	W	Stone, sand and gravel.
Dutchess	W	W	Stone, sand and gravel, clays.
Erie	15,212,084	14,560,533	Cement, stone, sand and gravel, gypsum, lime, clays.
Essex	W	W	Iron ore, ilmenite, wollastonite, sand and gravel, stone, garnet.
Franklin	184,224	309,465	Stone, sand and gravel.
Fulton	242,000	204,000	Sand and gravel.
Genesee	3,110,967	3,348,383	Stone, gypsum, sand and gravel.
Greene	14,496,706	17,286,207	Cement, stone, clays.
Herkimer	W	W	Stone, sand and gravel.
Jefferson	1,050,483	W	Do.
Lewis	W	W	Do.
Livingston	W	W	Salt, sand and gravel, stone.
Madison	699,381	854,992	Stone, sand and gravel.
Monroe	4,672,163	4,595,122	Stone, sand and gravel, gypsum.
Montgomery	653,800	W	Stone, sand and gravel.
Nassau	4,239,200	4,813,500	Sand and gravel, clays.
Niagara	W	4,266,497	Lime, stone.
Oneida	2,436,266	2,947,000	Stone, sand and gravel.
Onondaga	17,840,928	W	Lime, salt, stone, cement, sand and gravel, clays.
Ontario	1,152,200	1,491,395	Sand and gravel, stone.
Orange	1,508,350	1,616,320	Sand and gravel, stone, clays, peat.
Orleans	203,000	W	Sand and gravel.
Oswego	538,000	579,000	Sand and gravel.
Otsego	226,367	W	Do.
Putnam	W	W	Do.
Rensselaer	1,138,240	1,298,450	Sand and gravel, stone.
Rockland	W	6,288,000	Stone, sand and gravel.
St. Lawrence	42,364,191	43,159,479	Zinc, iron ore, talc, stone, lead, sand and gravel, silver.
Saratoga	1,112,131	909,426	Stone, sand and gravel.
Schenectady	369,000	W	Sand and gravel.
Schoharie	W	W	Cement, stone, clays, sand and gravel.
Schuyler	W	W	Salt, sand and gravel.
Seneca	364,476	322,663	Stone, peat.
Steuben	682,000	W	Sand and gravel.
Suffolk	5,220,000	4,511,000	Do.
Sullivan	W	W	Stone, sand and gravel.
Tioga	493,000	356,000	Sand and gravel.
Tompkins	W	W	Salt, stone, sand and gravel.
Ulster	18,100,327	16,841,504	Cement, stone, clays, sand and gravel.
Warren	W	7,194,616	Cement, garnet, sand and gravel, stone.
Washington	981,753	925,768	Stone, sand and gravel.
Wayne	513,089	655,744	Do.
Westchester	923,573	917,982	Stone, sand and gravel, emery, peat.
Wyoming	W	W	Salt, stone.
Yates	----------	7,000	Sand and gravel.
Undistributed [3]	122,720,048	156,053,800	
Total	290,057,000	301,264,000	

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

[1] Bronx, Hamilton, Kings, New York, Queens, and Richmond Counties are not listed because no production was reported.

[2] Natural gas and petroleum not listed by counties; value included with "Undistributed."

[3] Includes natural gas, petroleum, sand and gravel, and gem stones that cannot be assigned to specific counties, and values indicated by symbol W.

Albany Gravel Co., Inc., produced building sand and gravel and gravel for fill, paving, and railroad ballast at Cedar Hill. Whitehead Bros. Co. produced molding sand from a pit near Slingerlands. J. H. Maloy, Inc., did not operate in 1966.

Allegany.—Building and paving sand and gravel was produced by Alfred Atlas Gravel & Sand Corp. and by The Buffalo Slag Co., Inc., Alfred and by Thomas Moogan at Friendship.

Bronx.—Crude gypsum was calcined and

perlite was expanded by the National Gypsum Co. at its Bronx plant. The finished products were used by the company to manufacture building products.

Broome.—Increased production of sand and gravel was reported in the county. Five pits were in operation, the larger of which were operated by Barney & Dickenson, Inc., Vestal; Binghamton Sand & Crushed Stone Corp., Binghamton; and Bob Murphy, Inc., Vestal. Output consisted mostly of building and paving material. Corbisello Quarries and Arborio & Arborio produced crushed sandstone at Binghamton and Windsor, respectively, for concrete aggregate, roadstone, and riprap. Bluestone was quarried as dimension stone by the Paul Tompkins Estate at Hancock and W. R. Strong & Son at Deposit. Building brick was manufactured at Binghamton by Binghamton Brick Co., Inc., from shale mined nearby.

Cattaraugus.—Sand and gravel production almost doubled over that of 1965. Eight pits were in operation. The Buffalo Slag Co., Inc., operated pits near Allegany and Franklinville producing mostly construction sand and gravel. The company received a citation for operating its Franklinville pit throughout 1966 without a disabling work injury. Country Side Sand & Gravel, Inc., produced building and paving sand and gravel near South Dayton. E. F. Lippert & Co. produced building sand and gravel at Allegany, and Work & Silvis Co., Inc., produced building sand and building and praving gravel near Red House. Sue Peat Co. recovered humus peat from a bog near Hinsdale for sale in both bulk and packaged form.

Cayuga.—Crushed limestone for concrete aggregate and roadstone was produced by the General Crushed Stone Co. at its Auburn quarry. The company engaged in overburden excavation in preparation for opening a new quarry at Oakwood in 1967. J. J. Harrington Sand Plant and Jay W. Robinson & Son produced construction sand and gravel from pits near Auburn, and John W. Dougherty, Inc., produced mostly gravel near Sennett. Zonolite Division, W. R. Grace & Co., exfoliated crude vermiculite at its Weedsport plant.

Chautauqua.—More than three times the amount of sand and gravel was produced compared with 1965. Evans Builders Supply, Inc., the largest of three producers, produced building sand, and building, paving, and fill gravel.

Chemung.—E. R. Wolcott, Inc., Big Flats, and Elmira Transit Mix, Inc., Horseheads, were the leading sand and gravel producers. The bulk of the output was used in highway construction.

Chenango.—Building and paving sand and gravel was produced by The Bundy Concrete Co. from a pit near Sherburne, and B & B Builders Supplies, Inc., produced building sand and gravel near Greene. The entire output was washed and screened.

Clinton.—Republic Steel Corp. mined magnetite iron ore by sublevel stoping at its Chateaugay mine, Lyon Mountain. The ore was concentrated at the mine and the mill concentrates were sintered at the company's agglomerating plant prior to shipment to pig iron and steel furnaces. Waste rock (gneiss) from the Chateaugay mine was sold for use mainly as roadstone. Limestone primarily for aggregate use was quarried and crushed near Plattsburgh by Plattsburgh Quarries, Inc.

The Chazy quarry of International Lime and Stone Corp. was closed. Concrete Materials Inc., recovered and processed building sand and gravel near Morrisonville.

Columbia.—Cement, the county's leading commodity, was produced by Lone Star Cement Corp., Greenport, and Universal Atlas Cement Division, United States Steel Corp., Hudson. Portland and masonry cements were produced. Both companies produced limestone from nearby quarries to supply the kilns, and Universal Atlas Cement Division also mined its own shale requirements. A. Colarusso & Son, Inc., Greenport, quarried limestone for use chiefly as concrete aggregate and roadstone. Sand for building, paving, fill, and ice control purposes was produced by F. H. Stickles & Son near Livingston.

Cortland.—Output of sand and gravel almost doubled over that of 1965. Concrete Materials Inc. produced processed building sand and gravel near Homer, and Aggregate Materials Corp. and Cortland Ready Mix, Inc., produced construction sand and gravel from pits near Cortland.

Delaware.—Production of dimension sandstone (bluestone) accounted for most of the value of mineral output in the

county. Five quarries were in operation producing stone that was finished for sale primarily as flagging. Other uses included architectural work, sawed, dressed, and rough construction building stone, rubble, and curbing. The leading producers were Johnston & Rhodes Bluestone Co. (Reynolds quarry) at East Branch; Willis Hankins and Paul Tompkins Estate, both near Hancock, and W. R. Strong & Son, Deposit. Crushed sandstone for use as concrete aggregate and roadstone was produced by Cooney Bros., Inc., Hancock.

Dutchess.—Production of limestone, the leading commodity in the county, increased over that of 1965. New York Trap Rock of Delaware, Inc., a Division of Lone Star Cement Corp., the major producer, operated its Clinton Point quarry near Wappingers Falls and produced concrete aggregate and roadstone, stone sand, and riprap. Dutchess Quarry & Supply Co., Inc., produced crushed limestone for aggregate at its Pleasant Valley quarry. New York Limestone Corp. continued to produce crushed marble at the Wingdale quarry for sale chiefly as floor tile and filler. The combined output of 10 sand and gravel producers increased 26 percent over that of 1965. Colonial Sand & Stone Co., Inc., started production at Wingdale. Other large producers were David Alexander, Wappingers Falls, and Amenia Sand & Gravel Inc., Amenia. Output, which was almost evenly divided between sand and gravel, was mostly for construction purposes. Beacon Brick Corp. mined miscellaneous clay and shale near Beacon for manufacturing building brick.

Erie.—Portland cement was produced by the Lehigh Portland Cement Co. at Buffalo. Penn-Dixie Cement Corp. ceased operations at its Buffalo plant at the end of 1965 but planned to convert existing storage facilities to a distribution station to serve the Buffalo area from the firm's Howes Cave (Schoharie County) plant. Cement shipments were less than those of 1965. Four companies operated limestone quarries producing crushed stone for use chiefly as concrete aggregate and roadstone. Buffalo Crushed Stone Co., Lancaster, and Federal Crushed Stone Corp., Cheektowaga, were the leading producers. The latter company received a citation from the National Safety Competition for working without a disabling work injury during 1966.

National Gypsum Co. and Bestwall Gypsum Division of Georgia-Pacific Corp. mined crude gypsum underground near Clarence Center and calcined the ore in nearby plants for use in the manufacture of wallboard and other building products. The Bestwall Akron mine received a citation from the National Safety Competition for the third consecutive year for having had no disabling work injuries. Universal Atlas Cement Division, United States Steel Corp. mined gypsum in the same district for use in crude form as a retarder in cement. The county ranked third in clay production. Shale was mined for use in manufacturing cement by Hamburg Shale Co., Inc. Penn-Dixie Cement Corp. did not operate its clay mine during 1966 following the closing of its cement plant. Anchor Concrete Products, Inc., mined shale for lightweight aggregate manufacture near Jewettville; Acme Shale Brick Co., Inc., and Empire Clay Products, Inc., mined shale for manufacturing building brick at Lake View and West Falls, respectively. Boston Valley Pottery Co., Hamburg, produced clay for making flower pots.

National Gypsum Co., Clarence Center, and Bestwall Gypsum Division of Georgia-Pacific Corp., Akron, expanded crude perlite for use in building plaster. Buffalo Perlite Corp. expanded perlite at its Cheektowaga plant for loose fill insulation, soil conditioning, ultralightweight concrete aggregate and other uses.

Bethelehem Steel Corp. began operating its 600-ton-per-day lime plant at Lackawanna. The three-kiln plant supplied quicklime for use in basic oxygen steel furnaces.

Production of sand and gravel decreased by almost ½ million tons to 1.2 million tons and the county dropped to fourth rank among the State's sand-and-gravel-producing counties. Most of the loss in sales were in paving sand and gravel and fill gravel. The larger of seven producers were the Pine Hill Concrete Mix Corp., Lancaster; Clarence Sand & Gravel Corp., Clarence; and Dan Gernatt Gravel Products, Inc., Collins.

Essex.—National Lead Co. mined ilmenite-magnetite ore at its MacIntyre opencut mine at Tahawus. The ilmenite and magnetite ore was processed by heavy-medium separation, flotation, and magnetic separation. Ilmenite was used mostly in the

manufacture of titanium dioxide pigments. Magnetite concentrate that was agglomerated was sold for pig iron and steel manufacture and for use in cement. Unagglomerated concentrates were shipped for use mainly as heavy media, for refractory use, and as ballast. Republic Steel Corp. produced magnetite from its underground Old Bed-Harmony mine near Mineville. The ore was concentrated and agglomerated at a nearby mill and sintering plant, and it was shipped to various Republic Steel Corp. steel plants.

Cabot Corp., Oxide Division produced wollastonite and byproduct garnet at its underground mine near Willsboro. The wollastonite was beneficiated and finely ground for use in manufacturing ceramics, paints, and plastics, and for other uses. Byproduct garnet was sold for sand blasting, coated abrasives, and other uses.

Production of sand and gravel was sharply increased because of the output of Theodore Zoli Construction Co., Inc. Schroon Lake, for a highway construction project. Paving gravel was produced by Mrs. Ernest Smith near Eliazabethtown. Rough architectural and monumental granite was quarried near Jay by the Lake Placid Granite Co., Division of Cold Springs Granite Co. International Paper Co. regenerated lime for use in paper manufacture at its Ticonderoga mills.

Franklin.—The value of dimension sandstone production almost doubled over that of 1965. Adirondak Stone Quarries, Inc. operated a quarry near Burke producing chiefly sawed and dressed building stone and flagging. Building sand and gravel was produced near Malone.

Fulton.—Mostly construction sand and gravel was produced by seven companies, the larger of which were A. Frederick, Gloversville; Cushing Stone Co., Inc., Broadalbin; and Paul Bradt, Northville.

Genesee.—Four companies, three of which had quarries near LeRoy, produced crushed limestone, the primary use for which was concrete aggregate and roadstone. LeRoy Lime & Crushed Stone Corp. and Genesee Stone Products Corp. (Stafford) also produced railroad ballast and riprap. General Crushed Stone Co. was the other large producer. Genesee Stone Products Corp. received a citation from the National Safety Competition for working throughout 1966 without a disabling work injury.

U.S. Gypsum Co. mined gypsum underground and calcined the crude material at its nearby Oakfield plant.

Batavia Washed Sand & Gravel Co. Inc., produced mainly paving sand and gravel near Batavia, and Frey Sand & Gravel Corp. produced principally building sand and gravel near Alexander.

Greene.—Alpha Portland Cement Co., Inc. Catskill, and Marquette Cement Manufacturing Co., Alsen, manufactured both portland and masonry cement. Lehigh Portland Cement Co., Alsen, produced only portland cement in 1966. These companies also quarried limestone from nearby deposits for raw material. In addition, Marquette mined clay raw material from its own pit. Both companies received citations from the National Safety Competition for working their limestone quarries through the year without a disabling work injury. Other limestone producers were Catskill Materials Corp., Catskill and Tri-County Stone Co., Inc., Windham, with output mainly for aggregate. Whitehead Brothers Co. did not produce molding sand at Coxsackie.

Herkimer.—Crushed limestone, mainly for use as concrete aggregate and roadstone, was produced by Eastern Rock Products Inc., at the Middleville No. 6 quarry and General Crushed Stone Co. at its Jordanville quarry. The latter company also produced agstone. Eastern Rock Products, Inc., received a citation from the National Safety Competition for working its quarry throughout 1966 without a disabling work injury. A small quantity of sand and gravel was produced near Gravesville, and building sand was produced near Poland.

Jefferson.—General Crushed Stone Co. produced concrete aggregate, roadstone, and agstone at its Watertown limestone quarry. The operation of Multi-Color Sandstone Co. was discontinued in 1966 and no production was reported. Increased output of sand and gravel was reported in the county but most of it was used for construction purposes. Seven pits were active; the larger were operated by Colwell Bros., Inc., Watertown, and Anthony Marzano, Inc., Watertown, and James Stephany, Alexandria Bay.

Lewis.—Carbola Chemical Co., Inc., a subsidiary of International Talc Co., Inc., operated an underground limestone mine

at Diana near Natural Bridge. The output was finely ground for use mainly as a paint filler. Other uses included calcimine and filler in rubber and putty. E. G. Delia & Son Construction Corp. quarried and crushed limestone near Boonville for aggregate use.

Livingston.—The county continued to rank as the most important salt-producing area in the State. International Salt Co. mined rock salt at its underground Retsof mine and marketed the product throughout New England and most of the Middle Atlantic States. Among its many uses were chemical manufacture, ice removal, and a wide variety of other applications.

Sand and gravel production increased over that of 1965. Valley Sand & Gravel Corp. produced mostly building sand and gravel from pits near Wadsworth and Canawaugus. Cole Sand & Gravel Corp. produced building sand and gravel and paving gravel near Caledonia. General Crushed Stone Co. produced crushed limestone from its Rochester quarry at Honeoye Falls for use as concrete aggregate and roadstone.

Madison.—Warren Brothers Roads Co., produced crushed limestone near Clockville for concrete aggregate, roadstone, and for riprap. Worlock Stone Co., Inc., Perrysville, and Munnsville Limestone Corp., Munnsville, produced limestone for aggregate, agstone, and riprap. Cossitt Concrete Products, Inc., mined sand and gravel near Hamilton and processed the material for building and paving use.

Monroe.—Crushed limestone was the leading commodity produced in the county. Dolomite Products Co., the largest producer, operated its Gates plant and produced aggregate, railroad ballast, and agstone. Dolomite Products Company produced concrete aggregate, roadstone, and agstone at its Penfield limestone plant and Concrete Material, Inc., produced limestone aggregate near Sweden.

Sand and gravel production dropped 21 percent to 1.3 million tons. Ten pits were in operation; the larger ones were operated by Dolomite Products Co., Inc., Penfield; Ingersoll Supply & Equipment Corp., Spencerport; Don C. Russo Sand & Gravel Co., Mendon; and Clover Sand & Gravel Co., Inc., Pittsford. Output was used mainly for building and for fill.

Crude gypsum mined by The Ruberoid Co. at Wheatland was processed at the company's Caledonia plant (Livingston County) where it was converted into building products.

Montgomery. — Production of crushed limestone more than doubled to meet the demands of an accelerated roadbuilding program. Cushing Stone Co., Inc., and Crushed Rock Products, Inc., both operated quarries near Amsterdam producing concrete aggregate and roadstone. The latter company also produced agstone. A small quantity of processed construction sand and gravel was produced by St. Johnsville Supply Co., Inc., at a pit near St. Johnsville.

Nassau.—The county moved into first place in production and value of sand and gravel in 1966. Output increased 19 percent to 4.9 million tons valued at $4.7 million. Eight pits were reported to be in operation. Colonial Sand & Stone Co., Inc., operated pits at Port Washington and Hempstead producing primarily building sand. Penn Industries, Inc., operated a plant at Roslyn also producing mostly building sand. Certified Industries, Division of U.S. Steel Corp., operated three dredges producing building and paving sand and gravel. Pine Hollow Sand & Gravel Co., Inc., also was in operation in 1966. Clay was produced by Nassau Brick Co., Inc., from a pit near Farmingdale for use in manufacturing building brick.

Niagara.—Olefins Division of Union Carbide Corp., Niagara Falls, produced quicklime and hydrated lime. All of the quicklime and a small part of the hydrated lime was consumed by the company mostly in the manufacture of calcium carbide. Most of the hydrated lime was sold for treatment of trade wastes, ore beneficiation, and construction. International Paper Co., North Tonawanda, regenerated lime used in paper manufacture.

Crushed limestone mainly for use as concrete aggregate and roadstone was produced by Niagara Stone Div., Great Lakes Color Printing Corp., Niagara Falls; Frontier Stone Products, Inc., Lockport; and Royalton Stone Corporation, Gasport. Some limestone also was sold for railroad ballast, agstone, and metallurgical flux.

Oneida.—Eastern Rock Products, Inc., produced crushed limestone at its Oriskany Falls No. 5 quarry, mainly for use as aggre-

gate in road construction. Some agstone and riprap also were produced. The company completed a modernization program consisting of new tertiary crushing, recrushing, and washing departments. Advanced standards of automation and control insured product quality and uniformity. Sand and gravel production increased by almost one-fourth to 800,000 tons. Nine pits were in operation. Eastern Rock Products, Inc., operated pits at Barneveld and Boonville, producing mostly paving sand. The company received citations from the National Safety Competition for operating both plants throughout 1966 without a disabling work injury. Whitehead Brothers Co. and George W. Bryant Core Sands, Inc., produced molding sand from pits near McConnelsville. Ludlow Sand & Gravel Co., Inc., produced paving sand and gravel and miscellaneous gravel near Clayville.

Onondaga.—Solvay Process Division, Allied Chemical Corp., manufactured quicklime for chemical manufacture from limestone produced at the company's quarry near Jamesville. Not all the limestone quarried was converted to lime; the company also marketed railroad ballast, agstone, and riprap. Brine was recovered by the company from salt wells near Tully to supply its chemical plant at Syracuse where brine and quicklime was used to produce soda ash. Some of the brine was evaporated in vacuum pans and was sold for highway ice control and other uses.

Alpha Portland Cement Co. produced portland and masonry cement at Jamesville. The company mined shale at a nearby pit but purchased the other raw materials needed in cement manufacture.

General Crushed Stone Company operated its Rock Cut limestone quarry near Jamesville producing concrete aggregate and roadstone. The company's new Skaneateles quarry began operation late in the year. Full-scale operation is anticipated in 1967. A small quantity of rubble (irregular-shaped stone) was produced at Manlius by Brickyard Falls Farm.

Sand and gravel production decreased below the 1965 level. Six pits were in operation producing construction sand and gravel. The larger were operated by General Crushed Stone Co., Fayetteville; and W. F. Saunders & Sons, Inc., and Consolidated Aggregates Corp., both at Nedrow.

Onondaga Lightweight Aggregate Corp. produced sintered lightweight aggregate from shale mined at a nearby pit. Red clay was mined by Syracuse Pottery, Inc., for making art pottery at Camillus.

Ontario.—Sand and gravel production increased 23 percent, to 726,000 tons. Ten pits were in operation producing principally construction sand; a small amount of filtration sand also was recovered. The larger producers were Hoadley Sand & Gravel Co., Inc., and Elam Brothers Corporation, both at Victor and DeWitt Concrete Corp., Clifton Springs. The latter company received a citation from the National Safety Competition for working throughout 1966 without a disabling work injury. Increased production of crushed limestone for concrete aggregate and roadstone was reported by General Crushed Stone Co. at its Geneva plant.

Orange.—Sand and gravel production increased 15 percent, to 736,000 tons valued at $1.1 million. Eleven pits were in operation producing mainly construction sand and gravel. The leading producers were The Windsor Building Supplies, Co., Inc., New Windsor, and Delaware Valley Sand & Gravel Co., Inc. Port Jervis. Windsor Building Supplies received a citation from the National Safety Competition for working throughout 1966 without a disabling work injury. Dutchess Quarry & Supply Co., Inc., quarried limestone at its Goshen quarry and crushed the material for use as concrete aggregate and roadstone. The Jova Brick Works at Newburgh produced miscellaneous clay and shale for manufacturing building brick and for other purposes. Mt. Bethel Humus Co., Inc., recovered humus peat from bogs near Middletown for bulk sale for soil improvement. Reed-sedge peat was produced from a bog near Tuxedo by Sterling Forest Peat Co., Inc., for sale in bulk and in packages.

Orleans.—B. R. DeWitt, Inc., operated the No. 2 and No. 5 sand and gravel pits at Ridgeway and the No. 4 pit near Shelby, producing mostly building and paving sand and gravel. A small amount of fill gravel was produced at the No. 2 pit. Oak Orchard Sand & Gravel Co. produced building sand and gravel and fill sand near Medina.

Oswego.—Paving sand and gravel was produced by General Crushed Stone Co. from a pit near Lacona. Midstate Aggre-

gates, Inc., produced building and fill sand and gravel for other uses at Hastings, and Sea Way Sand & Gravel, Inc., produced paving and fill gravel near Oswego. Whitehead Bros. Co. produced molding sand near Pulaski.

Otsego.—General Crushed Stone Company's Springfield quarry was idle in 1966. A small amount of building sand and gravel was produced near Milford and Unadilla.

Putnam.—Building and other sands and fill gravel was produced by Leemac Sand & Stone Corp. from a stationary plant near Cold Springs.

Rensselaer.—Sand and gravel production increased 18 percent, to 753,000 tons valued at $884,000. Sixteen pits were in operation; the larger ones were operated by Albany Gravel Co., Inc., Albany, Valente Sand & Gravel, Troy, and Troy Sand & Gravel Co., Inc., West Sand Lake. The Albany Gravel Co., Inc., received a citation from the National Safety Competition for working throughout 1966 without a disabling work injury. Building, paving, and fill were the main uses for both sand and gravel. Fitzgerald Brothers Construction Co., Inc., produced miscellaneous stone (graywacke) for road construction at the Campbell Mountain quarry near Brunswick.

Richmond.—U.S. Gypsum Co. calcined crude gypsum at its New Brighton plant for use in manufacturing building products.

Rockland.—Rock Industries, Division of Martin Marietta Corp., produced crushed limestone for concrete aggregate at Tomkins Cove and crushed basalt for concrete aggregate, roadstone, and riprap at Haverstraw. New York Trap Rock Corp. quarried and crushed basalt at West Nyack for aggregate plus a small amount for riprap. The company received a citation from the National Safety Competition for working without a disabling work injury during 1966. Rockland Materials Corp. began operations of its renovated plant (formerly owned by Suffern Stone Co.) and produced crushed basalt for aggregate and roadstone.

Sand and gravel production was one-third less than that of 1965. Ward Pavements, Inc., Thiells, produced paving sand and gravel. Mt. Ivy Sand & Gravel Co., Inc. and Graney Building Material Corp. produced mostly building sand and gravel at Congers and Sparkill, respectively. There was considerably less fill sand produced than in 1965.

St. Lawrence.—Zinc was produced at the Edwards mine, and zinc with byproduct lead and silver was produced at the Balmat mine by the St. Joseph Lead Co. Both mines were located near Gouverneur. Output from both mines was greater than in 1965. The production of lead and silver, which was recovered, from the Balmat mine only, was considerably higher than in 1965 because the zinc ore being mined was from a section of the mine where the vein was rich in these elements. Zinc concentrate from both mines was shipped to the company smelter at Josephtown, Pa. Lead concentrate from the Balmat mine was shipped to the company smelter at Herculaneum, Mo., for the recovery of lead and silver. Jones & Laughlin Steel Corp., the largest iron ore producer in the State, mined magnetite at the Benson open pit mine near Star Lake. The ore was concentrated at the company's nearby mill and most of the concentrate was agglomerated by sintering before shipment. Both concentrates and sinter were used in making pig iron and steel.

International Talc Co., Inc., recovered talc from the Arnold open pit and the Wight and No. 3 underground mines. Gouverneur Talc Co., Inc., mined talc at its Balmat mine near Arnold. Both companies operated grinding mills and sold talc for use in ceramics, rubber, paints, and floor covering. The Barrett Division of Allied Chemical Corp. produced crushed limestone at its Norwood quarry for concrete aggregate, roadstone, agstone, cement manufacture, and riprap. The company received a citation from the National Safety Competition for working its quarry throughout 1966 without a disabling work injury. McConville, Inc., quarried limestone at Ogdensburg for use mostly as an aggregate material. The Balducci Crushed Stone Co. produced crushed marble for roadstone near Gouverneur.

Sand and gravel, the majority of which was used as a building aggregate, was produced by seven operators. The larger producers were Putnam-Hawley Building Materials Inc., Potsdam; and the Carry Construction Corp., Colton.

Saratoga.—Crushed limestone was produced by Glens Falls Portland Cement Co., Division of The Flintkote Co. near Glens

Falls. The limestone was carried by conveyor belt to the company's cement plant at Glens Falls across the county line in Warren County. Pallette Stone Corp. quarried and crushed limestone at Saratoga Springs for aggregate, roadstone, agstone, and riprap.

Thirteen sand and gravel pits were in operation. Considerable quantities of industrial sand was produced in addition to construction sand. Only a small quantity of gravel was produced. The larger producers of molding sand were Whitehead Brothers Co., Mechanicville; Jewett Sand Co., Clifton Park; and W. J. Dyer Molding Sand Co., Jonesville. The latter company and William & Douglas Fawthrop produced engine sand. Pallette Stone Corp. operated two sand plants at Corinth.

Schenectady.—Output of sand and gravel was 75 percent greater than in 1965. The most significant increase was in the production of building and paving sand. The leading producers were the Scotia Stone & Gravel Co., Scotia, and De Luke Sand & Gravel Co., Inc., Glenville. Capitol Concrete Products reported its shale pit inactive in 1966.

Schoharie. — Penn-Dixie Cement Corp. produced portland and masonry cement at its Howes Cave plant. The company mined its shale and limestone raw material at nearby locations and received a citation from the National Safety Competition for working the limestone quarry a full year without a disabling work injury. Crushed limestone for concrete aggregate and roadstone was produced by Schoharie Stone Corp., Schoharie. Cobleskill Stone Products Division of Allied Materials Corp. produced crushed limestone for aggregate and agstone and Masick Soil Conservation Co. produced agstone.

Schuyler.—Brine was pumped from salt wells near Watkins Glen by International Salt Co. and Watkins Salt Co., Inc. The evaporated salt was used mainly by chemical manufacturers, food processors, and by a variety of other consumers. Markets were mostly in New York, Pennsylvania, and other northeastern States. A small quantity of construction sand and gravel was produced near Watkins Glen.

Seneca.—Limestone was quarried and crushed at Seneca Falls by Warren Brothers Roads Co. Most of the output was used for roadstone; some was used for riprap. Reed-sedge peat was recovered from a bog near Junius by Finger Lakes Peat Moss Co. Sales were in bulk mostly for general soil improvement.

Steuben.—Less sand and gravel was produced as the market for paving sand and paving and fill gravel was less than that of 1965. The leading producers were Rhinehart Sand & Gravel, Inc., Corning; and Dalrymple Gravel & Construction Co., East Corning.

Suffolk.—The county dropped from first to second place among the sand-and-gravel-producing counties in the State. Output decreased 12 percent below that of 1965, to 4.4 million tons. Over three-fourths of the output was sand. Eighteen operations were active. The leading producers in decreasing order of output were Steers Sand & Gravel Corp., Northport; West Hills Silica Sand Mining Corp., Farmingdale; Jefferson Sand & Gravel Co., E. Setauket; Suffolk Dredging Corp., New York; Roanoke Marbro Sand & Gravel Corp. Riverhead; and Suffolk Materials Mining Corp., E. Setauket.

Sullivan.—Sullivan Highway Products Corp. produced crushed sandstone at the Bridgeville quarry, Monticello, and Fosterdale quarry, Kenoza Lake. Output was used for concrete aggregate, roadstone, and stone sand. The company also produced building and paving sand and gravel at Monticello. Other sand and gravel producers were in operation at Summitville and Mongaup Valley.

Tioga.—Production of sand and gravel decreased 29 percent, to 269,000 tons. The leading producers were Concrete Materials, Inc., and C. & C. Ready-Mix Corp., both of Owego. The former company produced only building sand and gravel; the latter, both building and paving material.

Tompkins.—Rock salt was produced at an underground mine near Myers by the Cayuga Rock Salt Co., Inc. The principal markets for the products were State and local governments for use in ice control. There was also a variety of chemical uses for the product. Much of the production was consumed within the State but Pennsylvania, Virginia, and New Jersey also received considerable shipments.

Cayuga Crushed Stone, Inc., produced crushed limestone at its South Lansing quarry for use mainly as an aggregate in

road construction. Other uses included agstone, riprap, and stone sand for ice control. The company received a citation from the National Safety Competition for working throughout 1966 without a disabling work-injury. Finger Lakes Stone Co., Inc., quarried dimension sandstone (bluestone) at its University quarry near Dryden. Much of the stone was sawed for architectural purposes; some was sold for dressed architectural and rough construction uses. Rumsey-Ithaca Corp. and University Sand & Gravel Co. produced construction sand and gravel from pits near Ithaca.

Ulster.—Hudson Cement Division, Colonial Sand & Stone Co., Inc., produced portland cement at its Kingston plant. Raw material consisted of limestone quarried nearby; the company purchased gypsum and other necessary products. Much of the cement was shipped by barge to the New York City market. Natural and masonry cement was produced by Century Cement Manufacturing Co., Inc., from natural cement rock mined underground at the plant site. The Callanan Road Improvement Co., produced crushed limestone at its No. 3 plant at Kingston for use in road construction.

Ulster County was the leading clay producing area in the State. Increased consumption of clay and shale was reported for the manufacture of lightweight aggregate. Nytralite Aggregate, Inc., Division of Lone-Star Cement Corp. and Hudson Lightweight Stone, Division of Colonial Sand & Stone Co., Inc., both located near Kingston and Hudson Valley Lightweight Aggregate Corp., Mt. Marion, were the producers. The Hutton Co. and Star Brick Corp., both of Kingston, mined clay for manufacturing building brick.

Building and paving sand was produced by Hurley Sand & Gravel Co., Inc., High Falls, and Inter-County Block Corp. produced building sand at Marlboro. A small quantity of paving gravel was produced near Milton.

Warren.—Glens Falls Portland Cement Co., a division of The Flintkote Co. produced portland and masonry cement at its Glens Falls plant, using as primary raw material limestone (cement rock) quarried in Saratoga County. Shipments were mostly to consumers in New York and New England. Barton Mines Corp. mined and processed abrasive garnet at its North Creek open pit mine and plant. The product was used as coated abrasive, for grinding and polishing glass and lapping metal. Garnet gem and mineral specimens from this area were in great demand. Some rough specimens and polished garnet from this deposit were marketed.

Limestone was mined and crushed for road construction by the Jointa Lime Co., Inc., at its Glens Falls quarry. Crushed granite and sand and gravel was produced near Chestertown by Warren Aggregates, Inc. The granite was for concrete aggregate, roadstone, stone sand, and riprap, and the sand and gravel was for paving.

Washington.—Dimension slate was produced by 11 operators with quarries at Granville (5), Middle Granville (3), Hampton (2), and East Whitehall. Flagging was the main use for the product as more than 80 percent of the total output was sold for this purpose. Tile was another important product. Other uses included structural and sanitary applications and roofing. Western Slate Co. was the leading producer followed by Darius Slate Products, The A. B. Potter Slate Co., Inc., and A. A. Hadeka Quarry. Crushed limestone was produced at Hudson Falls by Tri-County, Stone Co., Inc., for use as concrete aggregate and roadstone. A new operation, the Middle Falls quarry, owned by Batten Kill Stone, Inc., produced limestone aggregate and agstone. Paving gravel was produced by John Le Claire near Dresden. Building and fill sand and fill gravel were produced near Greenwich.

Wayne.—General Crushed Stone Co. quarried and crushed limestone at Sodus for use in road construction and as agstone. Dolomite Products Co. operated the Walworth quarry producing crushed limestone for concrete aggregate and roadstone. Construction sand and gravel was produced by three companies, the largest of which was M. A. Montemorano & Sons near Clyde.

Westchester.—Dimension granite was quarried near Yonkers by Baratta & D'Amato and Di Rienzo Brothers and near White Plains by Lake Street Granite Quarry, Inc. The greater part of the output was blocks for rough construction, rubble, and rough architectural uses. Granite for curbing and dressed construction and architectural uses also was produced. Uni-

versal Marble Products Corp. produced crushed marble near Thornwood chiefly for terazzo but also for a variety of uses such as stucco, garden nuggets, agstone, filler, and roofing granules. Camarco Materials & Supply Co., Carmel, and Peekskill Masons Supply Co., Peekskill, produced sand and gravel for construction.

Emery was produced from three open-pit mines near Peekskill. DeLuca Emery Mine, DiRubbo American Emery Ore, and Peekskill Emery Co. mined and sold emery for abrasive purposes and as an aggregate in heavy-duty, nonslip floors. Humus peat was recovered by Stone Age Humus Corp. from a bog near Armonk.

Wyoming.—Morton Salt Co. produced evaporated salt in vacuum pans at its Silver Springs plant. Sales were chiefly for food processing, chemical, and industrial purposes. Rough dimension sandstone (bluestone) for rubble was quarried near Portageville by the American Blue Stone Co.

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 Geological Survey of North Carolina for collecting information on all minerals except fuels.

By John W. Sweeney [1] and Stephen G. Conrad [2]

Mineral production in North Carolina set a record of almost $72 million, about $12 million above that of the previous record year of 1965. Principal commodities mined were stone, sand and gravel, phosphate rock, feldspar, mica, clay, and lithium minerals. Leading companies were Superior Stone Co., Ideal Cement Co., and Vulcan Materials Co.

North Carolina ranked first among the States in the production of lithium minerals, feldspar, and scrap mica, second in the production of olivine, and crushed granite, and third in talc.

Developments during the year included the following:

Approval of a contract between the North Carolina State Ports Authority and Texas Gulf Sulphur Co., calling for construction of a $10 million bulk cargo handling facility at Morehead City.

Construction was started on an additional potline at the Badin works

[1] Geologist, Bureau of Mines, Knoxville, Tenn.
[2] State geologist, North Carolina Department of Conservation and Development, Division of Mineral Resources, Raleigh, N.C.

Table 1.—Mineral production in North Carolina [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Clays [2] thousand short tons	3,383	$2,162	3,381	$2,241
Feldspar thousand long tons	279	3,153	302	3,157
Gem stones	NA	15	NA	15
Mica:				
Scrap thousand short tons	72	1,987	63	2,348
Sheet pounds	713,293	185	4,500	1
Sand and gravel thousand short tons	10,499	10,076	11,601	11,132
Stone [3] do	18,835	30,920	22,377	36,136
Talc and pyrophyllite do	110	556	113	576
Value of items that cannot be disclosed: Asbestos, cement, kaolin, lithium minerals, olivine, phosphate rock and stone (marble and slate)	XX	11,329	XX	16,272
Total	XX	60,383	XX	71,878

NA Not available. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes kaolin; included with "Value of items that cannot be disclosed."
[3] Excludes certain stone, included with "Value of items that cannot be disclosed."

for Aluminum Company of America that will increase capacity 50,000 tons per year.

Shallow drilling was begun for possible copper and other mineral deposits on land options in Cabarrus County held by Bear Creek Mining Co.

Plans to spend $2.6 million to expand the brickmaking operations of Boren Clay Products Co.

At yearend, 401.8 miles of North Carolina's total interstate Highway

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value
1957	$38,066
1958	41,521
1959	40,365
1960	44,196
1961	50,004
1962	54,352
1963	45,131
1964	r 54,932
1965	r 59,770
1966	p 70,355

r Revised. p Preliminary.

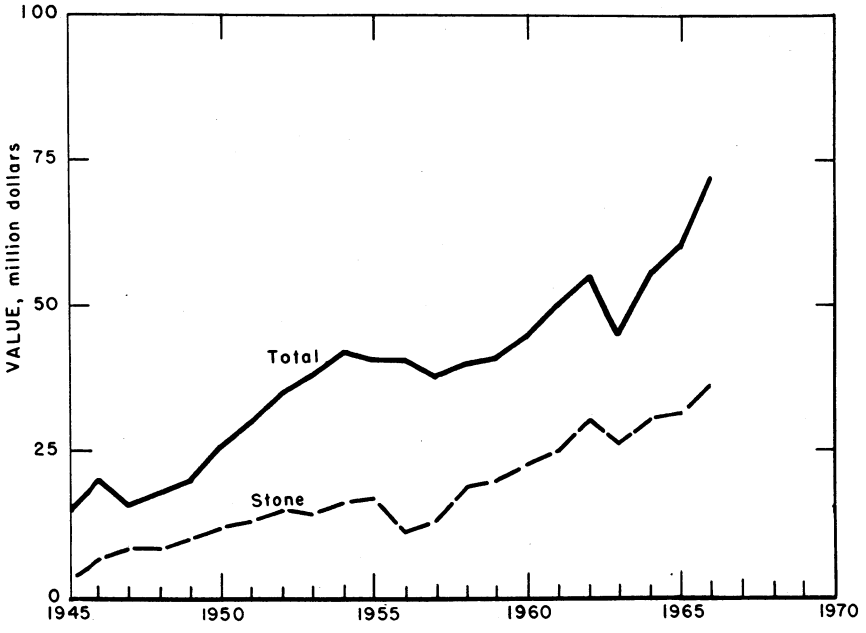

Figure 1.—Value of stone and total value of mineral production in North Carolina.

Table 3.—Employment 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
1965:								
Metal and nonmetal	1,749	238	416	3,297	3	91	28.51	6,727
Sand and gravel	863	229	197	1,702	-----	34	19.98	412
Stone	1,848	237	438	3,614	-----	46	12.73	910
Total	4,460	236	1,051	8,613	3	171	20.20	3,038
1966: p								
Metal and nonmetal	1,800	262	470	3,799	-----	95	25.01	738
Sand and gravel	1,000	217	217	1,839	-----	32	17.40	410
Stone	1,985	241	477	3,996	-----	69	17.27	4,373
Total	4,785	243	1,164	9,634	-----	196	20.34	2,183

p Preliminary.

System mileage was open to traffic. Work was in progress on an additional 353.1 miles, and work had not started on the remaining 15.3 miles.

The North Carolina Department of Conservation and Development, Division of Mineral Resources, published an informative book on North Carolina geology and mineral resources.[3]

[3] Stuckey, Jasper L. North Carolina: Its Geology and Mineral Resources. North Carolina Dept. Conserv. and Devel., Div. Miner. Res., 1965, 550 pp.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Nonmetals accounted for the entire mineral production of the State. No metals or fuels were produced.

Asbestos.—Amphibole asbestos was mined by Powhatan Mining Co. near Burnsville, Yancey County. Output increased 66 percent in quantity and 69 percent in value.

Cement.—Shipments of portland cement from the Castle Hayne plant of Ideal Cement Co. increased substantially during this plant's third year of production.

Types I and II, general-use and moderate-heat, and Type III, high-early-strength, cements were produced. Of the total shipments of portland cement, 51 percent was within the State, 32 percent was made to Florida, 5 percent to South Carolina, 4 percent to Oregon, and the remainder to other States and foreign countries. Seventy-three percent of masonry cement shipments was in North Carolina. Florida and South Carolina each received 11 percent, and other States and foreign countries the remaining 5 percent. The cement was shipped chiefly in bulk; 63 percent by truck, 35 percent by railroad, and 2 percent by boat. Sales of portland cement were to ready-mixed concrete companies (69 percent), concrete product manufacturers (14 percent), highway contractors (6 percent), building material dealers (5 percent), and others (6 percent).

Clay.—The quantity of miscellaneous clay produced remained about the same, but value increased 4 percent. Miscellaneous clay was mined by 27 companies from 32 pits in 20 counties for manufacturing brick, lightweight aggregate, vitrified sewer pipe, and other clay products. Principal producers were Sanford Brick Corp., Carolina Solite Corp., Boren Clay Products Co., Borden Brick and Tile Co., and Pine Hall Brick and Pipe Co.

Kaolin output decreased 14 percent in tonnage and 17 percent in value. Harris Clay Co., Avery County, was the only kaolin producer.

Feldspar.—Crude feldspar production increased 8 percent, but value remained about the same. Mixed and soda feldspar made up the bulk of the tonnage, with some potash type produced. Of the total crude output, 94 percent was in the form of flotation concentrate. International

Table 4.—Miscellaneous clay sold or used by producers, by counties

County	1965		1966	
	Short tons	Value	Short tons	Value
Catawba	W	W	126,000	W
Chatham	398,976	$258,135	367,402	$250,038
Cumberland	40,000	26,000	W	W
Davidson	80,000	25,000	70,000	21,000
Halifax	W	W	83,140	W
Harnett	68,620	44,600	W	W
Lee	543,636	364,500	549,109	377,000
Montgomery	W	W	13,413	9,000
Rockingham	W	W	204,000	W
Rowan	253,024	164,500	230,568	182,900
Stanly	W	W	443,680	287,000
Union	165,585	82,792	182,833	119,000
Undistributed [1]	1,833,385	1,196,355	1,060,567	995,113
Total	3,383,226	2,161,882	3,380,712	2,241,051

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

[1] Includes Alamance, Durham, Guilford, Henderson, Johnston, Moore, New Hanover, Sampson (1965), and Stokes Counties, and counties indicated by symbol W.

Minerals & Chemical Corp. (Hawkins mine), Lawson-United Feldspar and Minerals Co. (Minpro mine), The Feldspar Corp. (Poteat and Wiseman mines), and Roy Grindstaff (Fluking Ridge mine) were the leading firms mining alaskite and recovering feldspar concentrate in Mitchell County. Kings Mountain Mica Co. (Moss and Patterson mines) and Foote Mineral Co. (Kings Mountain mine) recovered by-product feldspar from their operations in Cleveland County. Crude lump feldspar from Mitchell and other counties comprised the balance of the production.

Sales of ground feldspar totaled 337,000 tons, an 11-percent increase over those of 1965. Value was $3.7 million, an increase of 7 percent. Ground feldspar was used mainly for glass and pottery with a small amount for enamel. Shipments were made to Illinois (15 percent), Ohio (13 percent), Tennessee (10 percent), West Virginia (9 percent), Texas (7 percent), and other States and exports (46 percent).

Lithium.—Foote Mineral Co. mined and milled spodumene at Kings Mountain, Cleveland County. Production increased 16 percent in tonnage, and value increased 9 percent.

Mica.—Production of scrap mica was 63,000 tons valued at $2 million, a decrease of 12 percent in tonnage, but an increase of 18 percent in value. Production of sheet mica was only 4,500 pounds. Output was reported from 13 mines in 5 counties, compared with 15 mines in 5 counties in 1965 and 78 mines in 10 counties in 1962. Cleveland County with four mines accounted for 54 percent of the total value of mica production; Mitchell County with five mines accounted for 15 percent; Avery, Macon, and Yancey Counties accounted for 31 percent. Principal scrap mica producers were Deneen Mica Co., Kings Mountain Mica Co., Inc., Harris Clay Co., Southern Mica Co. of North Carolina, and The Feldspar Corp. Output of ground mica decreased 12 percent and the value decreased 5 percent. Nine mica grinders were active; both wet and dry processes were used. The ground mica was used for roofing (35 percent), paint (17 percent), and rubber (10 percent), and the remaining 38 percent was used for wallpaper, plastic, well drilling, and other uses.

Olivine.—Output of olivine increased 19 percent in tonnage and 23 percent in value to set a production record for the State. The material was used for refractories, molding sand, and slag conditioner. Mines were operated in Jackson County by Harbison-Walker Refractories Co. and Balsam Gap Co. and in Yancey County by Northwest Carolina Olivine, Inc.

The major manufacturing assets of E. J. Lavino and Co. are to be acquired by International Minerals and Chemical Corp. This will include E. J. Lavino's Balsam Gap Co.

Phosphate Rock.—The Lee Creek fertilizer complex of Texas Gulf Sulphur Co. went into production on April 1, a shipment of dried phosphate ore was made to Europe. The shipment ended the first phase of development for the $80 million industrial complex that began in 1964. The second phase will end with the first shipments of chemical fertilizers. The installation is designed to produce 3 million tons of phosphate rock per year. In addition, product plants under construction at the Lee Creek complex include the following: Sulfuric acid, 1 million tons per year; phosphoric acid, 54 percent, 640,000 tons per year; triple superphosphate, 357,000 tons per year; diammonium phosphate,

Table 5.—Ground mica sold or used by producers, by uses

Use	1965			1966		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Roofing	24,139	$809,981	$33.55	18,491	$621,298	$33.60
Paint	7,896	1,189,430	150,64	8,700	1,155,985	132.87
Rubber	4,548	644,592	141.73	5,314	684,620	128.83
Plastic	474	61,677	130.12	503	68,400	135.98
Other uses[1]	21,988	1,039,431	47.27	19,159	1,016,778	53.07
Total	59,045	3,745,111	63.43	52,167	3,547,081	67.99

[1] Includes wallpaper, well drilling, and other uses.

220,000 tons per year; superphosphoric acid, 89,800 tons per year. The entire installation is designed to permit doubling of capacity.

Texas Gulf Sulphur Co. furthered its anti-air-pollution program by installing air scrubbers to remove contaminants from stack exhausts, and the company also set up monitoring and weather stations.

Perlite.—Carolina Perlite Co., Inc. expanded perlite at Gold Hill, Rowan County, using crude material from other States. Quantity and value remained about the same.

Sand and Gravel.—Sand and gravel continued to be the second leading mineral commodity produced in the State. Production increased 10 percent and came from 79 of the State's 100 counties. Commercial sand and gravel accounted for 66 percent of the total tonnage and value. Government-and-contractor output, which accounted for the remainder, increased 21 percent in quantity and 27 percent in value. Overall average unit values remained the same. Of the total tonnage produced, commercial operations provided 30 percent of the quantity and 33 percent of the value of sand and gravel used for building purposes and 27 percent and 31 percent of the tonnage and value, respectively, used for paving. Three percent of the commercial sand and gravel production was sold as unprocessed material. Industrial sand production (unground) accounted for less than 1 percent of the total tonnage and value. Forty-seven companies operated 56 pits in 31 counties, compared with 51 pits in 30 counties in 1965. Commercial sand and gravel was produced in 14 counties, sand only in 11 counties, and gravel only in 6 counties. Leading producers were the North Carolina State Highway and Public Works Commission, Becker County Sand and Gravel Co., lessees of B. V. Hedrick Gravel and Sand Co., and W. R. Bonsal Co.

Table 6.—Sand and gravel sold or used by producers, by counties

(Thousand short tons and thousand dollars)

County	1965		1966	
	Quantity	Value	Quantity	Value
Alexander	36	$14	34	$14
Avery	W	W	43	30
Beaufort	107	38	124	39
Bertie	7	2	8	2
Bladen	75	48	395	238
Brunswick	40	25	55	37
Buncombe	W	W	776	W
Burke	W	W	85	W
Cabarrus	W	W	6	4
Caldwell	W	W	139	231
Camden	14	9	12	8
Carteret	8	3	10	3
Caswell	4	4	14	14
Catawba	43	17	65	28
Chowan	4	1	8	2
Cleveland	W	W	154	W
Columbus	73	48	101	59
Craven	W	W	57	W
Cumberland	W	W	308	W
Currituck	7	4	12	8
Dare	2	1	4	3
Davidson	350	175	357	179
Davie	36	22	36	23
Duplin	15	9	25	17
Edgecombe	133	109	188	167
Forsyth	122	147	112	138
Franklin	5	2	4	2
Gates	20	12	9	6
Granville	5	5	-----	-----
Greene	62	22	67	21
Guilford	3	3	-----	-----
Harnett	W	W	1,924	2,194
Haywood	W	W	350	W
Hertford	23	6	22	6
Hoke	20	6	8	5
Hyde	5	1	5	1
Iredell	53	21	63	26
Johnston	40	39	32	33

See footnotes at end of table.

Table 6.—Sand and gravel sold or used by producers, by counties—Continued

(Thousand short tons and thousand dollars)

County	1965		1966	
	Quantity	Value	Quantity	Value
Jones	45	16	40	12
Lee	293	238	275	262
Lincoln	51	21	69	34
Macon	8	6	-----	-----
Martin	-----	-----	14	4
McDowell	219	134	106	72
Mitchell	W	W	274	W
Montgomery	52	21	48	52
Moore	648	353	541	317
Nash	-----	-----	65	26
New Hanover	12	8	-----	-----
Northampton	W	W	200	W
Onslow	18	11	15	10
Pamlico	3	1	3	1
Pasquotank	18	11	18	12
Pender	36	23	25	17
Perquimans	6	4	7	5
Person	3	3	1	1
Pitt	140	81	146	77
Polk	34	11	118	61
Randolph	-----	-----	11	5
Richmond	26	14	27	16
Robeson	140	83	145	89
Rockingham	4	4	3	3
Rowan	65	32	55	28
Rutherford	103	41	111	44
Sampson	W	W	25	17
Scotland	42	33	30	24
Stanly	2	4	-----	-----
Stokes	52	31	48	32
Surry	73	87	35	47
Union	45	34	48	36
Vance	4	2	-----	-----
Wake	8	6	2	2
Washington	4	1	7	2
Watauga	W	W	62	57
Wayne	W	W	44	36
Wilkes	29	21	22	20
Wilson	154	108	131	93
Yadkin	7	11	4	5
Yancey	W	W	108	117
Undistributed [1]	6,843	7,829	3,106	5,958
Total	10,499	10,076	11,601	11,132

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

[1] Includes Anson, Ashe, Clay (1966), Gaston, Halifax, Lenoir, Madison, and Transylvania (1966) Counties, and counties indicated by symbol W.

Stone.—Stone was the principal mineral commodity of the State, with crushed stone accounting for over 99 percent of the total production. Increased output of crushed granite, 16 percent in quantity and 15 percent in value, and crushed limestone, 18 percent in quantity and 15 percent in value over that of 1965, set new records for the State. Crushed traprock production increased 34 percent and 30 percent, respectively, in tonnage and value. Production of crushed sandstone (quartz) decreased 18 percent in tonnage, but the value increased 15 percent. Crushed marble output increased in tonnage, but declined slightly in value. Performance of the dimension stone industry with respect to 1965 varied. Output of dimension granite decreased in tonnage, but increased in value, whereas dimension slate increased in tonnage, but decreased in value. Dimension marble production increased in tonnage but decreased in value. Byproduct quartz was recovered from feldspar flotation plants in Mitchell County.

Stone was quarried in a total of 49 counties: Granite in 34, traprock in 9, limestone in 7, slate in 2, sandstone in 1, and marble in 1. Commercial stone, excluding quartz, was produced by 31 operators from 85 quarries; 62 granite, 11 limestone, 7 traprock, 2 slate, 2 sandstone, and 1 marble. The State highway department crushed stone from six granite and three traprock quarries.

Table 7.—Sand and gravel sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1965			1966		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Paving	2,411	$1,626	$0.67	3,363	$2,300	$0.68
Structural	2,551	2,133	.84	2,376	2,023	.85
Fill	618	360	.58	996	616	.62
Blast	11	11	1.00	-----	-----	-----
Other sands [1]	758	332	.44	428	213	.50
Total	6,349	4,462	.70	7,163	5,152	.72
Gravel:						
Paving	2,422	2,619	1.08	2,643	2,865	1.08
Structural	1,169	1,888	1.62	1,116	1,698	1.52
Railroad ballast	24	21	.88	W	W	W
Fill	12	11	.92	W	W	W
Other gravel [2]	523	1,075	2.06	679	1,417	2.09
Total	4,150	5,614	1.35	4,438	5,980	1.35
Total sand and gravel	10,499	10,076	.96	11,601	11,132	.96

W Withheld to avoid disclosing individual company confidential data.

[1] Includes railroad ballast, filtration, and other sands.

[2] Includes uses indicated by symbol W and other gravel.

Leading producers of crushed stone were Superior Stone Co. (granite, limestone, and traprock); Vulcan Materials Co. (granite); Nello L. Teer Co. (granite and traprock); Ideal Cement Co. (limestone); Nantahala Talc and Limestone Co. (limestone); and Young Stone Co. Inc. (traprock).

Leading producers of dimension stone were North Carolina Granite Corp., Harris Granite Quarries, Comolli Granite Co., Columbia Marble Co., and Jacobs Creek Stone Co. (dimension slate).

Talc and Pyrophyllite.—Talc and pyrophyllite production increased 3 percent in tonnage and 4 percent in value. Sawed talc (crayons) production increased 50 percent in tonnage and 16 percent in value. Ground talc was sold principally for textile use and toilet preparations. Ground pyrophyllite was used mainly in refractories, ceramics, insecticides, and rubber products. Pyrophyllite was mined in Alamance, Moore, and Orange Counties, and talc in Cherokee County. Leading producers were Piedmont Minerals Co., Inc., Standard Minerals Co., Inc., and General Minerals Co.

Vermiculite.—W. R. Grace & Co. operated an exfoliating plant at High Point, Guilford County, and Lee-V-Lite Inc. operated an exfoliating plant at Sanford, Lee County, both companies used crude vermiculite shipped into the State. Principal uses for the finished product were as concrete aggregate, loose-fill insulation, and building plaster.

Table 8.—Crushed granite sold or used by producers, by counties

County	1965		1966	
	Short tons	Value	Short tons	Value
Cabarrus	80,530	$120,794	92,365	$138,547
Macon	82,557	82,557	173,846	217,300
Moore	18,265	22,000	-------	-------
Orange	24,480	36,720	18,885	28,330
Undistributed [1]	12,424,990	19,047,152	14,414,401	21,895,607
Total	12,630,822	19,309,223	14,699,497	22,279,784

[1] Includes Alamance, Alexander (1966), Alleghany (1966), Ashe (1966), Buncombe, Burke, Caldwell, Caswell, Catawba, Forsyth, Gaston, Guilford, Haywood (1966), Henderson (1965), Iredell, Jackson, Lincoln (1966), McDowell, Mecklenburg, Nash, Pitt (1966), Polk, Randolph, Rockingham, Rowan, Rutherford (1966), Surrey, Vance, Wake, Watauga (1966), Wilkes, Wilson, and Yadkin (1965) Counties.

REVIEW BY COUNTIES

Ninety-six of the 100 counties reported mineral production; New Hanover, Cleveland, Beaufort, Guilford, and Mitchell were the leading counties. The North Carolina State Highway and Public Works Commission produced sand and gravel, crushed granite and crushed traprock in 77 counties for paving, concrete, and roadstone use. These operations are not discussed in the following county sections. Counties with only sand and gravel production by the State highway department also are not discussed; see table *6* for additional details. In addition to the detailed production listed in table *9*, substantial quantities of crude feldspar and gem stones of undetermined county origin were produced.

Alamance.—Superior Stone Co., a division of Martin Marietta Corp. (Burlington quarry) crushed granite for concrete and roads. Hanford Brick Co., Inc. mined miscellaneous clay for heavy clay products from its Hanford mine near Burlington. Boren & Harvey, Inc. mined pyrophyllite at its Snow Camp mine for refractory and ceramic uses.

Table 9.—Value of mineral production in North Carolina, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Alamance	W	W	Granite, miscellaneous clay, pyrophyllite.
Alexander	$14,000	W	Granite, sand and gravel.
Alleghany	------	W	Granite.
Anson	W	W	Sand and gravel.
Ashe	W	W	Sand and gravel, granite.
Avery	W	W	Mica, kaolin, sand and gravel.
Beaufort	38,000	W	Phosphate rock, sand and gravel.
Bertie	2,000	$2,000	Sand and gravel.
Bladen	48,000	238,000	Do.
Brunswick	25,000	37,000	Do.
Buncombe	W	W	Sand and gravel, stone.
Burke	W	W	Granite, sand and gravel.
Cabarrus	W	941,847	Traprock, granite, sand and gravel.
Caldwell	W	W	Sand and gravel, granite.
Camden	9,000	8,000	Sand and gravel.
Carteret	3,000	3,000	Do.
Caswell	W	W	Granite, sand and gravel.
Catawba	W	W	Granite, miscellaneous clay, sand and gravel.
Chatham	396,946	380,811	Miscellaneous clay, traprock.
Cherokee	W	W	Marble, talc.
Chowan	1,000	2,000	Sand and gravel.
Clay	------	W	Limestone, sand and gravel.
Cleveland	W	W	Limestone, lithium minerals, mica, feldspar, sand and gravel.
Columbus	48,000	59,000	Sand and gravel.
Craven	W	W	Limestone, sand and gravel.
Cumberland	W	W	Sand and gravel, miscellaneous clay.
Currituck	4,000	8,000	Sand and gravel.
Dare	1,000	3,000	Do.
Davidson	W	W	Traprock, sand and gravel, slate, miscellaneous clay.
Davie	22,000	23,000	Sand and gravel.
Duplin	9,000	17,000	Do.
Durham	W	W	Traprock, miscellaneous clay.
Edgecombe	109,000	167,000	Sand and gravel.
Forsyth	W	W	Granite, sand and gravel.
Franklin	2,000	2,000	Sand and gravel.
Gaston	W	W	Sand and gravel, granite.
Gates	12,000	6,000	Sand and gravel.
Granville	5,000	------	
Greene	22,000	21,000	Sand and gravel.
Guilford	W	W	Granite, traprock, miscellaneous clay.
Halifax	W	W	Sand and gravel, miscellaneous clay.
Harnett	W	W	Do.
Haywood	W	W	Sand and gravel, granite.
Henderson	464,557	W	Limestone, miscellaneous clay.
Hertford	6,000	6,000	Sand and gravel.
Hoke	6,000	5,000	Do.
Hyde	1,000	1,000	Do.
Iredell	W	W	Granite, sand and gravel.
Jackson	W	W	Granite, olivine.
Johnston	W	W	Traprock, sand and gravel, miscellaneous clay.
Jones	16,000	12,000	Sand and gravel.
Lee	602,500	639,000	Miscellaneous clay, sand and gravel.
Lenoir	W	W	Sand and gravel.
Lincoln	21,000	W	Sand and gravel, granite.
Macon	130,782	235,584	Granite, mica.

See footnote at end of table.

Table 9.—Value of mineral production in North Carolina, by counties [1]—Continued

County	1965	1966	Minerals produced in 1966 in order of value
Madison	W	W	Sand and gravel.
Martin	------	$4,000	Do.
McDowell	W	W	Sand and gravel, granite.
Mecklenburg	W	W	Granite.
Mitchell	$3,749,172	3,208,792	Feldspar, mica, sand and gravel, sandstone.
Montgomery	W	W	Sandstone, sand and gravel, miscellaneous clay, slate.
Moore	W	W	Sand and gravel, pyrophyllite, miscellaneous clay.
Nash	W	W	Granite, sand and gravel.
New Hanover	W	W	Cement, limestone, miscellaneous clay.
Northampton	W	W	Sand and gravel.
Onslow	W	W	Limestone, sand and gravel.
Orange	268,220	W	Pyrophyllite, granite.
Pamlico	1,000	1,000	Sand and gravel.
Pasquotank	11,000	12,000	Do.
Pender	23,000	17,000	Sand and gravel.
Perquimans	4,000	5,000	Do.
Person	3,000	1,000	Do.
Pitt	81,000	W	Sand and gravel, granite.
Polk	W	W	Granite, sand and gravel.
Randolph	W	W	Do.
Richmond	14,000	16,000	Sand and gravel.
Robeson	83,000	89,000	Do.
Rockingham	W	W	Granite, miscellaneous clay, sand and gravel.
Rowan	W	W	Do.
Rutherford	41,000	W	Granite, sand and gravel.
Sampson	W	17,000	Sand and gravel.
Scotland	33,000	24,000	Do.
Stanly	W	347,810	Miscellaneous clay, traprock.
Stokes	W	W	Miscellaneous clay, sand and gravel.
Surry	W	W	Granite, traprock, sand and gravel.
Swain	152,634	102,340	Limestone.
Transylvania	------	5,000	Sand and gravel.
Union	W	W	Traprock, miscellaneous clay, sand and gravel.
Vance	W	W	Granite.
Wake	W	W	Granite, sand and gravel.
Washington	1,000	2,000	Sand and gravel.
Watauga	W	W	Sand and gravel, granite.
Wayne	W	36,000	Sand and gravel.
Wilkes	W	W	Granite, sand and gravel.
Wilson	W	W	Do.
Yadkin	W	5,000	Sand and gravel.
Yancey	W	W	Mica, olivine, sand and gravel, asbestos.
Undistributed	53,899,189	65,167,816	
Total	60,383,000	71,878,000	

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

[1] The following counties are not listed because no production was reported: Graham, Tyrrell, and Warren.

Alexander.—Carl W. Clement Co. crushed granite at its Taylorsville quarry for concrete and road use.

Anson.—Lessees of B. V. Hedrick Gravel and Sand Co. (Lilesville mine) and W. R. Bonsal Co., Inc. (Bonsal mine) mined sand and gravel for building, paving, railroad ballast, filtration, and miscellaneous uses.

Ashe.—Maymead Lime Co., Inc. (Buffalo mine), and Lyalls Construction Co. (Jefferson mine) mined sand and gravel for paving. C. W. McCreary (Ashe quarry) and Blythe Bros. (Ashe quarry) crushed granite for concrete and roads.

Avery.—Harris Clay Co. recovered mica and kaolin at its Gusher Knob mine. This firm and English Mica Co. ground mica for roofing, paint, rubber, wallpaper, plastic, well drilling, and other uses. Clark, Anderson, & Guy (Frank mine) mined gravel for paving use.

Beaufort.—Texas Gulf Sulphur Co. made its first shipment of phosphate ore April 1. The phosphate rock stockpile was built-up during the year. Construction of plant facilities was in progress.

Buncombe.—Seven companies mined sand and gravel for building, paving, railroad ballast, and fill uses. Leading producers were Grove Stone & Sand Branch (Grove mine) and Western Stone Co., Inc. (Asheville mine). Vulcan Materials Co. (Enka quarry) and J. L. Colville Construction Co. (Buncombe County quarry) crushed granite for concrete and roads. Asheville Mica Co. produced ground mica.

Burke.—Great Lakes Carbon Corp. manufactured carbon and graphite products at its Morgantown plant. A. P. Causby Stone Co. (Causby quarry) crushed granite for concrete and road use. Clark, Anderson, & Guy, A. P. Causby Sand Co., and A. R.

Thompson, Contractor, Inc., mined sand and gravel for building and paving use.

Cabarrus.—Young Stone Co. crushed traprock from its Gold Hill quarry for concrete and road use. Morrison & White mined sand and gravel for paving.

Caldwell.—Miller Brothers Co. mined paving sand and gravel. Carl W. Clement Co. crushed granite at the Whitmill quarry for concrete and road use.

Catawba.—Superior Stone Co. crushed granite at the Hickory quarry for concrete and road use. Statesville Brick Co. mined miscellaneous clay at the Statesville mine for heavy clay products.

Chatham.—Pomona Terra Cotta Co. (Gulf mine), Sanford Corp., and Boren Clay Products Co. (Gulf mine), mined miscellaneous clay for heavy clay products.

Cherokee.—Columbia Marble Co. (Pleasant Valley quarry) quarried dimension marble for rough interior; sawed and cut interior building stone; cut and dressed monumental stone; and crushed marble for terrazzo, roofing granules, and other uses. Hitchcock Corp. (Nancy Jordan mine) mined talc for crayons, toilet preparations, textiles, and other uses.

Clay.—Nantahala Talc and Limestone Co. crushed limestone at the Brasstown quarry for concrete and road use, and mined paving gravel near Andrews.

Cleveland.—Superior Stone Co. (Kings Mountain Nos. 1, 2, and Shelby quarries), crushed limestone for concrete and road use. Foote Mineral Co. at Kings Mountain mined and milled lithium minerals and also produced byproduct feldspar for glass. Kings Mountain Mica Co., Inc. (Moss and Patterson mines), U.S. Gypsum Co. (Industrial mine), and Foote Mineral Co. (Kings Mountain mine), produced scrap mica. Kings Mountain Mica Co. recovered byproduct feldspar from the Moss mine. Shelby Sand & Stone, Inc. (First Broad River mine) mined sand for building, paving, and fill uses.

Craven.—Superior Stone Co. crushed limestone from the New Bern quarry for concrete and roads and Southern Sand Co. (New Bern mine) mined building and stabilization sand.

Cumberland.—Becker County Sand & Gravel Co. (Fayetteville mine) mined building, paving, and fill sand and gravel. Ideal Brick Co., Inc. (Linden mine) mined miscellaneous clay near Fayetteville for heavy clay products.

Davidson.—Superior Stone Co. (Lexington quarry) crushed traprock for concrete and roads. Jacob's Creek Stone Co., Inc. (Flagstone quarry) quarried dimension slate for structural millstock and flagging. Cunningham Brick Co. (Thomasville mine) mined miscellaneous clay for heavy clay products.

Durham.—Nello L. Teer Co. (Durham County quarry) crushed traprock for concrete and roads. Tri-Angle Brick Co. (Durham mine) and Borden Brick & Tile Co. (Durham mine) mined miscellaneous clay for heavy clay products.

Edgecombe.—Quality Sand & Gravel Co. (Rocky Mount mine), and Tar River Sand and Gravel (Whitehurst mine), mined building, paving, fill, and stabilization sand and gravel.

Forsyth.—Vulcan Materials Co. (North, Piedmont, and 421 quarries) crushed granite for concrete and roads. Ira Pope & Sons, Inc. (Yadkin River mine) mined building and paving sand.

Gaston.—H. D. Bartlett Sand Co. (Charlotte mine) mined paving sand, and Superior Stone Co. crushed granite at the Gaston quarry for concrete and roads.

Guilford.—Superior Stone Co. (Pomona, Jamestown, and Buchanan quarries) and Vulcan Materials Co. (Stokesdale quarry) crushed granite for concrete, roads, and railroad ballast. Superior Stone Co. crushed traprock from the Hicone quarry for concrete and roads. Boren Clay Products Co. (Pleasant Garden mine), mined miscellaneous clay for heavy clay products. W. R. Grace & Co. exfoliated vermiculite at its High Point plant.

Halifax.—Superior Stone Co. (Weldon mine) mined paving sand and gravel. Nash Brick Co., Inc. (Ita and Page mines), mined miscellaneous clay for heavy clay products. Albemarle Paper Manufacturing Co. recovered quicklime at the Roanoke Rapids mill.

Harnett.—Becker County Sand & Gravel Co. (Senter mine), Nello L. Teer Co. (Erwin mine), and Erwin Sand & Gravel Co. (Williams mine), mined sand and gravel for building, paving, fill, railroad ballast, and other uses. Carolina Lightweight Aggregate Co., Inc., mined miscellaneous clay for lightweight aggregate manufacture and Norwood Brick Co. (Lilling-

ton mine) mined miscellaneous clay for heavy clay products.

Haywood.—A. M. Sale, Inc., mined paving sand and gravel from the Waynesville mine. Carl W. Clement Co. crushed granite from the Pigeon River quarry for concrete and roads. Champion Papers, Inc. recovered quicklime at the Canton mill.

Henderson.—Fletcher Limestone Co., Inc. and Cogdill Limestone Co. crushed limestone for concrete and roads. Moland-Drysdale Corp. (Fletcher mine) mined miscellaneous clay for heavy clay products.

Iredell.—Gilbert Engineering Co. (Mooresville quarry) and Superior Stone Co. (Statesville quarry) crushed granite for concrete, roads, and stone sand.

Jackson.—Rock Products, Inc. crushed granite at the Dillsboro quarry for concrete, roads, and stone sand. Harbison-Walker Refractories Co. (Addie quarry) and Balsam Gap Co. (Balsam Gap mine) mined olivine for refractories, molding sand, and slag conditioners.

Johnston.—Nello L. Teer Co. (Princeton quarry) crushed traprock for concrete and roads. Crumpler Brick & Tile Co. (Smithfield mine) mined miscellaneous clay for heavy clay products.

Lee.—Sanford Brick & Tile Co. (Colon mine), Borden Brick & Tile Co. (Sanford mine), and Lee Brick & Tile Co. (Sanford mine) mined miscellaneous clay for heavy clay products. Lee-V-Lite, exfoliated vermiculite at its Sanford plant.

Macon.—Franklin Construction Co. (Tubb Mill quarry) crushed granite for concrete and roads. Eugene Owenby (Sheppard Knob mine) mined sheet and scrap mica. Franklin Mineral Products Co. ground mica for paint, rubber, wallpaper, plastic, and other uses.

McDowell.—McCreary Construction Service, Inc. (Woodlawn mine), and E. P. Boyd (Clear Creek mine), mined sand and gravel for paving. Pendley & Duncan crushed granite from the Pendley quarry for concrete and roads.

Mitchell.—International Minerals & Chemical Corp. (Hawkins mine), Lawson-United Feldspar & Minerals Co. (Minpro mine), The Feldspar Corp. (Poteat and Wiseman mines), and Roy Grindstaff (Fluking Ridge mine) mined crude feldspar. Ground feldspar for glass, pottery, enamel, and filler uses was produced by International Minerals & Chemical Corp. (Kona and Spruce Pine plants), Lawson United Feldspar & Minerals Co. (Feldspar plant), and The Feldspar Corp. (Spruce Pine plant). Quartz was recovered from these feldspar milling operations and was used for concrete, roads, glass, and pottery. Southern Mica Co. of North Carolina (Bailey mine), The Feldspar Corp. (Poteat and Wiseman mines), International Minerals & Chemical Corp. (Hawkins mine), and Lawson-United Feldspar Minerals Co. (Minpro mine) mined scrap mica. Diamond Mica Co., Carolina-Southern Manufacturing Co., Inc., and Lawson-Boone Mica Co. ground mica for paint, rubber, wallpaper, plastic, roofing, well drilling, and other uses. Pitman Stone Co., Inc. (Bakersville mine), and Crabtree Stone & Gravel Co. mined sand and gravel for paving use.

Montgomery.—Southern Aggregates, Inc. and Thomas & Woody Manufacturing Co. produced quartz for use as ornamental aggregate and precast panels, respectively. Mt. Gilead Brick Co. mined miscellaneous clay from the Mt. Gilead mine for heavy clay products. Jacob's Creek Stone Co., Inc. (Edenboro quarry), quarried dimension slate for structural millstock and flagging.

Moore.—Five companies mined sand and gravel for building, paving, and fill. The leading producers were Pleasant Sand & Supply Co. and Aberdeen Sand & Gravel Co. Standard Mineral Co., Inc. and General Minerals Co. (Glendon mine) mined and ground pyrophyllite for ceramics, insecticides, paint, rubber, brick and plaster, and refractory uses. Borden Brick & Tile Co. mined miscellaneous clay for heavy clay products.

New Hanover.—Ideal Cement Co. manufactured portland and masonry cement at its 3.5 million barrel wet process plant near Castle Hayne. Raw materials used in cement manufacture were limestone, from the firm's Wilmington quarry, miscellaneous clay, from its Wilmington mine, gypsum, mill scale, pyrite cinder, and other iron-rich slags. Two 11-by-450-foot rotary kilns were operated. A total of 84 million kilowatt-hours of electricity was consumed; all was purchased. Superior Stone Co. (Castle Hayne quarry) crushed limestone for concrete and roads.

Orange.—Piedmont Minerals Co., Inc. (Hillsboro mine) mined pyrophyllite for ceramics, refractories, and brick and plaster

products. Duke University quarried dimension granite for building stone and rubble.

Pitt.—Hurst Concrete Products Co., Inc. (Greenville mine) and White Concrete Co., Inc. (Munford mine) mined sand for building and other uses. Superior Stone Co. (Fountain quarry) crushed granite for concrete and roads.

Polk.—Carl W. Clement, Contractor, Co. (Columbus quarry) and A. R. Thompson, Contractor, Inc. (Mill Spring quarry) crushed granite for concrete and roads.

Rockingham.—Superior Stone Co. crushed granite from the Reidsville quarry for concrete and roads. Virginia Solite Corp. (Leakesville mine) mined miscellaneous clay for use in the manufacture of lightweight aggregates. Webster Brick Co., Inc. mined miscellaneous clay from the Draper mine for heavy clay products.

Rowan.—Superior Stone Co. (Woodleaf and Kannapolis quarries) crushed granite for concrete, roads, and railroad ballast. Five companies quarried dimension granite from seven quarries for use as rough and dressed monumental stone, curbing and flagging, and rubble. The leading producer was Harris Granite Quarries Co. (Collins, Balfour, and Shuping quarries). Carolina Tuff-Lite Corp. and Isenhour Brick & Tile Co. (East Spencer and Clearwater mines) mined miscellaneous clay for lightweight aggregate and heavy clay products, respectively. Carolina Perlite Co., Inc., expanded crude perlite shipped from Colorado at the Gold Hill plant for use as building plaster, concrete aggregate, soil conditioner, insulation, and charcoal base.

Rutherford.—A. R. Thompson Contractor, Inc. crushed granite at the Miller Creek quarry near Rutherfordton for concrete and roads.

Stanly.—Carolina Solite Corp. (Aquadale mine), Stanley Shale Products, Inc. (Norwood mine), and Yadkin Brick Yards, Inc., mined miscellaneous clay for lightweight aggregate and heavy clay products.

Stokes.—Pine Hall Brick & Pipe Co. (No. 1 mine) mined miscellaneous clay for heavy clay products.

Surry.—Vulcan Materials Co. (Elkins, Pilot Mountain, and Mount Airy quarries) and North Carolina Granite Corp. crushed granite for concrete, roads, riprap, and poultry grit. North Carolina Granite Corp. (Mt. Airy quarry), quarried dimension granite for rough and dressed monumental stone, paving blocks, curbing, flagging, rough and dressed architectural stone, and rubble. Ararat Products Co. (Surry quarry) crushed traprock for concrete and roads. Mt. Airy Sand Co. mined paving and fill sand.

Swain.—Nantahala Talc & Limestone Co. crushed limestone at its Hewitt quarry near Andrews. The material was used for concrete, roads, and agricultural stone.

Union.—Superior Stone Co. (Bakers quarry) mined and crushed traprock for concrete, roads, and railroad ballast. Kendrick Brick & Tile Co. mined miscellaneous clay from the Monroe mine for heavy clay products.

Wake.—Nello L. Teer (Crabtree and Raleigh quarries) and Superior Stone Co. (Garner and Knightdale quarries) crushed granite for concrete and roads.

Watauga.—Maymead Lime Co., Inc. (Maymead mine) and J. W. Hampton Stone Co. (Boone mine) mined sand and gravel for paving. J. L. Colville Construction Co. crushed granite form the Watauga quarry for concrete and roads.

Wilson.—Superior Stone Co. crushed granite for roadstone and for railroad ballast at Neverson Gray Concrete Pipe Co., Inc. (Stantonsburg mine) and Deans Sand Co. (Wilson mine) mined sand for paving, building, fill, and stabilization uses.

Yancey.—Deneen Mica Co. (International mine) produced scrap mica. Deneen Mica Co. and Hassett Mining Co. ground mica for roofing, well drilling, and other uses. Northwest Carolina Olivine, Inc. (Wray mine), mined olivine for refractory uses. The Feldspar Corp. ground feldspar at the Burnsville plant for use in pottery and enamel. Clark, Anderson, and Guy (Burnsville mine), Yancey Sand & Gravel Co., Inc. (Fox mine), McCrary Associates (Pensacola mine), and Deneen Mica Co. (International mine), mined sand and gravel for building, paving, and fill. Powhatan Mining Co. mined amphibole asbestos at Burnsville.

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 R. G. Raabe [1] and William C. Henkes [2]

North Dakota mineral production was valued at $101.8 million, 10 percent more than in 1965. Mineral fuels—coal (lignite), natural gas, natural gas liquids, peat, and crude petroleum—comprised most of the total value of mineral production. The quantity and value of metals and stone produced dropped sharply whereas sand and gravel production increased significantly.

Employment and Injuries.—Final employment and injury data for 1965 and prelim-

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[2] Petroleum engineer, Bureau of Mines, Denver, Colo.

Table 1.—Mineral production in North Dakota [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Clays—thousand short tons	81	$114	68	$92
Coal (lignite)—do	2,732	5,848	3,543	6,976
Gem stones	NA	1	NA	1
Natural gas (marketed)—million cubic feet	35,652	5,704	46,585	7,547
Natural gas liquids:				
LP gases—thousand gallons	85,174	3,066	91,884	3,859
Natural gasoline and cycle products—do	21,059	1,263	23,200	1,415
Petroleum (crude)—thousand 42-gallon barrels	26,350	65,875	27,126	69,170
Sand and gravel—thousand short tons	7,574	7,895	10,145	10,568
Stone—do	356	624	170	305
Uranium ore—short tons	44,558	1,359	W	W
Value of items that cannot be disclosed: Lime, molybdenum, peat, salt, vanadium (1965), and values indicated by symbol W	XX	1,129	XX	1,874
Total	XX	92,878	XX	101,807

NA Not available. W Withheld to avoid disclosing individual company confidential data, included with "Value of items that cannot be disclosed." XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]	Year	Value [1]
1957	$56,025	1962	$89,922
1958	59,440	1963	94,162
1959	68,196	1964	93,095
1960	78,670	1965	92,977
1961	84,858	1966	100,634

[1] Data for 1957–65 revised.

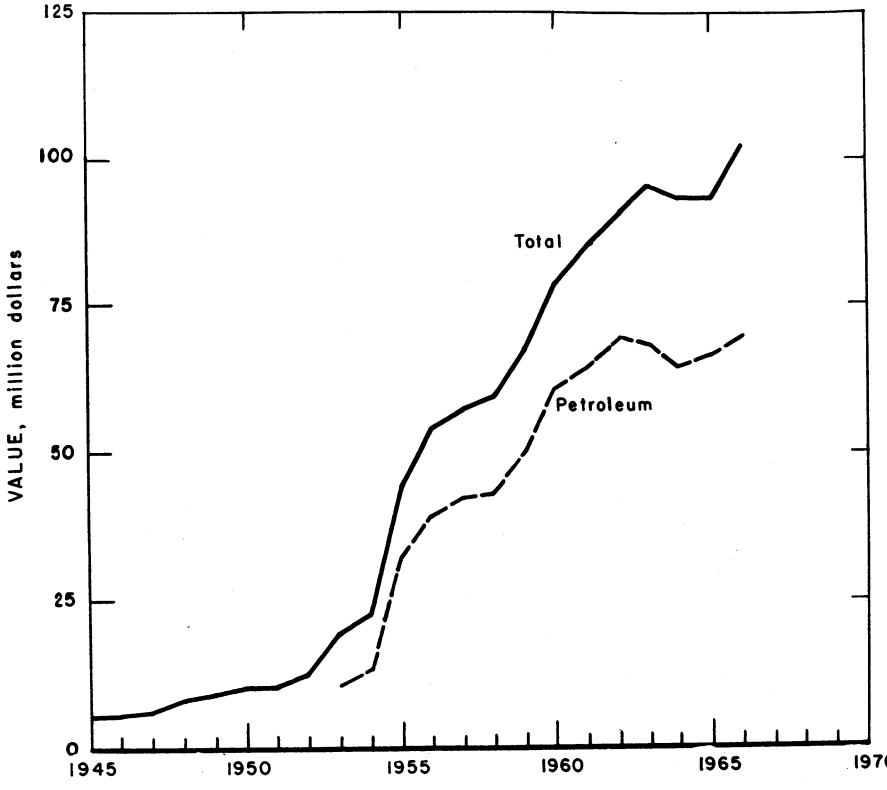

Figure 1.—Value of petroleum and total value of mineral production in North Dakota.

inary data for 1966—excluding all mineral fuels industries except coal—compiled by the Federal Bureau of Mines are shown in table.

Table 3.—Employment 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
1965:								
Coal and peat	324	195	63	500	1	22	46.00	14,018
Metal	55	217	12	96	---	2	20.93	6,477
Nonmetal	42	217	9	73	---	1	13.69	233
Sand and gravel	491	179	88	753	---	17	22.59	456
Stone	34	68	2	18	---	---	---	---
Total	946	184	174	1,440	1	42	29.86	5,577
1966: p								
Coal and peat	330	186	61	476	---	20	42.02	2,017
Metal	55	251	14	113	---	1	8.85	9
Nonmetal	25	302	8	60	---	1	16.67	433
Sand and gravel	550	169	93	806	---	15	18.61	443
Stone	15	69	1	9	---	---	---	---
Total	975	182	177	1,464	---	37	25.27	918

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REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Lignite).—Production of lignite coal reached a record high of 3.5 million tons, exceeding 3 million tons for the first time since 1955. The value of production was $7 million, 7 percent of the total value of mineral production in the State.

Truax-Traer Coal Co. Division, Consolidation Coal Co., which operated the Glenharold, Velva, and Kincaid mines, produced almost half of the State output. The Glenharold mine, site of the largest bucket-wheel excavator in the United States, alone yielded 30 percent of the total. Second leading producer was Knife River Coal Mining Co., which operated the Beulah and Peerless strip mines. Truax-Traer Coal Co. and Knife River Coal Mining Co. produced over 75 percent of the North Dakota lignite.

At Stanton, the site of several lignite mines including the Glenharold, the Leland Olds powerplant of Basin Electric Power Cooperative went on line, furnishing power early in the year; in addition, United Power Associates new steam-electric generating plant, adjacent to the Leland Olds plant, began operating in November. The two plants were fueled with lignite coal from nearby mines.

On September 10, Baukol-Noonan, Inc., and Great Northern Railway Co. completed joint exploration for new deposits of lignite coal. Three hundred and sixty-two drill holes averaging 144 feet deep were drilled in Burke, Divide, McKenzie, Mountrail, Renville, Ward, and Williams Counties; and Richland, Roosevelt, and Sheridan Counties of Montana. North Dakota, with over 350 billion tons, had the largest reserves of all ranks of coal in the United States.

Table 4.—Coal (lignite) production, by counties

(Short tons)
(Excludes mines producing less than 1,000 short tons)

County	1965	1966
Adams	17,388	21,162
Bowman	83,369	112,933
Burke	510,946	479,873
Burleigh	7,327	5,808
Dunn	1,058	---
Grant	19,515	17,924
Hettinger	2,500	2,318
McLean	46,038	38,380
Mercer	1,538,032	2,343,472
Morton	19,029	16,414
Oliver	3,323	110,849
Stark	77,769	91,885
Ward	400,429	293,821
Williams	5,212	8,000
Total	2,731,935	3,542,839

Natural Gas.—Production of dry gas declined appreciably because of reservoir depletion in the Cedar Creek field, Bowman County. Gas associated with crude oil (casinghead gas) increased substantially; because of the large volume of casinghead gas in comparison with dry gas, total gas output was up 31 percent. As in previous years, the casinghead gas was processed at three gas plants and, after removal of liquids, sold to Montana-Dakota Utilities Co.

Natural Gas Liquids.—The three gas plants processed more gas during the year and, consequently, produced more liquids than during the previous year. The Signal Oil & Gas Co. plant at Tioga, Williams County, and the Texaco Inc. plant at Lignite, Burke County, extracted sulfur as well as liquids from the processed gas.

Petroleum.—For the third successive year, output of crude oil increased slightly, reaching an alltime high for the State. From the discovery of oil in 1951 to the end of 1966, 257 million barrels were produced. Except for slight declines in 1957 and 1963, production had steadily increased. At yearend, 2,017 wells were producing oil in 99 fields from 116 reservoirs. Of these, 370 were classed as "stripper" (marginal) wells. Estimated[3] known primary- and secondary-recoverable reserves of oil were 667.6 million barrels, an increase of nearly 6 percent over those of 1965. Most of the increase was in the southwestern counties because of new discoveries in that area. Rocks of Mississippian age contained most of the reserves (76 percent); however, reserves in Ordovician rocks increased from 1.3 percent of the total in 1965 to 7.5 percent of the total in 1966.

A comprehensive report on the oilfields of North Dakota was published by the Federal Bureau of Mines.[4] The report dis-

[3] Folsom, Clarence B., Jr. North Dakota Crude Oil Inventory as of Jan. 1, 1967. North Dakota Geological Survey, Miscellaneous Series No. 29, 1967, p. 2.

[4] Hamke, J. R., L. C. Marchant, and C. Q. Cupps. Oilfields in the Williston Basin in Montana, North Dakota, and South Dakota. BuMines Bull. 629, 1966, 487 pp.

Table 5.—Drilling for petroleum in 1966, by counties

County	Oil	Dry	Total	Footage
Exploratory completions:				
Benson	---	1	1	2,850
Billings	---	4	4	33,577
Bottineau	2	10	12	43,866
Burke	---	4	4	28,825
Divide	---	2	2	13,199
Golden Valley	---	1	1	11,365
Grand Forks	---	1	1	598
Grant	---	2	2	9,408
McHenry	---	1	1	4,033
McKenzie	---	4	4	47,343
Mercer	---	1	1	8,075
Mountrail	---	2	2	19,097
Pierce	---	1	1	3,223
Renville	2	19	21	103,670
Rolette	---	1	1	2,707
Slope	1	---	1	11,566
Stark	2	---	2	19,535
Steele	---	1	1	661
Ward	---	10	10	58,943
Wells	---	2	2	6,515
Williams	1	---	1	10,396
Total	8	67	75	439,452
Development completions:				
Billings	20	5	25	219,611
Bottineau	17	10	27	96,887
Bowman	4	---	4	34,005
Burke	7	6	13	86,508
Divide	1	---	1	9,012
McHenry	---	1	1	4,660
McKenzie	8	3	11	114,173
Renville	10	11	21	102,362
Slope	1	2	3	34,546
Williams	1	1	2	19,663
Total	69	39	108	721,427
Total all drilling	77	106	183	1,160,879

Source: Committee on Statistics of Drilling, American Association of Petroleum Geologists.

cussed the development and problems of the industry, the geology of the Williston basin, transportation, refining, and details of the individual fields.

Exploratory drilling during the year resulted in eight discoveries, a success ratio of 9.6 percent. Seven of the discoveries were new fields; one was a new pay zone in the McGregor field. Most interest was created by the discovery of the Eleven Bar field in Slope County with the H. L. Hunt, No. 1 NPRR "A" well, sec 9, T136N, R101W. This well was completed flowing 640 barrels of oil per day from the Ordovician Red River formation at a depth of 11,500 feet. Although the discovery touched off a widespread leasing program in the southwestern part of the State, subsequent drilling in the field was disappointing—two dry holes and one small producer.

Two other significant discoveries were made by Continental Oil Co. and Texaco Inc., both in Stark County. The Continental well—the No. 1 Zahradnik, sec 34, T140N, R97W—was completed for an initial potential of 557 barrels per day, on pump, from the Health formation (Mississippian). The Texaco well was an Ordovician Red River formation discovery 50 miles east of the Eleven Bar field, which is the nearest Red River producing field. The well—No. 1 Schank, sec 15, T137N, R92W—was completed for a flow gage of 265 barrels of oil per day from 10,425 feet.

In June, the Fort Berthold Indian Agency held an oil- and gas-lease sale at which 2,796 acres was leased for a total bonus of $14,831. The State conducted five oil- and gas-lease sales at which 111,747 acres was leased for a total bonus of $154,389; response was varied with average bids ranging from $1.25 to $1.80 per acre.

Table 6.—Crude petroleum production, by counties

(Thousand 42-gallon barrels)

County	1965	1966	Principal fields in 1966 in order of production
Billings	1,252	2,180	Fryburg, Medora, Rocky Ridge.
Bottineau	2,685	2,642	Newburg, South Westhope, Wiley, Mohall, Haas.
Bowman	706	754	Cedar Creek.
Burke	3,392	2,992	North Tioga, Rival, Black Slough, Foothills, Portal.
Divide	293	352	North Tioga, Stoneview.
Dunn	24	33	Lost Bridge.
McHenry	54	43	Pratt.
McKenzie	7,538	7,490	Antelope, Blue Buttes, Charlson, Hawkeye, Clear Creek.
Mountrail	1,129	1,139	Tioga, White Earth, East Tioga.
Renville	2,525	2,252	Sherwood, Glenburn, Mouse River Park.
Slope	---	70	Eleven Bar.
Stark	104	111	Dickinson, West Dickinson, Buffalo Creek.
Ward	7	5	Southwest Aurelia.
Williams	6,641	7,063	Beaver Lodge, Tioga, Capa, Grenora.
Total	26,350	27,126	

Source: North Dakota Geological Survey.

The North Dakota Industrial Commission, in June, adopted a policy under which production restrictions could be imposed on any field where maximum oil recovery might not be obtained because of failure to initiate secondary-recovery projects. As a followup of the 1965 law providing for compulsory unitization of oil fields and gasfields, this law was part of the State continuing effort to insure maximum ultimate recovery of its oil and gas resources.

In July, Shell Oil Co., increased, by 10 cents per barrel, prices on about 41,000 barrels per day of crude oil production in the Williston basin, to bring the price of 40.0° to 44.9° API oil to $2.68 per barrel. In October, Pan American Petroleum Corp. increased its crude oil prices, affecting about 50,000 barrels per day, by 5 cents per barrel to $2.93 per barrel for 40.0° to 44.9° API crude.

Refinery activity was slightly higher than that during 1965; 17.5 million barrels of crude oil was run to stills, compared with 16.4 million barrels the previous year. A relatively small amount of oil, 235,000 barrels, was received from Montana. Slightly less than 10 million barrels of oil was shipped out of the State, virtually all to Minnesota.

The proposed expansion of the Williston refinery of Westland Oil Co., begun during the year, had not been completed by yearend.[5]

NONMETALS

Although the quantity and value of stone production decreased by more than 50 percent, the total value of nonmetals output increased 27 percent. The drop in stone production was offset by an appreciable increase in sand and gravel production.

Clays.—Clay output continued to decrease. Miscellaneous clay, including shale, was used in manufacturing lightweight aggregate and building brick. A small quantity of bentonite was produced for manufacturing prepared mortar.

Gem Stones.—Chalcedony (chiefly agate), jasper, petrified wood, and other gem stones and mineral specimens, valued at approximately $1,000, were collected.

Lime.—Lime production, reported for the first time in 1965, increased 6 percent in quantity and 5 percent in value. American Crystal Sugar Co. produced lime for use at its sugar factory at Drayton.

Salt.—The value of salt production, by solution mining from the Charles formation, increased 47 percent; the quantity produced increased 3 percent. Most of the salt was used for stock and other feeds. Other uses included food processing, oil refining, railroad car refrigeration, water softening, and ice removal from roads.

Sand and Gravel.—Output and value of sand and gravel, mostly used in constructing Federal-aid highways, increased 34 percent and comprised 10 percent of the State total value of mineral production.

At yearend, of a total 570.6 miles designated Interstate and Defense Highways System, 386 miles (26th in the Nation) was open to traffic, 105.8 miles was under construction, and 78.8 miles was not yet in progress.[6]

Ten leading commercial producers accounted for 33 percent of the total production and 36 percent of the total value of sand and gravel. Production by Government crews and contractors, 22 and 78 percent, respectively, was used almost entirely for road construction. Production came from 430 operations—193 commercial and 237 Government-and-contractor operations —52 percent more than in 1965.

Prices ranged from 40 cents per ton for miscellaneous gravel to $1.43 per ton for building gravel. The average value of all sand and gravel produced was $1.04 per ton, the same as that produced in 1965.

Stone.—Output of stone, used for riprap, concrete, and roadstone, decreased sharply. Contractors for the U.S. Army Corps of Engineers used stone in relocating the Northern Pacific Railway at the Oahe Reservoir project near Flasher and Mandan in Morton County; at the Garrison Dam and Reservoir for slope protection of the Snake Creek embankment in Burleigh County; and on the Missouri River, Garrison Dam to Oahe Reservoir bank stabilization, near Stanton in Mercer County.

Sulfur.—Elemental sulfur was recovered at natural gas processing plants at Lignite in Burke County and at Tioga in Williams County. Because of the difficulty in deter-

[5] Work cited in footnote 3, p. 9.
[6] Bureau of Public Roads. Quarterly Report on The Federal-Aid Highway Program, Dec. 31, 1966. Press Release BPR 67–5, Feb. 1, 1967.

Table 7.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	325	$392	538	$645
Paving	202	224	927	889
Fill	186	194	121	101
Other	---	---	1	1
Total	713	810	1,587	1,636
Gravel:				
Construction:				
Building	363	538	516	737
Paving	1,193	1,606	2,524	3,106
Railroad ballast	321	201	207	103
Fill	397	390	215	169
Other	2	1	---	---
Miscellaneous	---	---	10	4
Total	2,276	2,736	3,472	4,119
Total sand and gravel	2,989	3,546	5,059	5,755
Government-and-contractor operations:				
Sand: Paving	1,702	1,462	2,144	2,034
Gravel:				
Building	8	8	128	128
Paving	2,875	2,879	2,772	2,609
Fill	---	---	42	42
Total	2,883	2,887	2,942	2,779
Total sand and gravel	4,585	4,349	5,086	4,813
All operations:				
Sand	2,415	2,272	3,731	3,670
Gravel	5,159	5,623	6,414	6,898
Total	7,574	7,895	10,145	10,568

mining the source of some sulfur recovered at natural gas plants and petroleum refineries, particularly on the eastern seaboard and Gulf ports, the quantity and value recovered is not included in the States mineral production statistics.

METALS

Molybdenum.—Two companies reported recovery of molybdenum from uraniferous-lignite ores—Mines Development, Inc., a subsidiary of The Susquehanna Corp., from ores mined in Billings County, and Union Carbide Corp., from ores mined in Billings and Stark Counties. Quantity and value decreased in 1966.

Uranium Ore.—The quantity and value of uranium oxide, contained in ash derived from uraniferous lignite, decreased. Three firms—Union Carbide Corp., Susquehanna-Western, Inc., a subsidiary of The Susquehanna Corp., and Geo Resources Exploration, Inc.—mined uranium-bearing lignite in Billings, Slope, and Stark Counties. The uranium ore was recovered by strip mining lignite, which was concentrated into ash by burning. The ash was shipped to mills in Colorado and South Dakota for recovery of the contained uranium and molybdenum.

REVIEW BY COUNTIES

Billings.—Petroleum production increased 74 percent because of development drilling the Fryburg and Medora fields. Fryburg, with nearly 1.2 million barrels output, continued as the major oilfield in the county.

Uranium output, produced by burning uraniferous lignites, increased 30 percent in tonnage and 48 percent in value; byproduct molybdenum was recovered at processing plants in other States.

Bottineau.—The county ranked fourth in the State in oil production, which was vir-

Table 8.—Value of mineral production in North Dakota, by counties

County	1965	1966	Minerals produced in 1966 in order of value
Adams	$98,158	$74,804	Coal, sand and gravel.
Barnes	W	455,000	Sand and gravel.
Benson	101,000	369,000	Do.
Billings	3,690,684	6,280,602	Petroleum, uranium ore, sand and gravel, natural gas, molybdenum.
Bottineau	7,017,700	7,151,000	Petroleum, sand and gravel, natural gas, peat.
Bowman	2,243,018	2,275,331	Petroleum, coal, natural gas, sand and gravel.
Burke	12,071,775	11,637,988	Petroleum, LP gases, natural gas, coal, natural gasoline, sand and gravel.
Burleigh	932,752	575,338	Sand and gravel, coal, stone.
Cass	68,000	64,000	Sand and gravel.
Cavalier	255,000	315,000	Do.
Dickey	93,000	73,000	Do.
Divide	940,160	1,038,324	Petroleum, sand and gravel, natural gas, clays.
Dunn	361,400	100,000	Petroleum, natural gas.
Eddy	367,000	509,169	Sand and gravel, stone.
Emmons	3,000	135,000	Sand and gravel.
Foster	114,000	170,169	Sand and gravel, stone.
Golden Valley	12,000	10,000	Sand and gravel.
Grand Forks	326,000	730,000	Do.
Grant	169,507	163,697	Sand and gravel, coal.
Griggs	-----	80,000	Sand and gravel.
Hettinger	7,000	W	Sand and gravel, coal.
Kidder	58,000	115,420	Sand and gravel, stone.
La Moure	94,000	68,000	Sand and gravel.
Logan	-----	1,554	Stone.
McHenry	W	140,000	Petroleum, sand and gravel, natural gas.
McIntosh	203,000	W	Sand and gravel.
McKenzie	21,622,750	23,405,000	Petroleum, natural gas, LP gases, natural gasoline, stone, sand and gravel.
McLean	590,456	390,249	Sand and gravel, coal.
Mercer	3,131,411	4,456,517	Coal, stone, sand and gravel.
Morton	203,769	876,448	Sand and gravel, clays, coal, stone.
Mountrail	3,367,000	3,307,000	Petroleum, natural gas, sand and gravel.
Nelson	169,000	370,000	Sand and gravel.
Oliver	124,038	311,453	Coal, sand and gravel.
Pembina	W	W	Lime, sand and gravel.
Pierce	107,000	387,000	Sand and gravel.
Ramsey	270,000	416,000	Do.
Ransom	112,000	34,000	Do.
Renville	6,543,000	5,866,000	Petroleum, natural gas, sand and gravel.
Richland	223,000	393,000	Sand and gravel.
Rolette	249,000	362,000	Do.
Sargent	W	-----	
Sheridan	17,000	51,000	Sand and gravel.
Sioux	46,000	1,000	Do.
Slope	W	W	Petroleum, uranium ore, sand and gravel.
Stark	1,896,222	702,114	Petroleum, coal, uranium ore, stone, sand and gravel, natural gas, molybdenum.
Steele	W	96,000	Sand and gravel.
Stutsman	273,860	351,858	Sand and gravel, stone.
Towner	W	W	Sand and gravel.
Traill	309,000	274,000	Do.
Walsh	152,000	511,000	Do.
Ward	1,411,361	1,464,360	Sand and gravel, coal, petroleum, natural gas.
Wells	90,000	16,000	Sand and gravel.
Williams	21,415,531	24,273,136	Petroleum, natural gas, LP gases, salt, natural gasoline, sand and gravel, coal.
Undistributed [1]	1,328,567	959,583	
Total	92,878,000	101,807,000	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes gem stones and some sand and gravel (1965) that cannot be assigned to specific counties, and values indicated by symbol W.

tually the same as in 1965. At yearend, 23 fields were productive with the Newburg field continuing to have the highest production.

Sand and gravel output, used mostly for road construction, increased 75 percent.

The production of peat, mined and dried for use as a soil conditioner, from bog deposits at Turtle Mountain, increased.

Burke.—Although oil production declined 12 percent, the county was ranked third in output. Three of the four largest fields had declines. Drilling also declined; there were 4 exploratory and 13 development wells, compared with 10 and 23 wells respectively, in 1965.

Though production and value declined slightly, the county was again ranked second in the value of coal (lignite).

Eddy.—Although production and value of sand and gravel increased 21 and 37 percent, respectively, the county dropped from second to fourth in total State output. Sheyenne Sand & Gravel, Inc., the major producer in the county, sold building sand and gravel, and paving, railroad ballast, and fill gravel. Contractors for the North Dakota State Highway Department produced paving sand and gravel.

Grand Forks.—With production and value of sand and gravel increasing 87 and 124 percent, respectively, in 1966, the county was ranked third for total yield in the State. Seventy-eight percent of all sand and gravel was used for paving. Paving sand and gravel, produced by Bradshaw Gravel Supply and the North Dakota State Highway Department crews and contractors, comprised more than one-half of the county total.

McKenzie.—The county continued to rank first in oil production in the State; output was at about the same level as during 1965. Production was from 22 reservoirs in 14 fields. The Sanish (Mississippian/Devonian) at Antelope field and the Madison (Mississippian) at Blue Buttes field were the principal oil-producing reservoirs.

The county again ranked third in the State in the output of stone, 24 percent of the total—all produced by the McKenzie County Highway Department.

Mercer.—The quantity and value of coal (lignite) produced increased 52 and 41 percent, respectively, as the county continued to lead the State in lignite output: 66 percent of the total.

Morton.—The county ranked first in the output of sand and gravel and clay. Hebron Brick Co. produced miscellaneous clay for manufacturing brick and bentonite for use in prepared mortar. Baukol-Noonan, Inc., produced shale for manufacturing lightweight aggregates.

Northern Improvement Co. was the major sand and gravel producer in the county. The North Dakota State Highway Department and the U.S. Army Corps of Engineers produced paving sand and gravel; the Morton County Highway Department and Schriock Construction, Inc., produced paving gravel; Helm Bros., Inc., produced building sand and gravel and paving and fill gravel; and Mandan Transfer & Storage, Inc., produced building and fill sand and gravel.

Renville.—Although production declined 11 percent, the county ranked fifth in the State in oil output. Renville County had almost twice as many wildcat wells as the next most active county, Bottineau; two of these resulted in small oil discoveries.

Slope.—The county joined the ranks of oil producers in late July when the Eleven Bar field discovery well was completed. At yearend, the field had two producing wells and two dry holes.

The county also produced uranium ore and sand and gravel.

Stark.—Oil drilling resulted in two apparently significant and successful exploratory wells: Continental No. 1 Zahradnik and Texaco No. 1 Schank. The Texaco discovery was designated the Buffalo Creek field; the Continental was named West Dickinson. These new fields, offsetting the decline in production at the Dickinson field, accounted for the 7-percent increase in oil output.

The county dropped from first to second place in the production of uranium ore and byproduct molybdenum from lignite ash, and although the output increased by 18 percent, from fifth to sixth in coal (lignite) production.

Ward.—Although the county had the lowest oil production in the State, it accounted for 13 percent of the exploratory drilling; only Renville and Bottineau Counties had more wildcat activity. The reservoir depletion at the Southwest Aurelia field resulted in a 29-percent decline in oil output.

Output of sand and gravel increased in quantity and value 85 and 71 percent, respectively, ranking the county second in quantity and first in value for sand and gravel production in the State. Minot Sand & Gravel Co., Northern Improvement Co., and Schriock Construction Inc., produced 77 percent of the county total. The North Dakota State Highway Department and Northern Improvement Co. produced paving sand and gravel and Archie Campbell, Inc., Oberg Construction Co., and Schriock Construction, Inc., produced paving gravel. Great Northern Railway Co. and Soo Line Railroad Co. produced railroad-ballast gravel. The Ward County Highway Department produced paving and fill gravel. Atlas Sand & Gravel, Inc., and Minot Sand & Gravel Co. produced building, paving, and fill sand and gravel.

The county was ranked third in output and value of coal (lignite). Lignite was produced from the Velva strip mine of Truax-Traer Coal Co. and the Valley strip mine of Valley Coal Co.

Williams.—With a 6-percent increase in petroleum production, the county maintained its second position in output in the State.

Dakota Salt and Chemical Co. produced salt by solution mining of beds through 8,500-foot wells in the Charles formation.

The Mineral Industry of Ohio

By Joseph Krickich [1]

Spurred by a substantial increase in the output of coal, the value of mineral production in Ohio rose to a new high of $488 million, exceeding the previous high year, 1965, by $23.8 million. Aiding in the overall value gain were record outputs of salt and sand and gravel, and substantial increases in shipments of cement and stone. Accelerated building and highway construction also were major contributing factors with demand for aggregate material at record levels. Nationally, the State continued as an important producer of clay, coal, lime, and salt, as well as ferroalloys and iron and steel.

[1] Mineral specialist, Bureau of Mines, Pittsburgh, Pa.

Table 1.—Mineral production in Ohio [1]

Mineral		1965		1966	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:					
Portland	376-pound barrels	14,786,190	$47,499	15,180,526	$48,740
Masonry	280-pound barrels	1,050,064	3,004	976,141	2,785
Clays	thousand short tons	5,070	14,816	5,089	14,522
Coal (bituminous)	do	39,390	146,028	43,341	164,444
Gem stones		NA	3	NA	3
Lime	thousand short tons	3,831	53,208	3,858	50,997
Natural gas	million cubic feet	35,684	8,421	43,133	10,223
Peat	short tons	5,352	80	5,214	84
Petroleum (crude)	thousand 42-gallon barrels	12,908	37,940	10,899	32,700
Salt	thousand short tons	5,026	34,816	5,138	35,735
Sand and gravel	do	40,852	49,305	43,851	52,909
Stone	do	42,263	66,969	45,002	72,900
Value of items that cannot be disclosed: Abrasive stones and gypsum		XX	2,163	XX	1,998
Total		XX	464,252	XX	488,040

NA Not available. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957–59 dollars

(Millions)

Year	Value [1]	Year	Value [1]
1957	$380	1962	$403
1958	347	1963	431
1959	399	1964	464
1960	393	1965	477
1961	386	1966	[p] 493

[p] Preliminary.
[1] Data for 1957, 1959–65 revised.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Stones.—Production and value of abrasive stones (grindstones) were below that of 1965. Output from Lorain County was as a byproduct of sandstone quarrying. Production in Washington County was only for the first half of 1966

as the operating company discontinued business at midyear.

Cement.—Production of portland cement reached the highest level since 1963 and was 8 percent greater than that of 1965. Shipments increased only 3 percent above the previous year. The average value per barrel of portland cement was unchanged at $3.21. Production, shipments, and value of masonry cement were below that of 1965; average value per barrel declined $0.01 to $2.85. Total plant capacity declined from 19.7 million barrels to 19.4 million barrels. Companies operated at 81 percent of capacity compared with 74 percent in 1965. Yearend stocks were 671,000 barrels higher than at the end of 1965. In terms of value of shipments, Greene, Paulding, and Muskingum were the leading cement-producing counties.

Shipments of portland cement were chiefly to consumers in Ohio (65 percent), Michigan (15 percent), Indiana (7 percent), and West Virginia (7 percent).

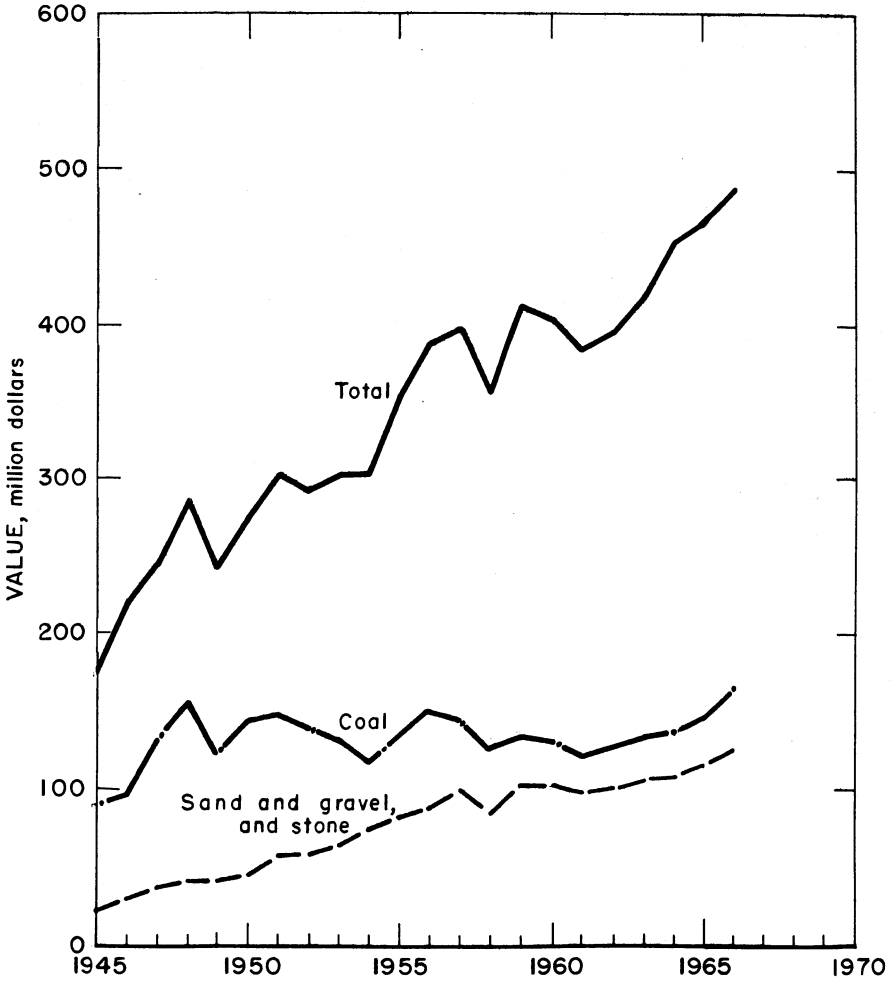

Figure 1.—Value of coal, sand and gravel, and stone and total value of mineral production in Ohio.

Table 3.—Employment 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
1965:								
Coal	7,580	229	1,738	13,963	8	347	25.42	4,797
Nonmetal	2,494	257	642	5,154	2	125	24.64	3,425
Sand and gravel	2,214	238	526	4,369	4	60	14.65	6,024
Stone	5,560	274	1,524	12,333	4	134	11.19	2,286
Peat	18	100	2	14	---	---	-----	-----
Total	17,866	248	4,432	35,833	18	666	19.09	3,883
1966: p								
Coal	7,800	232	1,811	14,680	12	365	25.68	6,272
Nonmetal	2,575	261	672	5,375	---	122	22.70	1,107
Sand and gravel	2,240	239	536	4,464	3	68	15.91	4,764
Stone	5,380	283	1,520	12,419	2	196	15.94	2,060
Peat	17	117	2	15	---	---	-----	-----
Total	18,012	252	4,541	36,953	17	751	20.78	3,921

p Preliminary.

Shipments also were made to Kentucky and Pennsylvania. Most of the masonry cement was consumed in Ohio, Indiana, and West Virginia. Distribution of portland cement shipments by types of customers was as follows: Ready-mixed concrete companies, 9.6 million barrels; concrete product manufacturers, 2.6 million barrels; and highway and other contractors, 2.0 million barrels. The remainder went to building material dealers and miscellaneous customers. Over 13.7 million barrels of portland cement was shipped by truck and the remainder was shipped by rail, or consumed at plants. Bulk shipments predominated; only 7 percent was shipped in containers, mainly paper bags.

Cement companies used over 4.4 million tons of limestone, cement rock, and marl, 623,000 tons of clay and shale, 130,000 tons of gypsum, and 87,000 tons of sand as primary raw materials. Quantities of fluorspar, iron ore, and mill scale also were used. Fuel used for power generation was predominantly bituminous coal but quantities of natural gas and fuel oil also were consumed. Producers used 411.2 million kilowatt-hours of electrical energy, of which 28 percent was generated by the producers and the remainder was purchased from public utility companies.

The Jonathan mine and plant of Columbia Cement Co. was awarded a Certificate of Achievement in Safety in National Safety Competition. The company worked 120,000 man-hours without any disabling injuries.

Clays.—Total clay production (fire clay and miscellaneous clay or shale) increased for the fourth consecutive year. However, Ohio was displaced by Georgia as the Nation's leading clay-producing State. Of the total production, 55 percent was miscellaneous clay or shale. compared with 51 percent the previous year. Clay output for refractories declined by 105,000 tons to nearly 1 million tons. Production of clay used for heavy clay products, (mainly building brick) increased by 78,000 tons to over 2.9 million tons; clay used for manufacturing cement increased 12 percent to 676,000 tons. A slight decline was reported in production of shale used for manufac-

Table 4.—Finished portland cement produced, shipped, and in stock

(Thousand barrels and thousand dollars)

Year	Number of active plants	Production	Shipments from mills		Stocks at mills, Dec. 31
			Quantity	Value	
1957–61 (average)	10	16,284	16,122	$54,298	1,937
1962	10	15,465	15,353	51,006	1,857
1963	10	16,300	16,218	53,244	2,064
1964	10	15,606	15,553	50,647	2,079
1965	9	14,599	14,786	47,499	1,600
1966	9	15,755	15,181	48,740	2,271

turing lightweight aggregate. Fire clay was used principally in refractories and for manufacturing heavy clay products. Other uses of Ohio clay included pottery and stoneware, floor and wall tile, and as rotary-drilling mud. Fire clay was produced in 16 counties; Tuscarawas, Stark, Columbiana, and Jackson Counties led in output and supplied 66 percent of the total fire clay tonnage. Among the 36 miscellaneous clay or shale producing areas, Cuyahoga, Tuscarawas, Greene, and Stark Counties led in production.

Gem Stones.—Gem stones (mineral specimens) were recovered mostly from mines and quarries throughout the State by members of mineral and lapidary clubs. Specimens collected included calcite, celestite, flint, and jasper.

Gypsum.—Increased production of crude gypsum was reported, but value declined because of lower unit prices. Output from two underground mines in Ottawa County was calcined at nearby plants for use in manufacturing building products. Crude gypsum shipped from outside the State also was calcined at the Lorain plant of National Gypsum Co.

Iron Oxide Pigments.—Red iron oxide pigments were produced by Minnesota Mining & Manufacturing Co. at Copley, Summit County. Primary raw material utilized by the company was pyrite cinder recovered as a byproduct of sulfuric acid manufacturing in Delaware.

Lime.—Continuing an increasing trend of the last 5 years, output of lime reached a record high and was 1 percent greater than the previous high year, 1965. Greater demand for chemical and other industrial lime more than offset declines in agricultural, building, and refractory lime. Output of agricultural lime resumed a declining trend, temporarily reversed in 1965. Total value of lime was 4 percent less than in 1965, owing to lower average values for three of the four types produced; only refractory lime had a higher unit value in 1966. The greatest change was in building lime which dropped from $19.66 to $18.36. Ohio accounted for 21 percent of the national output in 1966, compared with 23 percent in 1965 but was still the leading lime-producing State.

Data in table 5 excludes regenerated lime which was produced in Montgomery and Ross Counties; no primary lime production was reported in these counties. Two-thirds of the primary lime production was used for chemical and other industrial uses and was chiefly quicklime. Sandusky County continued as the leading area for lime production.

Almost 57 percent of the total lime production was captive tonnage or was marketed in Ohio. Other leading marketing areas for Ohio lime were Pennsylvania (8 percent), Indiana (7 percent), and Michigan (7 percent). Significant shipments also were made to Illinois and New York. Lime also was exported to Canada, Chile, United Kingdom, and Venezuela. Quicklime manufacture was predominately by means of shaft-type kilns. Both batch and continuous hydrators were used by hydrated lime producers. Fuels used included anthracite and bituminous coal, coke, natural gas, producer gas, and carbon monoxide.

Perlite (Expanded).—Expanded perlite was produced at three plants, one each in Cuyahoga, Hamilton, and Lorain Counties. Crude perlite shipped from Western States was processed mainly for insulation and plaster aggregate applications. Producers were The Cleveland Gypsum Co., Division of Cleveland Builders Supply Co., Cleveland; National Gypsum Co., Lorain; and The Philip Carey Manufacturing Co., Lockland.

Table 5.—Lime sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Year	Agricultural		Building		Chemical and other industrial		Refractory		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	32	$444	460	$8,305	1,341	$14,450	1,073	$17,130	2,906	$40,329
1962	26	396	383	7,257	1,743	20,734	950	15,405	3,102	43,792
1963	24	393	369	7,003	1,820	22,187	994	16,374	3,207	45,957
1964	23	352	374	7,561	2,147	26,209	1,120	19,186	3,664	53,308
1965	27	410	327	6,425	2,387	27,905	1,090	18,468	3,831	53,208
1966	17	253	299	5,490	2,574	28,740	968	16,514	3,858	50,997

Salt.—A new record high output of salt was established as production increased 2 percent above that of 1965, the previous high year. Value increased $919,000 to $35.7 million. Rock salt and brine production increased but evaporated salt output declined. Rock salt recovered in Cuyahoga and Lake Counties was sold mainly for highway ice control and in chemical applications. Brine production in Lake and Summit Counties was primarily captive tonnage used for manufacturing chlorine and soda ash. Evaporated salt produced in Meigs, Summit, and Wayne Counties was sold for a wide variety of uses; some was marketed as pressed blocks. Producers used both the vacuum-pan and open pan processes for recovering the salt. As in previous years, Lake County continued as the leading area for salt production.

Sand and Gravel.—For the second consecutive year, production of sand and gravel reached record highs. Output was 3 million tons above the previous year as primarily more structural and paving sand and gravel was produced to meet the increased demand. Commercial sand and gravel used in building and highway construction totaled 36.5 million tons, compared with 33.9 million tons in 1965. Demand for other construction sand and gravel increased but production of industrial sand declined slightly. Industrial sand output was only 12,000 tons below that of 1965, but with higher average unit prices, value increased 3 percent to $5.6 million. Industrial sands were mostly for molding, glass manufacturing, and furnace construction and repair.

Sand and gravel was produced in 69 counties; Franklin, Hamilton, Montgomery, Portage, and Butler Counties were the leading areas. In addition, production exceeded 1 million tons in six other counties. Producers processed 88 percent of the total tonnage, by washing, screening, sizing, or crushing. Over 41.6 million tons was shipped to consumers by truck, 1.8 million tons by rail and the remainder by water. Of the 433 commercial operations, 156 had production below 25,000 tons but accounted for 4 percent of the total commercial tonnage. Three operators had outputs exceeding 1 million tons and seven operations produced from 500,000 to 1 million tons.

In National Safety Competition, seven plants of American Aggregates Corp. were awarded Certificates of Achievement in Safety for working without any disabling injuries. Awards also went to Fredericktown Sand & Gravel Co., Hamilton Gravel Co., and Zanesville Gravel Co.

Slag (Iron-Blast Furnace).—Production of iron-blast furnace slag declined 509,000 tons below that of 1965 to 6.1 million tons valued at $11.7 million. However, the average value per ton increased from $1.89 to $1.92 and was greater than the national average of $1.75. Of the total processed slag 71 percent was screened air-cooled material; the remainder consisted of granulated and lightweight (expanded) slag. The primary uses for screened, air-cooled slag were as aggregate for concrete and bituminous construction, highway and airport construction, and as railroad ballast. Processing plants were located primarily near steelmaking facilities in Cleveland, Middletown, and Youngstown. Nationally, the State ranked second in production and supplied 23 percent of the total output.

Stone.—Total stone (limestone and sandstone) output increased in both tonnage and value for the second consecutive year, reflecting the continuing high level of activity in all phases of highway and building construction. Output was 6 percent greater and value increased by $5.9 million above that of 1965. Crushed limestone production increased by 1 percent and supplied 98 percent of the total stone tonnage. Miscellaneous uses of crushed limestone included whiting, filter beds, stone sand, paper and glass manufacture, poultry grit, fertilizer filler, and for controlling dust in coal mines. Production of dimension limestone decreased slightly and was used in architectural and construction applications. Limestone was produced in 56 counties; Sandusky, Erie, Wyandot, Seneca, and Franklin Counties were the leading areas for production.

Dimension sandstone production increased, but that of crushed sandstone was virtually unchanged compared with the previous year. Most of the dimension sandstone was fabricated for use as architectural stone; some of the rough and sawed stone was sold for lining steel furnaces. Dimension sandstone was also used in construction and as curbing and flagging. Crushed sandstone was sold for refractory (ganister), aggregate, riprap, glass manufacture, and foundry uses. Sandstone pro-

Table 6.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	6,407	$6,974	7,044	$7,799
Paving	7,917	8,347	8,678	9,011
Fill	1,556	937	1,881	1,234
Molding	525	2,198	543	2,311
Fire or furnace	W	W	173	523
Other [1]	1,081	3,416	962	3,082
Total	17,486	21,872	19,281	23,960
Gravel:				
Building	6,219	7,502	7,024	8,223
Paving	13,312	16,117	13,716	16,851
Railroad ballast	3	2	12	9
Fill	2,054	1,184	1,931	1,095
Other	1,650	2,541	1,773	2,721
Total	23,238	27,346	24,456	28,899
Total sand and gravel	40,724	49,218	43,737	52,859
Government-and-contractor operations:				
Sand:				
Paving	----	----	7	2
Fill	16	21	8	2
Total	16	21	15	4
Gravel:				
Paving	102	59	84	38
Fill	10	7	15	8
Total	112	66	99	46
Total sand and gravel	128	87	114	50
All operations:				
Sand	17,502	21,893	19,296	23,964
Gravel	23,350	27,412	24,555	28,945
Total	40,852	49,305	43,851	52,909

W Withheld to avoid disclosing individual company confidential data.
[1] Includes the following sands: Glass, blast, filtration, engine, grinding and polishing (1965), ground, other, and data indicated by symbol W.

duction was reported in 13 counties; Lorain County again ranked first in tonnage and value.

For the second consecutive year, the Barberton, Summit County, limestone mine of Pittsburgh Plate Glass Co., Chemical Division, won the Sentinel of Safety trophy in the underground nonmetal category of National Safety Competition sponsored jointly by the Bureau of Mines and the American Mining Congress. The mine worked 297,124 man-hours without any disabling injury. This marks the sixth year of competiton for the mine. Other Ohio limestone quarries had notable safety records for the year. In the quarry group of National Safety Competition, the following companies were awarded Certificates of Achievements in Safety for working without any lost-time injuries: Basic, Inc., The France Co. (two mines), National Lime & Stone Co. (two mines), National Gypsum Co., Ohio Lime Co., Toledo Stone & Glass Sand Co., and United States Gypsum Co.

Sulfur (Recovered Elemental).—Production and shipments of elemental sulfur recovered at the Toledo refinery of Sun Oil Co. were below that of 1965. However, value was greater because of a 26-percent increase in the average unit price for recovered sulfur. Sulfur was recovered by the catalytic oxidation of hydrogen sulfide.

Vermiculite (Exfoliated).—The Cleveland Gypsum Co., Division of Cleveland Builders Supply Co. produced exfoliated vermiculite at its Cleveland plant. The processed material was used in plaster and concrete aggregate, horticultural and other industrial applications.

Table 7.—Crushed and broken limestone sold or used by producers, by uses[1]

(Thousand short tons and thousand dollars)

Use	1965		1966	
	Quantity	Value	Quantity	Value
Riprap	218	$314	255	$366
Concrete aggregate and roadstone	22,465	29,747	24,523	32,685
Fluxing stone	5,811	8,876	4,851	6,926
Agriculture	2,031	3,626	2,218	4,037
Railroad ballast	1,103	1,359	1,014	1,274
Cement	4,001	5,260	4,619	6,924
Lime	5,088	8,398	5,594	10,664
Miscellaneous uses	815	2,338	1,175	3,017
Total	41,533	59,917	44,249	65,893

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

MINERAL FUELS

Coal (Bituminous).—Production of bituminous coal increased for the fifth consecutive year and reached the highest level since 1920, the record high year. Output was 10 percent greater than in 1965 and was the third highest level of production on record. Strip mines supplied 66 percent of the total tonnage; 30 percent came from underground mines and the remainder (4 percent) from auger mines. The average value per ton of coal was $3.79, an increase of $0.08 compared with that of the previous year. A total of 426 mines producing 1,000 tons or more were active, 9 more than the total in 1965. Underground mines decreased by 4 to a total of 89 but the number of strip mines increased from 264 to 274 and auger mines from 60 to 63.

Strip-mined tonnage was nearly 2.2 million tons above that of 1965 and totaled 28.5 million tons valued at $101 million. Average value per ton increased from $3.49 in 1965 to $3.54. Production was reported in 23 counties; Harrison, Jefferson, Belmont, and Coshocton Counties, in decreasing order of tonnage, were the leading strip mine areas. Equipment used by strip mine operators included 44 electric, 16 diesel electric, 490 diesel, and 24 gasoline shovels or draglines. Most of the equipment had dipper capacities of less than 3 cubic yards; 13 shovels and 14 draglines had capacities exceeding 12 cubic yards.

Coal tonnage recovered from underground mines increased from 11.3 million tons to 13.1 million tons; average value per ton was $4.38 compared with $4.31 in 1965. Of the 17 counties with output from underground mines, Belmont and Harrison Counties accounted for over half of the tonnage. The number of continuous mining machines used at underground mines increased from 52 to 59, reflecting greater mechanization at Ohio underground mines. Although the number of auger mines increased, production was 1 percent below that of 1965 and totaled 1.7 million tons valued at $6.1 million. The average value per ton increased from $3.17 to $3.54. Noble, Jefferson, Tuscarawas, and Belmont Counties, in decreasing order of tonnage, were the leading areas for auger mining and supplied over 50 percent of the output.

Twenty-one coal cleaning and preparation plants were active, one less than in 1965. Nearly 16.2 million tons of coal was cleaned, of which only 876,000 tons was cleaned by pneumatic methods; the remainder was cleaned by washing. At preparation plants, over 4 million tons of coal was dried after cleaning in 19 thermal drying units. At mines having crushing and treatment facilities, 21.9 million tons of coal was crushed and 4.5 million tons treated with dust-allaying and antifreezing materials. Of the total output, 26.9 million tons were shipped by rail or water, 12.6 million tons by truck, and the remainder was consumed locally. Coal production by captive operators furnished 10 percent of the total State output.

Preliminary employment data indicated that an average of 7,800 men worked 14.7 million man-hours compared with 14.0 million man-hours in 1965. Twelve fatalities and 365 nonfatal injuries were recorded, four more fatal injuries than in 1965. In National Safety Competition, six strip mines were given Certificates of Achievement in Safety Awards for operating without any lost-time injuries. They were the West Farm No. 22, Georgetown No. 12, Bradford No. 16, and Crescent Valley No. 7

mines of Hanna Coal Co., Division of Consolidation Coal Co.; Betsy mine of Boich Mining Co.; and Mapleton mine of Magnolia Mining Co.

Coke and Coal Chemicals.—Production of oven-coke was 11 percent greater than in 1965 and totaled 8.5 million tons valued at $146.3 million. Average value per ton increased from $16.11 in 1965 to $17.18. Producers carbonized 12.1 million tons of bituminous coal; coke yield decreased slightly from 70.41 percent in 1965 to 70.34 percent. Most of the coking coal received at Ohio plants came from West Virginia and Pennsylvania. Thirteen plants (12 in 1965) operating 2,249 slot-type ovens were in existence at yearend, an increase of 413 ovens above that of 1965. Nearly 89 percent of the coke produced was consumed by producing companies mainly in blast furnaces. Coke breeze produced at plants totaled 547,000 tons valued at $3.9 million. Coproducts recovered included coke-oven gas, ammonium sulfate, coke-oven tar, and crude light oil. The crude light oil was further processed for recovery of benzene, toluene, xylene, and solvent naphtha.

Table 8.—Bituminous coal production

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	34,037	$132,065
1962	34,125	127,051
1963	36,790	136,113
1964	37,310	137,776
1965	39,390	146,028
1966	43,341	164,444

Table 9.—Coal (bituminous) production, by counties

(Thousand short tons and thousand dollars)

County	1965					1966				
	Number of mines			Total production		Number of mines			Total production	
	Underground	Strip	Auger	Quantity	Value	Underground	Strip	Auger	Quantity	Value
Athens	9	3	---	142	$487	8	2	1	187	$717
Belmont	9	21	12	7,698	31,235	13	22	6	8,286	33,619
Carroll	1	7	---	268	925	2	8	1	275	906
Columbiana	3	38	8	1,428	4,476	6	34	13	1,356	4,440
Coshocton	5	11	1	2,606	10,781	6	10	4	2,761	11,855
Gallia	12	7	3	494	1,413	6	7	2	288	960
Guernsey	1	6	1	365	1,144	---	6	1	1,845	4,710
Harrison	6	13	3	8,585	34,414	6	17	3	10,650	43,506
Hocking	1	6	1	103	339	1	7	2	87	342
Holmes	1	1	---	188	631	---	5	1	244	815
Jackson	6	12	---	609	2,316	4	17	2	855	3,068
Jefferson	8	34	10	4,970	17,802	8	39	10	4,787	18,040
Lawrence	---	3	---	W	W	---	3	---	W	W
Mahoning	---	16	1	689	2,582	---	14	---	501	1,903
Meigs	8	5	3	257	885	4	---	1	30	94
Monroe	---	---	---	---	---	1	---	---	W	W
Morgan	1	3	---	1,800	5,844	---	3	---	W	W
Muskingum	5	7	---	132	575	6	8	---	283	924
Noble	---	9	4	2,985	8,534	---	12	5	2,222	6,862
Perry	5	9	1	W	W	6	10	2	2,133	8,324
Portage	---	1	---	7	27	---	---	---	---	---
Stark	---	14	1	435	1,401	---	17	1	525	1,636
Tuscarawas	9	29	10	2,936	10,175	8	23	7	2,995	10,427
Vinton	3	5	---	141	558	4	5	---	154	604
Washington	---	1	1	W	W	---	3	1	200	707
Wayne	---	3	---	45	136	---	2	---	24	57
Undistributed	XX	XX	XX	2,507	9,348	XX	XX	XX	2,653	9,928
Total	93	264	60	39,390	146,028	89	274	63	43,341	164,444

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
XX Not applicable.

Peat.—Shipments of peat were slightly below that of 1965 but the value was greater because of higher unit prices. The average value per ton rose from $14.99 to $16.19. Production was reported in eight counties; Stark County ranked first in tonnage with three operations. At active operations, production of moss peat predominated. Ohio peat was used mostly for soil improvement purposes and was marketed chiefly in bulk form. Reserves at active operations increased from 513,000 tons to 704,000 tons.

Petroleum and Natural Gas.—Petroleum production continued to decline but natural gas output was greater than that of

1965. A sharp decrease in drilling activity also was recorded. According to the American Association of Petroleum Geologists, total well completions decreased from 1,896 to 1,312 and total footage drilled dropped from 5,609,000 to 3,733,000. A total of 1,174 development completions (662 oil, 217 gas, and 295 dry) was reported. Development wells were drilled in 48 counties; Morrow (145), Perry (136), Hocking (106), and Licking (103) Counties were the leading areas. Wildcat completions dropped from 312 in 1965 to 138 (12 oil, 19 gas, and 107 dry). Morrow County with 20 completions was the leading area for wildcat activity. Other leading areas were Richland (12), Huron (11), and Knox (10) Counties. Drilling operations in Ohio were mainly by the cable tool method. The Division of Oil and Gas, Ohio Department of Natural Resources, reported 14,192 petroleum and 7,000 gas wells were productive at the end of 1965.

According to American Gas Association and American Petroleum Institute, reserves on December 31, 1966, were 755,215 million cubic feet of natural gas (14.73 pounds per square inch absolute, at 60° F) and 101.2 million barrels of crude petroleum. Compared with the end of 1965, reserves of natural gas were up by 378 million cubic feet and petroleum up by 238,000 barrels. Crude oil capacity as of January 1, 1966, at the State's 11 petroleum refineries was 464,200 barrels per day, 1,000 barrels less than in the previous year. Gasoline output capacity increased from 178,000 barrels per day to 187,000. Refineries were operated by Ashland Oil & Refining Co., Canton and Findlay; Chevron Asphalt Co. (formerly American Bitumuls & Asphalt Co.), Cincinnati; Gulf Oil Corp., Cleves and Toledo; Pure Oil Co. (A Division of Union Oil Co. of California), Heath (Newark) and Oregon; Standard Oil Co. of Ohio, Cleveland, Lima, and Toledo; and Sun Oil Co., Toledo.

According to a survey, five companies operated underground liquefied petroleum (LP) gas storage facilities having a capacity of 2.4 million barrels. Texas Eastern Transmission Corp. operated the largest facility (1.5 million barrels) in Butler County; other facilities were operated in Allen, Butler, Cuyahoga, Hamilton, and Stark Counties.[2]

[2] Oil and Gas Journal. V. 64, No. 42, Oct. 17, 1966.

METALS

Aluminum.—Primary aluminum was produced at the Hannibal reduction plant of Ormet Corp., jointly owned by Olin-Mathieson Chemical Corp. and Revere Copper & Brass, Inc. Output and value were below that of 1965; the average value per ton was unchanged. Bauxite imported from Surinam was processed into alumina at the company-owned plant at Burnside, La. The alumina was then shipped by barge to the Hannibal plant for reduction into aluminum. Annual capacity of the reduction plant remained at 180,000 tons. Olin-Mathieson operated a casting and rolling mill adjacent to the reduction plant.

Beryllium.—The Brush Beryllium Corp. at Elmore processed hand-sorted beryl into beryllium metal, alloys, and compounds. Production was mostly beryllium and beryl-copper master alloy.

Ferroalloys.—Ferroalloy shipments totaled 784,000 tons valued at $165.8 million, 4 and 11 percent, respectively, greater than in 1965. Production was lower than in 1965, totaling 745,000 tons. Ohio continued as the foremost producer among the 17 ferroalloy-producing States, supplying 29 percent of the total national shipments. Increased shipments were reported for ferromanganese, silicomanganese, and ferrochromium and chromium briquets. Although shipments of ferrosilicon and miscellaneous silicon alloys declined, value was greater because of higher average unit prices. Thirteen principal ferroalloys were produced at Ohio plants. Producers were Interlake Steel Corp., Beverly; Jackson Iron & Steel Co., Jackson; Ohio Ferro-Alloys Corp., Brilliant, Philo, and Powhatan Point; Union Carbide Corp., Mining & Metals Division, Marietta and Ashtabula; and Vanadium Corporation of America, Cambridge and Vancoram.

Iron and Steel.—Steel production at Ohio plants was 4 percent greater than in 1965, according to the American Iron & Steel Institute. Nearly 23 million tons was produced, of which 14.9 million tons was open-hearth and Bessemer steel, 5.7 million tons basic oxygen, and 2.4 million tons electric furnace steel. Compared with 1965 figures, production by the open-hearth and Bessemer processes declined by 2.1 million tons and production in basic oxygen fur-

naces increased by 3 million tons. Steel production in electric furnaces was 92,000 tons below that of 1965. Shipments of pig iron totaled 16.2 million tons valued at $962.2 million, an increase of nearly 1 million tons and $56.8 million above that of 1965. Over 13.5 million tons of basic pig iron was produced, 560,000 tons more than the previous year. At the 19 active plants, nine of the 46 blast furnaces were idle.

Over 6.1 million tons of domestic and 4.4 million tons of imported iron ore were received at steel plants. Iron ore receipts were 2.2 million tons less than 1965, but receipts of agglomerated material having higher iron content increased by 1.9 million tons. Agglomerates received at plants totaled 12.9 million tons, most of which (10.1 million tons) were iron ore pellets. Most of the foreign iron ore was imported from Labrador and other parts of Canada and Venezuela. Quantities also were imported from Africa, Chile, and Brazil.

Titanium.—Titanium sponge metal was produced by sodium reduction of titanium tetrachloride at the Ashtabula plant of Reactive Metals, Inc., jointly owned by United States Steel Corp. and National Distillers & Chemical Corp. The sponge was shipped to the company's Niles plant for melting and processing. Titanium also was melted at the Massillon and Canton plants of Republic Steel Corp. Titanium Metals Corporation of America (TMCA) rolled and fabricated at Toronto primary metal shipped from Henderson, Nev. Titanium pigments (titanium dioxide) used in manufacturing paint was produced at the Ashtabula plant of Cabot Titanium Corp.

Zirconium.—Reactive Metals, Inc., produced zirconium chunklets at Ashtabula. The chunklets were shipped to Niles for ingot production. Zircon- and zirconia-based refractories were produced by The Chas. Taylor Sons Co., Cincinnati. Zirconium Corporation of America (ZIRCOA), Solon, produced zirconium oxide as well as zircon refractories. Vanadium Corporation of America produced zirconium alloys at Cambridge.

REVIEW BY COUNTIES

Mineral production was reported in 86 of Ohio's 88 counties. As in previous years, no mineral production was reported in Clermont and Fulton Counties. Harrison County continued as the State's leading area as value of mineral output increased by $9.1 million to $43.8 million. In addition to Harrison County, values in excess of $10 million were recorded for 13 other counties. County data on petroleum and natural gas operations were not available. Data on gem stones (mineral specimens) were not specified by county.

Adams.—Davon, Inc., Peebles, produced limestone for blast-furnace flux, aggregate, railroad ballast, agricultural stone (agstone), and for dust abatement in coal mines. The Adams County Highway Department produced and crushed limestone for road construction and maintenance.

Allen.—Production of limestone totaled 789,000 tons, 15 percent below that of 1965. Output was primarily for concrete aggregate, railroad ballast, and as agstone. Producers were National Lime & Stone Co., Lima; Suever Stone Co., Delphos; The

Table 10.—Value of mineral production in Ohio, by counties [1,2]

County	1965	1966	Minerals produced in 1966 in order of value
Adams	$1,266,766	$1,362,852	Stone.
Allen	1,461,380	1,369,627	Stone, sand and gravel.
Ashland	W	W	Sand and gravel, clays.
Ashtabula	W	W	Lime, sand and gravel.
Athens	1,365,302	1,591,870	Coal, stone, clays, sand and gravel.
Auglaize	W	W	Sand and gravel, stone, clays.
Belmont	31,405,605	33,847,850	Coal, stone.
Brown	102,900	120,871	Sand and gravel, stone.
Butler	2,512,000	3,001,000	Sand and gravel.
Carroll	1,063,779	1,133,731	Coal, clays, sand and gravel.
Champaign	W	W	Sand and gravel, peat.
Clark	W	W	Sand and gravel, lime, stone.
Clinton	W	W	Stone, sand and gravel.
Columbiana	7,565,711	7,097,442	Coal, clays, sand and gravel.

Table 10.—Value of mineral production in Ohio, by counties [1,2]—Continued

County	1965	1966	Minerals produced in 1966 in order of value
Coshocton	$12,164,347	$13,730,729	Coal, stone, sand and gravel.
Crawford	W	W	Stone, sand and gravel.
Cuyahoga	W	W	Salt, lime, sand and gravel, clays, peat.
Darke	W	W	Sand and gravel, clays.
Defiance	W	W	Sand and gravel.
Delaware	1,600,139	2,095,274	Stone, lime, clays.
Erie	8,395,304	3,966,174	Stone, sand and gravel.
Fairfield	W	W	Sand and gravel.
Fayette	631,295	718,938	Stone.
Franklin	9,914,192	10,307,668	Sand and gravel, stone, lime, clays, peat.
Gallia	2,233,239	1,724,174	Coal, stone, sand and gravel.
Geauga	1,461,019	1,319,029	Sand and gravel, stone.
Greene	W	W	Cement, stone, sand and gravel, clays.
Guernsey	1,144,195	4,750,087	Coal, stone.
Hamilton	W	W	Sand and gravel, stone.
Hancock	W	W	Stone, lime, clays, sand and gravel.
Hardin	W	W	Stone.
Harrison	34,709,562	43,807,793	Coal, stone, clays.
Henry	W	W	Sand and gravel, clays.
Highland	W	W	Stone, sand and gravel, clays.
Hocking	469,605	563,949	Coal, clays, sand and gravel.
Holmes	1,439,756	1,523,829	Coal, stone, clays. sand and gravel.
Huron	37,000	54,000	Sand and gravel.
Jackson	3,673,708	4,604,185	Coal, clays, stone, sand and gravel.
Jefferson	W	19,075,645	Coal, clays.
Knox	W	W	Sand and gravel, stone.
Lake	W	W	Salt, lime, sand and gravel.
Lawrence	10,850,028	9,744,323	Cement, stone, coal, clays, sand and gravel.
Licking	W	W	Sand and gravel, clays.
Logan	543,588	911,636	Stone, sand and gravel.
Lorain	W	W	Stone, sand and gravel, abrasives.
Lucas	W	W	Cement, stone, sand and gravel, clays.
Madison	W	W	Stone, sand and gravel.
Mahoning	W	W	Stone, coal, clays, peat.
Marion	1,693,910	1,540,229	Stone, clays, sand and gravel.
Medina	W	W	Sand and gravel, clays.
Meigs	W	W	Sand and gravel, coal, salt, stone.
Mercer	W	W	Stone.
Miami	W	W	Stone, sand and gravel.
Monroe	W	W	Coal, sand and gravel, stone.
Montgomery	4,858,983	4,658,041	Sand and gravel, stone.
Morgan	W	W	Coal, sand and gravel, stone.
Morrow	52,000	W	Sand and gravel.
Muskingum	W	W	Cement, stone, coal, sand and gravel, clays.
Noble	W	W	Coal, stone, clays.
Ottawa	7,841,931	7,700,649	Lime, stone, gypsum.
Paulding	W	W	Cement, stone, clays.
Perry	W	W	Coal, sand and gravel, clays, stone.
Pickaway	W	W	Sand and gravel, stone.
Pike	W	W	Do.
Portage	3,899,097	4,360,637	Sand and gravel, stone, peat, clays.
Preble	W	W	Lime, stone, sand and gravel.
Putnam	598,227	549,531	Stone, clays.
Richland	W	W	Sand and gravel, clays.
Ross	W	W	Sand and gravel, stone.
Sandusky	23,945,906	26,424,387	Lime, stone, sand and gravel.
Scioto	W	W	Stone, sand and gravel, clays.
Seneca	W	W	Lime, stone, clays.
Shelby	376,202	375,738	Sand and gravel, stone.
Stark	12,986,528	12,925,662	Cement, sand and gravel, stone, coal, clays, peat.
Summit	W	W	Salt, lime, stone, cement, sand and gravel, clays.
Trumbull	242,000	233,000	Sand and gravel.
Tuscarawas	14,252,457	15,136,065	Coal, clays, sand and gravel, stone.
Union	W	W	Stone, sand and gravel.
Van Wert	829,421	908,790	Stone, clays.
Vinton	637,915	732,170	Coal, stone, clays, sand and gravel.
Warren	1,291,000	1,331,000	Sand and gravel.
Washington	W	W	Coal, sand and gravel, abrasives.
Wayne	W	W	Salt, sand and gravel, stone, clays, coal.
Williams	W	W	Sand and gravel.
Wood	1,435,315	1,880,978	Stone.
Wyandot	W	W	Stone, lime, sand and gravel, peat, clays.
Undistributed [3]	258,300,766	240,860,667	
Total	464,252,000	488,040,000	

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

[1] Fulton and Clermont Counties not listed, as no production was reported.

[2] Natural gas and petroleum values are not listed by counties, as data are not available; included with "Undistributed."

[3] Includes natural gas, petroleum, and gem stones that cannot be assigned to specific counties, and values indicated by symbol W.

Bluffton Stone Co., Bluffton; and Western Ohio Stone Co., with two quarries near Lima. Processed construction sand and gravel was produced at the Westminster plant of Wapak Sand & Gravel Co. Bank-run gravel was produced by Prince Gravel Co. and Lucke & Treglia, both near Lima.

Ashland.—Sand and gravel production was slightly above that of 1965. Most of the commercial output was processed material produced principally by Young's Sand & Gravel Co., Loudonville, and Bolin & Son, Ashland. Limited quantities of gravel were produced by Jones Trucking Co., Red Haw; R. C. Meyers, Ashland; and Charles Bucklew, West Salem. The E. Bigelow Co. produced shale for drain tile at New London.

Ashtabula.—Quicklime for metallurgical and chemical uses was produced at Ashtabula. Output of sand and gravel was nearly double that of 1965. Principal producers of construction sand and gravel were Paul Campbell Sand & Gravel and Gleason Sand-Gravel, Inc., both near Conneaut; Northeast Materials, Inc., Kingsville; and A. C. Meade Excavating Co., Jefferson. Quantities of molding sand were produced by Peerless Mineral Products Co., Conneaut.

Athens.—Output of coal was substantially greater than that of 1965. Production was chiefly from underground mines; Karns Coal Co. at mines Nos. 60 and 61, was the leading producer. Furr Coal Co. was the principal strip mine operator. Ralph Perry Coal Co. operated the only auger mine. Diamond Stone Quarries, Inc., operated two limestone quarries near Albany for the production of aggregate stone. Natco Corp. mined plastic fire clay near Nelsonville for manufacturing heavy clay products. Sand and gravel production was greater than that of 1965; principal producers were The F. H. Brewer Co., Chauncey, and Athens Sand and Gravel Co., Nelsonville.

Auglaize.—National Lime & Stone Co. at its Buckland quarry produced limestone for aggregate, railroad ballast, and agstone. Production of sand and gravel was 287,000 tons compared with 303,000 tons in 1965. Processed material was produced by Wapak Sand & Gravel Co., Western Ohio Stone Co., and Quality Sand & Gravel & Ready Mix Co., all near Wapakoneta. Bank-run material was produced by Joseph Gravel Co. and Hardin-Coates, Inc., near Wapakoneta. Clay for heavy clay products was mined near Spencerville.

Belmont.—The county continued as the second ranking coal-producing area. Total production increased 588,000 tons above that of 1965. Production was chiefly from 13 underground mines; The North American Coal Corp., with 3 mines and Oglebay-Norton Co., with 2 mines were the leading producers. Hanna Coal Co., operator of the Crescent Valley No. 7 mine, was the leading strip mine producer. Most of the auger-mined coal was produced by Ohio River Collieries. Six preparation plants were active cleaning coal from underground mines. Limestone was produced by Thomas E. Ayers Limestone Quarry, Martins Ferry; Captina Limestone, Inc., Powhatan Point; Somerton Crushing Co., Wayne Township and McCort Brothers, Barnesville.

Butler.—Sand and gravel production totaled 2.7 million tons valued at $3 million, a 17-percent increase in tonnage and 19-percent increase in value compared with that of 1965. Although output was greater the county ranked fifth compared with fourth the previous year among the sand-and-gravel producing areas. Of the 12 active operations, the leading producers were American Materials Corp. (two plants), Ohio Gravel Co., Division of Dravo Corp., (two plants), The Middletown Sand & Gravel Co., The Hamilton Gravel Co., and The Moorman Sand & Gravel Co. Output from these operations consisted chiefly of processed gravel used in building and highway construction. Production was centered mainly near Fairfield, Hamilton, Middletown, and Ross.

Carroll.—Coal production was slightly greater than that of 1965, but value was lower, owing to lower average unit prices. Of the total tonnage 95 percent was from eight strip mines; The James Bros. Coal Co. was the leading strip mine operator. Clay production was more than double that of the previous year and consisted mainly of shale used for manufacturing heavy clay products. Production was reported from five pits; D. & M. Coal Co. was the leading producer. Malvern Sand & Gravel Co., produced paving sand and gravel at Malvern. Mineral City Sand Co., Mineral City, produced molding and loam sand. No production of dimension sandstone was reported as in previous years.

Champaign.—Sand and gravel was produced by American Aggregates Corp., and Miller's Excavating, Inc., both near Urbana, Walter R. Dorsey, Springhill, and R. H. Cushman & Son, Mechanicsburg. Most of the output from these operations was processed gravel used for paving and fill. Sphagnum Peat Moss Products produced shredded moss peat for packaged sales at West Liberty.

Clark.—Production of commercial sand and gravel totaled 1,085,000 tons, 6 percent greater than that of 1965. Output was from 13 operations and consisted mostly of processed construction sand and gravel. Limited quantities of molding and brick sand was produced near Enon. Leading producers were American Aggregates Corp., Fairborn and Springfield, and Springfield Sand & Gravel Co. and Eagle City Sand & Gravel Co., both near Springfield. Limestone for aggregate, blast furnace flux, agstone, and for manufacturing lime was produced at Springfield. Most of the lime was used in metallurgical applications.

Columbiana.—Although the number of active mines increased from 49 in 1965 to 53, total coal production was 5 percent below that of 1965. Nearly 85 percent of the output was strip-mined coal. Buckeye Coal Mining Co., Ferris Coal Co., and Industrial Mining & Engineering Co. were the leading strip mine operators. Moore Coal Corp. and R. D. Whitaker Coal Co., were the leading auger and underground operators, respectively. Total output of clay was below that of 1965; fire clay production predominated. Production was from six operations; H. K. Porter Co., Inc., Refractories Division, operator of the Pleasant Valley underground mine near Wellsville, was the leading producer. Production of sand and gravel totaled 116,000 tons and was reported from five operations. Most of the material was processed for use in construction but some furnace sand was produced.

Coshocton.—Coal production was primarily from 10 strip mines. Output was 6 percent greater than that of 1965. Leading strip mine operators were Peabody Coal Co. and Simco-Peabody Co. Output from the Peabody mine was processed at the company's Broken Aro preparation plant. Briar Hill Stone Co. operated six quarries for the production of dimension architectural sandstone. Nicholl-McBride Stone Holding Co. quarried sandstone for architectural uses at the Mullet quarry near Layland. For the second consecutive year output of sand and gravel increased, totaling 887,000 tons compared with 569,000 tons in 1965. Leading producers among the eight active operations were Spring Construction Co., Newcomerstown; W. P. McCarren Co., Walhonding and Canal, Lewisville; and Boyd Gravel Co., Coshocton.

Crawford.—Limestone used for flux, aggregate, agstone, railroad ballast and for glass manufacturing was produced at the Spore quarry near Bucyrus by National Lime & Stone Co. Construction sand and gravel was produced by Galion Gavel Co., Galion.

Cuyahoga.—International Salt Co. produced rock salt at its underground mine at Cleveland. Most of the salt was sold to governmental agencies in Ohio and Pennsylvania for use in controlling icy highways. Substantial quantities also were exported to Canada. Cuyahoga Lime Co., Cleveland, produced mainly metallurgical quicklime from limestone shipped from Michigan. Sand and gravel production increased 13 percent above that of 1965, and totaled 942,000 tons. Output consisted chiefly of processed sand used for construction. Leading producers among the nine active operations were Terra Vista Sand & Gravel, Pettibone Sand and Gravel Co., Testa Brothers, Inc., and Valley View Materials, Inc. Clay production was 400,000 tons compared with 351,000 tons in 1965. Production was reported from operations near Berea, Cleveland, Garfield Heights, and Independence. Hydraulic Press Brick Co., Independence, was the leading producer and continued as the State's only producer of expanded shale lightweight aggregate. Limited quantities of humus peat was recovered from a bog near Middleburg Heights by Dan E. Poljak.

Darke.—Output of sand and gravel was below that of 1965. American Aggregates Corp., Greenville, was the leading producer. Other operations were located near Greenville and New Madison. Darke County Tile Co., Greenville, produced clay for use in manufacturing heavy clay products.

Delaware.—Limestone output totaled 1.1 million tons compared with 776,000 tons in 1965. Four quarries, one each near Delaware, Powell, Ostrander, and Radnor, were active. National Lime & Stone Co., Dela-

ware, was the leading Producer. Quicklime and hydrated lime was produced from purchased limestone at the Delaware plant of Scioto Lime & Stone Co., Inc. The lime was used primarily for water purification and softening and in metallurgical applications. Shale used mostly for manufacturing building brick was mined by The Galena Shale Tile & Brick Co., Galena, and The Delaware Clay Co., Westerville.

Erie.—Sandusky Crushed Stone Co., Inc., Parkertown, Wagner Quarries Co., Sandusky, and Kellstone, Inc., Kelleys Island, quarried limestone used mainly for aggregate. The Castalia limestone quarry of Castalia Quarries Co. was abandoned in November 1965. Dimension architectual sandstone was recovered at the Birmingham quarry. Sandstone used for riprap was quarried at Berlin Heights by Harris Bros. Stone Co. Ohio Foundry Sand Co. and The Keener Sand & Clay Co., both near Huron, produced molding sand. Bank-run sand used as fill material was produced by Borchardt Construction Co., Inc., Castalia, and Harris Bros. Stone Co., Berlin Heights.

Fayette.—Limestone production was 532,000 tons compared with 414,000 tons in 1965. Producers were Blue Rock, Inc., Greenfield, and Sugar Creek Stone Quarry, Inc., and Fayette Limestone Co., both near Washington Court House. Output was mainly for aggregate and agstone.

Franklin.—The county continued as the State's leading sand and gravel producing area. Output by commercial producers totaled 5.8 million tons compared with 4.8 million tons the previous year. Government-and-contractor production was lower than that of 1965. Among the 19 active commercial operations (12 in 1965), leading producers included American Aggregates Corp. (3 plants), Colvin-Gravel Pits, Inc. (2 plants), The Olen Corp., Wm. Miller Sand & Gravel Co., and The Jackson Pike Sand and Gravel Co. Producers were active mainly near Columbus. The Marble Cliff Quarries Co. produced limestone near Columbus for commercial sales and for manufacturing quicklime and hydrated lime. Sales of limestone were mainly for flux, agstone, aggregate, and railroad ballast. The Claycraft Co., Gahanna, and The Columbus Clay Manufacturing Co., Blacklick, mined shale for manufacturing building brick and drain tile, respectively. W. C. Utzinger & Sons recovered reed-sedge peat from a bog near Grove City. Output was shredded for sale for soil improvement purposes and as earthworm culture medium.

Gallia.—Coal production continued to decline and was 42 percent below that of 1965. Of the total, 63 percent was strip-mined coal. Orchard Coal Corp. was the leading strip mine operator. Limestone used mostly for aggregate and agstone was quarried near Bidwell. The Keener Sand & Clay Co. produced molding sand at Kerr. Mostly construction sand and gravel was produced by M. T. Epling Co., Gallipolis.

Geauga.—Production of sand and gravel was below that of 1965. Most of the material was processed for use in construction. R. W. Sidley. Inc., Thompson, produced construction and industrial sands and was the leading producer. Other operations were active at Chesterland, Auburn Center, Burton, Newbury, Parkman, and Bainbridge Township. Harbison-Walker Refractories Co., Thompson, produced quartzite for refractory bricks.

Greene.—Southwestern Portland Cement Co. and Universal Atlas Cement Division of United States Steel Corp. produced portland and masonry cements at Fairborn. Southwestern used limestone and clay mined nearby for their primary cement raw materials; Universal Atlas mined limestone and clay and purchased sand for their cement requirements. The latter company also used substantial quantities of gypsum mined and shipped from out of the State. Limestone used for aggregate was quarried near Cedarville. Output of commercial sand and gravel increased 2 percent above that of 1965. Most of the output was processed material used for construction and came from 12 operations. Hilltop Concrete Corp., Fairborn; Phillips Sand & Gravel Co., Alpha; and Bellbrook Gravel, Inc., Bellbrook, were the leading producers.

Guernsey.—Output of coal increased by 1.5 million tons and was chiefly from six strip mines. Central Ohio Coal Co. accounted for most of the strip-mined tonnage. Coal was cleaned at the Carol No. 2 preparation plant of C. V. & W. Coal Co., Inc. Concord Quarry mined limestone for aggregate at New Concord.

Hamilton.—Although production of sand and gravel was slightly below that of 1965, the county continued as the second ranking

sand-and-gravel-producing area. Output was 4.5 million tons valued at $5.3 million. The leading producer was Ohio Gravel Co., Division of Dravo Corp., with plants at Camp Dennison, Cleves, Miamitown, and Newtown. Other leading producers included Barrett Division, Allied Chemical Corp., Bill Burkart, Inc., Queen City Gravel Co., (two plants), and Paul Willis Sand & Gravel. Limestone used for agstone was recovered as a byproduct of sand and gravel production at the Newtown and Camp Dennison plants of Ohio Gravel Division of Dravo. Barrett Division, Allied Chemical Corp. also recovered limestone used for agstone as a byproduct of sand and gravel production at New Baltimore.

Hancock.—Limestone was produced by The Tarbox-McCall Stone Co. and National Lime & Stone Co., both near Findlay, and by Pifer Stone Co., Williamstown. Northern Ohio Sugar Co., a subsidiary of the Great Western Sugar Co., produced quicklime for sugar refining at Findlay. Limestone for manufacturing quicklime was shipped from Michigan. Clay for manufacturing drain tile was mined by Hancock Brick & Tile Co., Findlay. Sand and gravel used for building, paving, and filtration was produced by H. & M. Sand & Gravel Co., Findlay.

Hardin.—Limestone used mainly for aggregate and agstone was produced by The Hardin Quarry Co., Dunkirk, and The Herzog Lime & Stone Co., Forest. The latter company also produced quantities of fluxing stone.

Harrison.—For the second consecutive year the county ranked first among the 25 coal-producing counties. Production from all types of mines increased as total tonnage was 2.1 million tons greater than that of 1965. Value increased by $9.1 million. In contrast with previous years, strip mining predominated and accounted for 56 percent of the total output. Hanna Coal Co., Division of Consolidation Coal Co., with four mines, was the leading producer of strip-mined coal. The company was also a leading producer of underground mined coal. The Youghiogheny & Ohio Coal Co., with two mines, was the leading producer of the underground tonnage. Hanna Coal Co. processed coal at its Georgetown preparation plant and The Youghiogheny & Ohio Coal Co. operated its Nelms No. 1 plant. Hurley Coal Co. operated the Tappan No. 1 preparation plant formerly operated by Tappan Lake Coal Co. Hanna Coal Co., also produced limestone for aggregate and agstone at Cadiz. The Bowerston Shale Co., Bowerston, mined shale used for farm drain tile.

Henry.—Napoleon Sand & Gravel Co. and Turkey Foot Sand & Gravel, both near Napoleon, produced mostly construction sand. August Honeck & Son, Malinta, and Napoleon Brick & Tile Works, Napoleon, mined clay used for manufacturing drain tile.

Highland.—Highland Stone Division, Davon, Inc., and Marshall Quarry, both near Hillsboro, and Ohio Asphaltic Limestone Co., New Vienna, produced limestone mainly for aggregate and agstone. Principal producers of sand and gravel were Greenfield Sand & Gravel Corp., Greenfield, and Hillsboro Gravel Co., Hillsboro. The Mowrystown Brick & Tile Co. mined clay and shale near Mowrystown for use in manufacturing building brick and drain tile.

Hocking.—Coal production declined 15 percent and was mainly from seven strip mines. Boyle Coal Co., Inc. was the leading strip mine operator. Clay production increased sharply above that of 1965. Miscellaneous clay and shale predominated. Pits were operated by General-Hocking Brick Co., Boyle Coal Co., Inc., and Kishler Coal & Clay Co. Construction sand and gravel was produced at the Logan stationary plant of Hocking Valley Sand & Gravel Co.

Holmes.—Output of coal increased chiefly because of a greater number of active operations compared with that of 1965. Hardy Coal Co. was a leading strip mine operator and the only auger mine producer. The underground mine of Union Coal Co. did not operate. Briar Hill Stone Co., operated two sandstone quarries near Glenmont. The stone was fabricated for architectural applications. Limestone and plastic fire clay was produced at Berlin by Holmes Clay Division of The Holmes Limestone Co. Total clay production was below that of 1965; fire clay output predominated. Production was from pits near Baltic, Berlin, and Millersburg; The General Clay Products Co. and The Belden Brick Co. were the leading producers. Output of sand and gravel was above that of 1965. Producers were Feikert Sand & Gravel, Salt Creek Township; Close Sand &

Gravel Co., Millersburg; and Edgar Spring, Inc., Holmesville. The Holmesville pit of Gallo & Sons, Inc., was closed at the end of 1965.

Jackson.—Coal production continued to increase and was 246,000 tons greater than that of 1965. Of the tonnage 90 percent was strip-mined coal; Waterloo Coal Co., Inc., was the leading producer and operated the county's only preparation plant. Fire clay production was 5 percent greater than that of 1965. Output was from six operations near Oak Hill. Leading producers were Cedar Heights Clay Co. and Ohio Fire Brick Co. Limestone and clay was produced at Oak Hill by Waterloo Coal Co., Inc. Limited quantities of blast sand was produced near Oak Hill by Cedar Heights Clay Co.

Jefferson.—Among the coal producing areas, the county continued to rank third in tonnage. Output was 4 percent below that of 1965, but an increase in average unit value was reported. Average value per ton increased from $3.58 in 1965 to $3.77. Nearly 78 percent of the total tonnage was strip-mined coal. Hanna Coal Co., Division of Consolidation Coal Co. was the leading strip mine producer and The North American Coal Corp. was the leading underground operator. Both companies operated coal preparation plants. Clay production increased above that of 1965; most of the output was fire clay used in refractories. Producers were H. K. Porter Co., Inc., Refractories Division, and Frederick J. Dando Co., both near Irondale, and Kaul Clay Co., Toronto.

Knox.—Output of sand and gravel was 18 percent below that of 1965 and totaled 901,000 tons. Construction sand and gravel was recovered at six operations; Fredericktown Sand & Gravel Co., Fredericktown, and Purdy Sand & Gravel Co., Mt. Vernon, were the leading producers. Glass, molding, and ground sand were produced by The Millwood Sand Co., Howard. Briar Hill Stone Co. recovered architectural sandstone from a quarry near New Castle.

Lake.—Rock salt was recovered from the Fairport underground mine of Morton Salt Co. Diamond Alkali Co. produced quicklime and recovered salt brine from wells at Painesville. The brine and quicklime were used for manufacturing chlorines and alkalies. Limestone quarried in Michigan was burned at the Grand River plant of Grand River Lime Co. The quicklime was sold for metallurgical uses and for water purification and softening. Sand and gravel production was above that of 1965. R. W. Sidley, Inc., Painesville, and Cappelli Sand & Gravel, Wickliffe, were the principal producers.

Lawrence.—Alpha Portland Cement Co., Ironton, and Marquette Cement Manufacturing Co., Superior, produced portland and masonry cements. Alpha mined limestone (cement rock) and Marquette mined limestone and shale for use as primary cement raw materials. Alpha discontinued mining sandstone and used purchased sand as a cement raw material. Both companies consumed quantities of gypsum in manufacturing cement. Engle Stone Co., Division of Benedict, Inc., mined limestone at Pedro. The Lawrence County Highway Department produced limestone for aggregate at its Buck Creek quarry. In addition to the clay mined and used for manufacturing cement at Superior, eight other mines were active, three each near Ironton and Pedro and one each near Blackfork and South Webster. Jerry Sand & Gravel, Inc., South Point, and Wilson Sand & Gravel Co., Chesapeake, produced construction sand and gravel. Output of coal was below that of 1965. Production was from three strip mines; producers were Collins Mining Co., D. & D. Coal Co., and Engle Stone Co., Division of Benedict, Inc. Output from the Collins mine was processed at the company's preparation plant.

Licking.—Sand and gravel production was below that of 1965 and totaled 706,000 tons. Commercial output was reported from 12 operations mainly near Newark, Granville, and Kirkersville. American Aggregates Corp. and Alexandria Sand & Gravel Co., both near Newark, were the leading producers. Shale used for manufacturing brick was produced at Hanover by The Bowerston Shale Co.

Logan.—Production of limestone totaled 585,000 tons compared with 342,000 tons in 1965. Producers were Connolly Construction Co., East Liberty; C. E. Duff & Son, Inc., Huntsville, and Northwood Stone & Asphalt Co., Belle Center. Sand and gravel output from 10 operations totaled 202,000 tons nearly double that of 1965. Neer's Engineering Labs, Bellefontaine, was the principal producer.

Lorain.—Cleveland Quarries Co. operated sandstone quarries at Amherst and Kipton. Substantial quantities of dimension stone for architectural work and for lining steel furnaces were produced. Some crushed and broken stone as well as byproduct abrasive grindstones also were produced. Sand and gravel production was 459,000 tons, 10 percent greater than that of 1965. Lorain Elyria Sand Co., Lorain, continued as the leading producer.

Lucas.—Portland cement was produced at Toledo by Medusa Portland Cement Co., from limestone, shale, and sand mined nearby. Limestone quarries also were operated by The France Stone Co., Waterville; Maumee Stone Co., Maumee; Toledo Stone & Glass Sand Co., Sylvania; and Toledo House of Correction, Whitehouse. Limestone output was below that of 1965 and totaled 2.1 million tons. Production of sand totaled 825,000 tons, 6 percent below that of 1965. Output consisted of sand used for construction and as fill material. Bellevue Trucking Corp. and Seaway Sand & Stone Co., Inc., both near Holland, were the leading producers.

Madison.—Limestone was quarried by American Aggregates Corp., Plain City, and Madison Stone Co., Inc., Galloway. The West Jefferson Sand & Gravel Co., West Jefferson, and Varga Sand & Gravel Co., Mt. Sterling, produced construction sand and gravel.

Mahoning.—Limestone production was greater than that of 1965. Producers were Alliance Stone Co., and Standard Slag Co., both near Alliance; Carbon Limestone Co., Lowellville; and Bessemer Cement Co., Division of Diamond Alkali Co., near Bessemer, Pa. The latter company also mined shale for consumption at the company cement plant at Bessemer, Pa. Clay production was below that of 1965. Most of the output was fire clay used in refractories and heavy clay products. American Fire Clay & Products Co., Canfield, and Natco Corp., Petersburg, were the leading producers. Coal production and the number of active mines was below that of 1965 all output came from strip mines. The East Fairfield Coal Co. and Thompson Bros. Mining Co. were the leading producers. Beaver Peat Products Co. produced reed-sedge peat at Damascus.

Marion.—National Lime & Stone Co., and, J. M. Hamilton & Sons Co., both near Marion, and Tri County Limestone Co., LaRue, produced limestone used chiefly for concrete aggregate. Output was below that of the previous year and totaled 772,000 tons. Marion Brick Corp. mined shale for brick manufacturing near Iberia. Output of sand and gravel was above that of 1965. Producers were Penry Stone Co., Radnor; Prospect Sand Co., Prospect; Green Camp Gravel Co., Green Camp; and Connolly Construction Co., Marion.

Medina.—Sand and gravel production increased 10 percent above that of 1965 and totaled 690,000 tons. Output was from seven operations located in Medina, Lodi, and Seville. Most of the material was processed for construction use. Seville Sand & Gravel, Inc., Seville, and Quillin Bros. Construction Co., Inc., Lodi, were the principal producers. Wadsworth Brick & Tile Co., Wadsworth, mined clay for brick manufacture.

Meigs.—Processed sand and gravel was produced by Tri-State Materials Corp. and Richards & Son, Inc., both near Apple Grove. Bank-run gravel was produced at Middleport by Goeglein Gravel Co. At Pomeroy, Excelsior Salt Works, Inc., Produced evaporated salt in open pans. Output was shipped mainly to consumers in Kentucky and Ohio. Sandstone used for riprap was quarried near Reedsville. A sharp decline in coal production was reported primarily because of fewer active mines than in 1965. Production was primarily from underground mines, no strip mine output was reported. Jeffers Coal Co. was the principal producer.

Miami.—Limestone used chiefly for flux, agstone, and aggregate was produced at Piqua by Armco Steel Corp. Gregory Stone Co., Inc., produced dimension limestone at West Milton. Sand and gravel output from seven commercial operations totaled 582,000 tons, 16 percent above that of 1965. Troy Gravel Co., Troy, and Vandalia Gravel, Inc. (formerly Miami Gravel Co.), Vandalia, were the leading producers. Producers also were active at Bradford, Covington, Ludlow Falls, Piqua, and Troy.

Monroe.—The North American Coal Corp. produced substantial tonnages of coal from its Powhatan No. 1 underground mine. Output was processed at the company's Powhatan No. 1 preparation plant in Belmont County. Processed construction sand and gravel was produced at Claring-

ton by Blaney Sand & Gravel Co., Inc. Bank-run paving gravel was recovered from the Witten gravel pit near Fly. Christman Quarry, Summerfield, produced limestone for aggregate and roadstone.

Montgomery.—Production of sand and gravel was 5 percent below that of 1965, totaling 3.4 million tons valued at $3.6 million. The county continued to rank third among producing counties with 26 active operations. Production was centered mainly near Dayton; leading producers were American Aggregates Corp., Moraine Materials Co., and Hilltop Concrete Corp. American Aggregates Corp. operated limestone quarries near Phillipsburg and Dayton. Carey Bros. Stone Co. produced crushed limestone for aggregate at Dayton. Quicklime was recovered from waste sludge and from the recarbonation of water in a purification and softening process by the City of Dayton Water Department. Output was consumed by the department for water treatment purposes.

Morgan.—Coal production continued to decline; output was limited to three strip mines. Most of the tonnage was from the Muskingum No. 4 strip mine of Central Ohio Coal Co. However, the company's Muskingum preparation plant was idle and did not process any of the strip-mined tonnage. Processed building and paving sand and gravel was produced by Stockport Sand & Gravel Co., Stockport. D. & K. Construction, Inc., Reinersville; Ball & Ball, Amesville; and Industrial Stone, Inc., McConnelsville, produced limestone used mainly for aggregate.

Muskingum.—Portland and masonry cements were produced at the East Fultonham plant of Columbia Cement Co. Limestone and shale recovered from the underground Jonathan mine near Zanesville as well as purchased sand and gypsum were utilized by the company for manufacturing cement. Limestone also was produced by Chesterhill Stone Co., East Fultonham; Sidwell Bros., Zanesville; D. K. Construction, Inc., Cumberland. Sand and gravel production totaled 591,000 tons, a 9-percent decline from that of 1965. Muskingum River Gravel Co., with three operations near Zanesville, was the leading producer. Other important producers were The Zanesville Gravel Co., Cox Gravel Co., Inc., and Symmes Creek Sand & Gravel, Inc., all near Dresden. Shale used for manufacturing brick was mined at Frazeysburg by The Bowerston Shale Co. Stoneware clay was produced near East Fultonham by Thelma Hammer. Coal production was more than double that of 1965. Of the total tonnage, 233,000 tons were recovered from eight strip mines and the remainder was recovered from six underground mines. Zanesville Coal Co., Inc., was the leading strip mine operator.

Noble.—Output of coal was 26 percent less than that of 1965. Although the number of strip mines increased, production was lower; tonnage by auger mining was slightly above that of the previous year. Central Ohio Coal Co. was the leading producer of strip-mined coal; Noon Coal Co. was the foremost producer of auger-mined coal. Production of limestone was below that of 1965. Producers were Lawrence King, Cumberland; James Merry Stone Co., Caldwell; and Herman Zerger Jr., Woodsfield. The Summerfield limestone quarry of Piatt Quarry was closed and abandoned. The Ava Brick Corp. mined shale for manufacturing brick at Ava.

Ottawa.—From limestone quarried nearby, United States Gypsum Co. produced quicklime and hydrated lime, for construction and chemical uses at its Genoa plant. Some of the limestone was sold for aggregate and riprap. Limestone quarries also were operated by Marblehead Stone Division, Standard Slag Co., Marblehead, and Basic, Inc., Clay Center. Crude gypsum was mined by The Celotex Corp. and United States Gypsum Co., Gypsum. Both companies calcined the material at nearby plants for use in manufacturing finished building products.

Paulding.—Peninsular Portland Cement Division, General Portland Cement Co., produced portland and masonry cements at Paulding. Limestone and clay mined nearby and purchased sand and gypsum were used as raw materials. Most of the limestone from the Peninsular quarry was utilized by the company but some was sold locally to The France Co. for future processing and resale. The Auglaize Stone Co., Oakwood, produced limestone, used for aggregate, flux and agstone. Baughman Tile Co., Inc., Paulding, and The Haviland Clay Works Co., Haviland, produced clay for drain tile.

Perry.—Output of coal was slightly above that of the previous year. The increase was attributed to greater production from un-

derground mines; output from strip and auger mines declined. An increase in the average unit price was recorded. Peabody Coal Co. was the foremost producer. Preparation plants were operated by Peabody Coal Co., Sandra Coal Mining. Inc., and Sidwell Brothers. The Central Silica Co., Glenford, and The Keener Sand & Clay Co., New Lexington, produced industrial sands. Clay production was 214,000 tons, 8 percent below that of 1965. Mostly miscellaneous clay and shale was mined and used for manufacturing heavy clay products. Output was from nine operations compared with 10 the previous year. The Claycraft Co., Shawnee, and The Belden Brick Co., Somerset, were the principal producers. Other operations were active near Crooksville, Gore, Junction City, Logan, and New Lexington. Maxville Stone Co., Logan, produced limestone for aggregate, riprap, agstone, and railroad ballast.

Pickaway.—Sand and gravel production was greater than that of 1965. The Sturm & Dillard Co., Circleville, was the foremost producer. Output also was reported from two operations near Circleville and one near Orient. Limestone used mainly for riprap and roadstone was quarried near Circleville.

Pike.—Compared with that of 1965, sand and gravel output declined. Sharon Silica Co. produced industrial sand and gravel at its Hay Hollow plant near Waverly. Construction sand and gravel was produced by The Standard Slag Co., Sargents, and Seal Builders Supply Corp., Waverly. The Lucasville operation of Leo Vulgamore was inactive. A. P. Green Fire Brick Co., Durex Division, and Cambria Clay Products Co. produced quartzite used chiefly for refractory (ganister) at quarries near Beaver. Seal Builders Supply Corp., Latham, produced limestone for aggregate, agstone, riprap, and railroad ballast.

Portage.—Sand and gravel production was 2.7 million tons valued at $3.9 million. Output was 31 percent greater than that of 1965; value increased by $800,000. Output was from 27 active operations mainly near Kent, Mantua, Mogadore, Ravenna, Streetsboro, and Shalersville. Leading producers of construction sand and gravel were Beck Sand & Gravel, Jefferson Materials Co., Hilltop Sand & Gravel Co., The Hugo Sand Co., and The Standard Slag Co., (two plants). Industrial Silica Division, Pennsylvania Glass Sand Corp. produced industrial sand at Aurora and Garretsville. Harbison-Walker Refractories Co. produced quartzite for refractory (ganister) at Garrettsville. The Nelson Ledges quartzite quarry of General Refractories Co., did not operate. United States Concrete Pipe Co. mined shale for manufacturing vitrified sewer pipe at Diamond. During the year the company abandoned mining and production facilities at this location. Humus peat was recovered from a bog near Ravenna by Portage Peat Co. Green Oaks Peat Moss Co. produced peat moss at Ravenna. The Atwater strip mine of Peterson Coal Co. was abandoned.

Preble.—Marble Cliff Quarries Co. produced limestone and lime at Lewisburg. Limestone used for aggregate was produced by Victory Limestone Quarries, Lewisburg. White Gravel Co., Camden, Blue Bank Gravel Co. and Steiner's Sand & Gravel Co., both near West Alexandria, produced processed construction sand and gravel.

Putnam.—Limestone production totaled 384,000 tons, 4 percent below that of 1965. Producers were Putnam Stone Co., Ottawa; Ottawa Stone Co., Inc., Gilboa; and National Lime & Stone Co., Columbus Grove. Clay for drain tile was mined by Glandorf Tile Co., Glandorf; Etter Tile & Coal Co., Dupont; and Miller Bros. Clay Works, Inc., Ottoville.

Richland.—Sand and gravel production was below that of 1965 and totaled 486,000 tons. Six operations were active; The Mohican Sand & Gravel Co., Perrysville, and Derwacter Sand & Gravel and D. H. Bowman & Sons, Inc., both near Bellville, were the leading producers. The Richland Shale Brick Co. and Ohio Brick & Supply Co., both near Mansfield, mined shale for manufacturing brick. Reynolds Farms, Inc., produced moss peat at Shelby.

Ross.—Sand and gravel production was 733,000 tons compared with 675,000 tons in 1965. Central Materials Co., Chillicothe, and Miami Gravel Co., Richmond Dale, were the leading producers. Quartzite used mainly for manufacturing glass sand for foundry uses was produced at Richmond Dale by Southern Silica, Inc. Limestone for aggregate and agstone was produced by Ohio Asphaltic Limestone Co., Inc., Bainbridge. The Mead Corp. produced and regenerated quicklime at its paper manufacturing plant at Chillicothe.

Sandusky.—The county continued as the State's foremost lime and limestone-producing area. Production of lime, including dead-burned dolomite, was 1.4 million tons, 25 percent greater than that of 1965. Value increased $837,000 to $18.5 million but lower average unit prices were reported. Most of the lime was dead-burned dolomite and quicklime used in metallurgical applications by the steel industry. Substantial quantities of quicklime used by the chemical industry and hydrated lime used in construction also were produced. The number of active lime plants remained at eight. Production of limestone increased from 4 million tons to nearly 5 million tons. Most of the stone was used for manufacturing lime, but substantial quantities were used for metallurgical flux and as aggregate. Quarries were active near Gibsonburg, Woodville, Bellevue, Fremont, and Millersville. The Home Supply Center, Inc., Fremont, recovered structural sand by dredging.

Scioto.—Dimension sandstone for furnace brick and architectural uses was produced by The Taylor Stone Co. and The Waller Bros. Stone Co., both near McDermott. Quartzite for silica brick was mined by General Refractories Co. at Minford. Commercial sand and gravel production was slightly below that of 1965. The Standard Slag Co. and Ohio River Dredging Co., Inc. were the leading producers. International Minerals & Chemical Corp., Industrial Minerals Division, Portsmouth, and William and James Belcher, Scioto Furnace, mined fire clay for refractories.

Seneca.—Basic, Inc., mined dolomite and produced dead-burned dolomite at its Maple Grove plant near Narlo. Most of the dolomite was used at the lime plant but substantial quantities were sold for metallurgical flux, aggregate and agstone. The France Co. and Webster Stone Co., both near Bloomville, and Northern Ohio Stone Co., Flat Rock, also produced limestone. The J. A. Miller Tile Co., Bascom, and St. Stephen Tile Co., St. Stephen, mined clay for drain tile.

Shelby.—Production of sand and gravel was 8 percent above that of 1965 and totaled 271,000 tons. Six operations were active; The Sidney Sand & Gravel Co., with two operations near Sidney, was the leading producer. Miami River Quarries, Inc., Sidney, produced limestone for aggregate.

Stark.—Portland and masonry cements were produced at Middle Branch by Diamond Portland Cement Co., Division of The Flintkote Co. The company utilized limestone, shale and clay mined nearby as well as purchased sand and gypsum for manufacturing cement. Limestone also was produced by East Ohio Limestone Co., Hartville, and Harmony Mining Co., Inc., Canton. The latter company's mine was abandoned in April. Stark Ceramics, Inc., produced sandstone and clay at East Canton. Sand and Gravel production was slightly greater than that of 1965 and totaled 1.8 million tons valued at $2.2 million. The number of active operations (18) was the same as the previous year. Canton Aggregate Co., with three operations near Canton, was the principal producer. Other leading producers were Massillon Washed Graveli Co., Navarre; Ray C. Oster Sand & Gravel, Canton; and Uniontown Sand & Gravel Supply, Inc., Uniontown.

Clay production totaled 571,000 tons compared with 686,000 tons in 1965. Both fire clay and miscellaneous clay and shale were mined with fire clay accounting for 61 percent of the total tonnage. Output was from 17 operations compared with 19 the previous year. Natco Corp. with two operations was the leading fire clay producer. Peat was recovered from bogs near Canton by Lantz Peat Moss, Inc., Sanders Peat Moss, and Raymond Sheets. A substantial increase in coal production was reported. Output was mostly strip-mined tonnage. Magnolia Mining Co. and Mullett Coal Co. were the leading producers. Eckenrode Coal Co. operated the county's only auger mine.

Summit.—Pittsburgh Plate Glass Co., Chemical Division, Barberton, dominated the county's mineral industry. The company produced portland and masonry cements, quicklime, and evaporated salt and mined brine, limestone, and sandstone. Chlorine and caustic soda was produced by the electrolysis of the salt brine. The brine solution was also combined with quicklime to produce soda ash. Some brine was evaporated and marketed for a variety of chemical uses. Calcium chloride was recovered as a byproduct of the soda ash process and was sold chiefly for dust control and ice removal. The company's nearby underground limestone mine supplied the lime plant (six shaft kilns) and the single ro-

tary cement kiln. Commercial sales for limestone were made for riprap uses. Output from the company's sandstone quarry was used in glass manufacture and a concrete aggregate. Sandstone for aggregate uses was quarried in Spring Township by Martz Crushed Rock Co.

Diamond Crystal Salt Co., Akron, produced salt brine. Most of the brine was evaporated in vacuum and open pans and sold for a variety of uses. The company also sold some of the brine direct and marketed some of the evaporated salt as pressed blocks. Production of sand and gravel increased 20 percent above that of 1965 and totaled 1.1 million tons. Output was from 16 operations compared with 14 the previous year. Leading producers were Clearwater Sand & Gravel Co., Bath; Rubber City Sand & Gravel Co., Akron; Paul Wilson Sand & Gravel, Inc., Peninsula; and The Acken Sand & Gravel Co., Inc., Tallmadge. Camp Brick Co. mined shale near Mogadore for use in manufacturing brick.

Tuscarawas.—Although the number of active mines decreased from 48 in 1965 to 38, coal production was 59,000 tons greater. Of the total output, 74 percent was strip-mined tonnage. Cross Creek Coal Co. was the leading producer. Midvale Coal Co., Inc., was the leading producer at underground mines. These two companies as well as Crossroads Coal Co. operated preparation plants. Output of clay increased 10 percent above that of 1965 and totaled 1 million tons. Fire clay accounted for 67 percent of the total and was used mainly for refractories and heavy clay products. A total of 28 operations were active compared with 24 the previous year. Among the State's clay-producing areas, the county continued to rank first.

Sand and gravel production was 1.2 million tons compared with 791,000 tons in 1965. Industrial sand was produced at the Coxey Works near Dundee by Industrial Silica Division, Pennsylvania Glass Sand Corp. Edgar Spring, Inc., with plants at Beach City, Bolivar, Midvale, New Philadelphia, and Sandyville, was the leading producer of construction sand and gravel. Other producers were Spring Brothers, New Philadelphia, and Stocker Sand & Gravel Co., Gnadenhutten. Limestone production was above that of 1965. Producers were Limestone Division of Wallick Coal, Inc., Strasburg; Kimble Coal & Limestone Co., Dover; and Bonum Lime Co., Sugarcreek. The sandstone quarry of the Briar Hill Stone Co. was idle.

Union.—Union Limestone, Inc., Ostrander, and L. G. Rockhold & Sons, York Center, produced limestone. Sand and gravel used for construction was produced at five plants near Marysville. Stationary plants were operated by Marysville Concrete & Materials, Inc., and Green Camp Gravel Co. One stationary and two portable plants were operated by Connolly Construction Co.

Van Wert.—Limestone production was greater than that of 1965. Producers were The Union Quarries Co., and Ridge Township Stone Quarry, both near Van Wert, and Delphos Quarries Co., Delphos. Clay for drain tile was mined by Weck Tile Co., Van Wert.

Vinton.—Coal production was greater than that of 1965. Strip mining predominated. Benedict, Inc., was the leading operator. Limestone used for aggregate and agstone was produced by McArthur Stone & Coal Co., McArthur, and Lowman's Lime, Inc., Wilkesville. Plastic fire clay was mined near Hamden by Jerald and Everett Eberts Coal Co. Lowman's Lime, Inc., produced bank-run building sand at Wilkesville.

Warren.—Sand and gravel production increased 4 percent above that of 1965 and totaled 1.2 million tons. Twelve operations were active compared with nine the previous year. Leading producers were Morrow Gravel Co., Morrow; Franklin Sand & Gravel Co., Inc., Franklin; and Ohio Gravel Co., Division of Dravo Corp., with plants at Morrow and Waynesville.

Washington.—Compared with that of 1965, output of coal was greater. Production was mainly from three strip mines; Peaker Run Coal Co. was the leading operator. Industrial Fuel Co., Inc. (formerly C. & C. Coal Co.) recovered coal by auger mining. Production of sand and gravel was below that of 1965. Most of the material was processed for construction; Muskingum River Gravel Co., New Matamoras, was the leading producer. Limited quantities of abrasive stones (grindstones) were produced at Constitution by The Hall Grindstone Co. The company discontinued business in July.

Wayne.—Morton Salt Co. recovered brine from wells at Rittman, which was evaporated in open and vacuum pans. Some of the evaporated salt was marketed in pressed blocks. Sand and gravel production declined from that of 1965 and totaled 440,000 tons. Producers were The Rupp Construction, Inc., Marshallville; Charles Zollinger Sand & Gravel, Rittman; Jones Sand & Gravel Co., Inc., and Prairie Lane Gravel Co., both near Wooster. Mullet Coal Co., mined limestone and plastic fire clay at Mt. Eaton. Holmes Clay Division of The Holmes Limestone Co. produced limestone for aggregate and agstone at Holmesville. Shale for brick was mined near Wooster by Medal Brick, Inc., and clay for heavy clay products was mined at Orrville by Orrville Tile Co. Holmes Limestone Co. and Mullet Coal Co. operated coal strip mines.

Wood.—Production of limestone totaled 1.4 million tons compared with 1.1 million tons in 1965. Most of the stone was used for aggregate, agstone, and flux. Quarries were operated by The Brough Stone Co., West Millgrove; The France Stone Co., North Baltimore and Luckey; Maumee Stone Co., Perrysburg and Portage; and The Pugh Quarry Co., Custar.

Wyandot.—National Lime & Stone Co. quarried limestone and produced quicklime and hydrated lime at Carey. In addition to supplying the lime plant, limestone from the quarry was sold commercially mainly as aggregate, fluxing stone, agstone, and for use in glass manufacturing. Output from the lime plant was used mainly for manufacturing glass and for sewage treatment. Other limestone quarries were operated by Kuenzli Quarries Co., and Charles H. McCarthy Quarry, both near Upper Sandusky, and Wyandot Dolomite, Inc., Carey. Construction sand and gravel was produced by Wilson Sand Co., Corfman Gravel Co., and Kuenzli Quarries Co., Inc. all near Upper Sandusky. Clay used for manufacturing brick was produced at Upper Sandusky by The Claycraft Co. The Humus Co., Carey produced humus peat for use as seed inoculant and for soil improvement purposes.

The Mineral Industry of Oklahoma

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

By Robert B. McDougal [1] and William E. Ham [2]

The mineral output of Oklahoma was valued at $997.4 million in 1966, an increase of 9.7 percent over that of 1965. This record value reflected a long-trend increase in the mineral industry with the State ranking fourth in the Nation in terms of mineral production value. Gains were noted in 12 mineral commodities and losses were incurred in eight. Increased production of petroleum, natural gas, natural gas liquids, helium, sand and gravel, lime, salt, tripoli, volcanic ash, lead, copper, and silver was responsible for the overall gain in value and compensated for lower values in coal, cement, clays, gypsum, stone, and zinc. Tight money, investment policy, and rising interest rates had a direct bearing on the overall decline in construction activity in Oklahoma in 1966. As a result, the total number of new homes started during the year was the lowest since 1953 and affected output of most construction commodities, notably cement, clays, gypsum, and stone.

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[2] Geologist, Oklahoma Geological Survey, Norman, Okla.

Table 1.—Mineral production in Oklahoma [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Clays [2] thousand short tons	794	$806	745	$754
Coal (Bituminous) do.	974	5,520	843	4,935
Gypsum do.	761	2,343	785	2,212
Helium, grade A thousand cubic feet	r 310,700	r 10,874	352,400	12,333
Lead (recoverable content of ores, etc.) short tons	2,813	878	2,999	907
Natural gas million cubic feet	1,320,995	182,297	1,351,225	189,172
Natural gas liquids:				
Natural gasoline and cycle products thousand gallons	570,129	34,561	576,124	35,715
LP gases do.	894,665	32,208	986,254	44,381
Petroleum (crude) thousand 42-gallon barrels	203,441	587,944	224,839	654,281
Salt thousand short tons	9	65	W	W
Sand and gravel do.	5,218	6,023	6,040	7,565
Stone do.	16,417	18,071	15,334	17,393
Zinc (recoverable content of ores, etc.) short tons	12,715	3,713	11,237	3,259
Value of items that cannot be disclosed:				
Bentonite, cement, copper, lime, silver, tripoli, and volcanic ash	XX	23,953	XX	24,484
Total	XX	r 909,256	XX	997,391

W Withheld to avoid disclosing individual company data; included with "Value of items that cannot be disclosed."
r Revised.
XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes bentonite; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in constant 1957–59 dollars
(Millions)

Year	Value [1]
1957	$802
1958	762
1959	778
1960	784
1961	788
1962	831
1963	861
1964	880
1965	904
1966	978

[1] Data for 1957–65 revised.

Petroleum and/or natural gas were produced in 69 counties covering most of the State. Helium was recovered in Cimarron County; coal in six eastern and northeastern counties. Sixty-one counties, primarily in the northeast, north-central, and central areas and in the Arbuckle and Wichita Mountain regions in the southern area, had nonmetals production. Metals were produced in Ottawa and Jackson Counties.

Employment and Wages.—The Oklahoma Employment Security Commission reported that the mineral industries employed 42,200 persons in 1966, including 40,400 engaged in oil and gas drilling and production. In 1965, the mineral industries employed 42,400 persons of which 40,500 were engaged in oil and gas drilling and production. Under the Oklahoma Employment Security Act, which covers establishments employing four or more persons, the mineral industries in 1966 paid $299 million in wages to 40,551 persons, compared with $289 million in wages paid to 40,827 persons in 1965.

Government Programs.—By the end of 1966, of the 18 authorized lock and dam structures on the Verdigris River segment of the Arkansas Navigation Project, all but lock and dam No. 18 were under construction. Construction was begun at lock and dam No. 14, 9 miles southwest of Ft. Smith, Ark., and continued at lock and dam No. 15 (Robert S. Kerr) and No. 16 (Webbers Falls) throughout the year. Other continuing projects of the Tulsa District U.S. Army Corps of Engineers were the Broken Bow Dam on Mountain Fork River and Pine Creek Dam on Little River in McCurtain County. Construction of the powerhouse at Keystone Dam west of Tulsa continued.

Work continued at the Bureau of Reclamation, U.S. Department of the Interior, Arbuckle Dam on Rock Creek southwest of Sulphur, Murray County.

The Grand River Dam Authority, a State agency, continued construction at its pumped storage project at Lake Hudson (Markham Ferry).

On May 28, the Federal Water Pollution Control Administration dedicated its new regional water laboratory, the Robert S. Kerr Water Research Center at Ada. Pollution problems peculiar to the Southwestern United States, such as: Proper disposal of brine wastes above and below the ground; methods of preventing natural salt pollution; methods of reducing harmful effects on water quality caused by mineral leaching from soils in irrigation; and development of advanced waste treatment methods to permit reuse of water, will be investigated.

Table 3.—Employment 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
1965:								
Coal	261	197	51	407	-----	7	17.20	658
Metal	306	273	84	668	1	13	20.95	9,761
Nonmetal	379	227	86	689	1	13	20.32	9,631
Sand and gravel	320	254	81	780	1	23	30.76	8,309
Stone	1,069	259	277	2,253	-----	57	25.30	1,352
Total	2,335	248	579	4,797	3	113	24.18	4,786
1966: [p]								
Coal	230	201	46	351	-----	10	28.49	1,083
Metal	335	260	87	697	-----	17	24.39	581
Nonmetal	550	243	134	1,071	-----	22	20.54	1,722
Sand and gravel	345	262	90	845	-----	22	26.04	832
Stone	1,210	271	328	2,709	1	72	26.95	4,681
Total	2,670	257	685	5,673	1	143	25.38	2,822

[p] Preliminary.

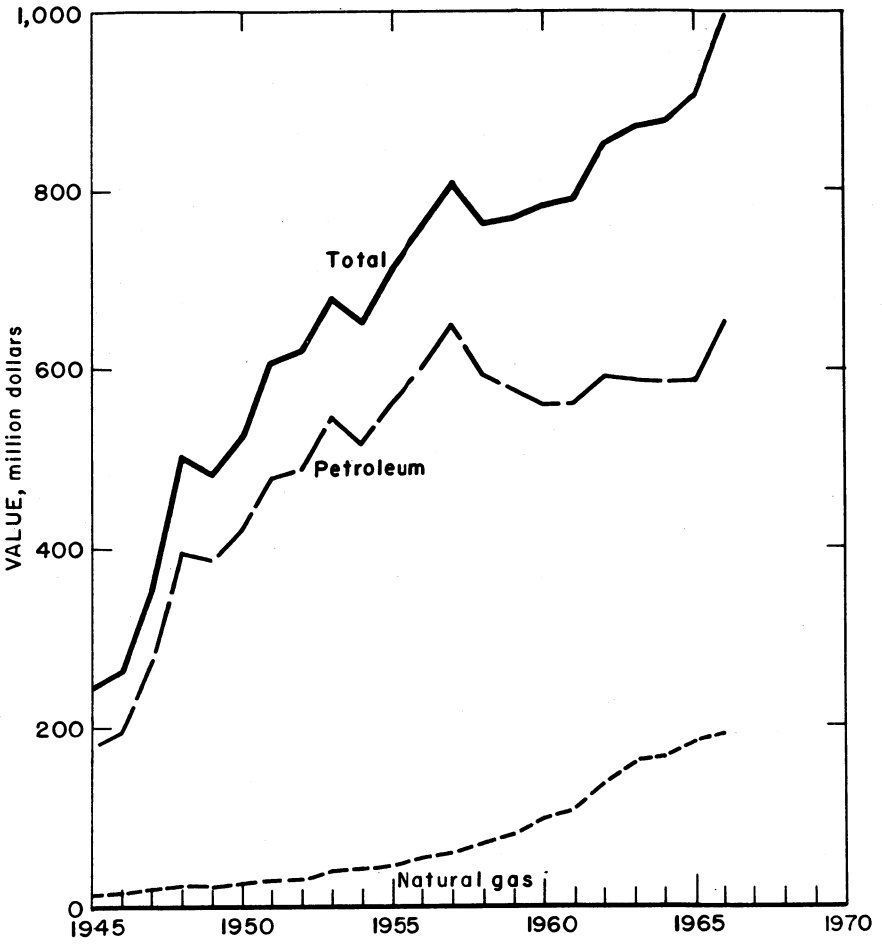

Figure 1.—Value of natural gas, petroleum, and total value of mineral production in Oklahoma.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Proved recoverable reserves of petroleum in 1966 increased for the first time since 1955 and thus halted a declining trend. Reserves of natural gas liquids substantially increased in 1966 from the previous year, but reserves of natural gas declined for the first time since records have been maintained.

The American Association of Petroleum Geologists statistical data on well drilling published in the annual review of The Oil and Gas Journal reported that Oklahoma, with 520 wells, ranked fifth in the Nation in exploratory drilling. Accumulated exploratory drilling totaled 3,150,032 feet; wells averaged 6,046 feet in depth in comparison with an average depth of 5,911 feet in 1965. The 3,212 field development wells drilled in 1966 totaled 14.7 million feet, averaging 4,562 feet per well, compared with an average of 4,292 feet per well in 1965.

In an effort to curb oilfield pollution, the Oklahoma Corporation Commission is-

sued regulations prohibiting the construction of unlined field pits and eliminating existing pits by June 1, 1967. Failure of an operator to comply with the Commission order would result in shut-in of production from the property and a notice for the operator to show why the shut-in order should not be made permanent. The Commission's first order under its new campaign against oilfield pollution was issued in December and affected 28 wells in a Washington County waterflood. Later, shut-in orders were issued to operators of 12 wells in Carter and Stephens Counties, effective January 1, 1967.

On August 1, Gulf Oil Corp. acquired 2,300 Citgo service stations in Oklahoma, Kansas, Nebraska, North and South Dakota, Minnesota, Iowa, Missouri, and Illinois (except for the greater Chicago region); 546 bulk stations and 175 distributors. Sequoia Refining Corp., in a separate transaction, acquired the Cities Service Oil Co.'s 35,000-barrel-per-day refinery at Ponca City and its pipeline gathering system in Oklahoma and Kansas. Cities Service's oil and gas production was not involved.

Kerr-McGee Corp. completed installation of a hydrocracker at its Wynnewood refinery in late October.

Oklahoma Cement Co., through a wholly owned subsidiary—Okmulgee Refining Co., Inc.—purchased the Phillips Petroleum Co. 19,000-barrel-per-day crude oil refinery at Okmulgee. The acquisition provided an internal source for asphalt products which would enable the parent company to supply a more complete line of road surfacing materials. The refinery, which produces a varied line of petroleum products such as motor fuels, heating oils, jet fuels, diesel fuels, and liquefied petroleum gas, can also produce up to 1,300 barrels per day of various grades of asphalt, asphalt emulsions, and road oils.

Pan American Petroleum Corp. completed a $1 million expansion program early in the year at its research facilities in Tulsa.

Williams Brothers Co. announced that its subsidiary Williams Brothers Pipe Line Co. acquired the pipeline system of Great Lakes Pipe Line Co. for $287.6 million. Great Lakes Pipe Line Co. operated for many years as a common carrier pipeline in the Central Midwest, moving refined petroleum products originating in Texas, Oklahoma, and Kansas to markets in the Central and Upper Midwest.

Oklahoma Natural Gas Co. completed a 93-mile natural gas pipeline from the Red Oak-Norris and Kinta fields in Latimer and Le Flore Counties to Sapulpa, Creek County.

Capacity of the 18- to 22-inch line is 260 million cubic feet per day. The company will consume about half the gas, and the remainder will be used by Public Service Company of Oklahoma (PSC) and Oklahoma Gas & Electric Co. (OG&E). In conjunction with the line, Pan American Petroleum Corp. for itself, Midwest Oil Corp., and several other producers constructed a 52-mile pipeline gathering system in the fields.

Mustang Fuel Corp. completed 26 miles of gas transmission pipeline from the Red Oak and Wilburton fields to serve PSC and OG&E. A new 18-mile line will transport OG&E's portion of the Red Oak gas to be gathered and delivered by Pan American Petroleum Corp. The line will link Red Oak with Kinta, where it will join the Mustang transmission system which serves OG&E's two large powerplants in the Oklahoma City area and Muskogee. Mustang will extend its gathering and transmission system south about 8 miles from Kinta to near Wilburton to gather and transport gas for OG&E and PSC.

Panhandle Eastern Pipeline Co. completed a 73-mile pipeline from new supply areas in Ellis County, Okla., and Hemphill County, Tex., to the company's existing Elk City transmission line in Dewey County, Okla.

Carbon Black.—The output of carbon black produced from petroleum distillate at Continental Oil Co.'s Ponca City refinery was 8 percent lower in quantity and 10 percent lower in value during 1966 than in the previous year.

Coal.—Production of low-ash bituminous coal decreased to less than 850,000 tons, 13 percent less than in 1965. Valued at $4.9 million, the coal was produced in six counties by 12 operators at 14 mines (three underground, 10 strip, and 1 auger).

Haskell, Rogers, and Craig Counties led in quantity and value of output. Five other producers, who mined less than 1,000 tons each, were active in Craig, Haskell, Latimer, and McIntosh Counties. Seventy-

four percent of the total output was supplied by three companies.

Strip mines supplied 99 percent of total production. Output from the strip mines decreased over 13 percent, and underground production declined 29 percent from 1965. Ninety-eight percent of the coal was shipped by railroad, and the remainder was shipped by truck.

Kerr-McGee Corp. announced plans to construct 50 ovens near Stigler, Haskell County, to produce metallurgical coke for the metals industry as the initial step in a multimillion dollar coal mining and coking plant operation.

Inasmuch as efforts to get voluntary adjustments in freight rates were not successful, The State of Oklahoma requested legal action to force an adjustment in railroad coal-hauling rates which discriminate against northeastern Oklahoma mine operators. The State Corporation Commission was asked to file a complaint with the Interstate Commerce Commission.

Table 4.—Coal (bituminous) production
(Thousand short tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	1,545	$10,239
1962	1,048	6,978
1963	1,008	5,667
1964	1,028	5,474
1965	974	5,520
1966	843	4,935

Helium.—The Federal Bureau of Mines helium plant at Keyes, Cimarron County, is the only helium producing facility in the State. During 1966, the plant produced 352.4 million cubic feet of grade A helium (99.995 percent purity), an increase of 41.7 million cubic feet (or about 13.4 percent) over the 310.7 million cubic feet produced in 1965. At the Bureau of Mines established sales price of $35.00 per 1,000 cubic feet (f.o.b. plant), the 1966 production was valued at $12.33 million.

Shipments (sales) of helium from the Keyes plant totaled 349.4 million cubic feet. The balance of the production was placed in underground storage in the Cliffside gasfield near Amarillo, Tex., as part of the helium conservation program. Shipments from the plant are made by railway tank cars or highway semitrailers. All shipments are of gaseous helium; the plant is not equipped to produce liquid helium.

Natural Gas.—Oklahoma was the third largest natural gas producing State; 64 Oklahoma counties, led by Texas, Beaver, Harper, Beckham, and Garvin Counties, in descending order, reported output. At year end, the proved recoverable reserve of natural gas in the State was approximately 16.3 cubic feet of gas for each cubic foot produced. According to the American Gas Association, new discoveries found through exploratory drilling added 595 billion cubic feet to the gas reserve; another 584 billion cubic feet was added through extensions and revisions.

Nine gas storage fields in nine counties were used by the natural gas industry. Underground storage facilities had a total capacity of 157.6 billion cubic feet of working gas volume (above minimum working pressure) and 121.9 billion cubic feet of cushion gas volume (below minimum working pressure). Maximum storage capacity is presently 301.7 billion cubic feet. Available storage capacity permitted continuous production and conservation of casinghead gas from oil wells during periods of low demand.

Table 5.—Marketed production of natural gas [1]

Year	Million cubic feet	Value (thousands)
1957–61 (average)	788,954	$83,469
1962	1,060,717	135,772
1963	1,233,883	160,405
1964	1,316,201	166,747
1965	1,320,995	182,297
1966	1,351,225	189,172

[1] Comprises gas either sold or consumed by producers, including losses in transmission, amounts added to storage, and increases in gas pipelines.

Natural Gas Liquids.—Seventy-seven natural gasoline plants (72 natural gasoline plants and five cycling plants) recovered about 1.6 billion gallons of natural gas liquids in 1966, an increase of 7 percent. Liquefied petroleum gases accounted for 63 percent of the volume and 55 percent of the value; natural gasoline and cycle products comprised the remainder.

Mobil Oil Corp. converted its Thomas plant, Dewey County from a refrigeration process to a refrigeration-absorption process to increase plant capacity. The firm also completed in Dewey County its 15-million-cubic-foot-per-day Putnam field plant. Allied Chemical Corp.'s Union

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

		Proved reserves Dec. 31, 1965	Changes in proved reserves, due to extensions and new discoveries in 1966	Proved reserves, Dec. 31, 1966 (production was deducted)	Changes from 1965, percent
Crude oil	thousand 42-gallon barrels	1,517,490	754	1,518,244	-----
Natural gas liquids [1]	do	358,297	117,308	475,605	+32.7
Natural gas	million cubic feet	20,357,414	−235,223	20,122,191	−1.2

[1] Includes condensate, natural gasoline, and LP gases.

Source: American Gas Association, American Petroleum Institute, and Canadian Petroleum Association, Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas, published in the Tulsa Daily World, 62d yr., No. 20, Apr. 3, 1967, p. 27.

Table 7.—Natural gas liquids production

(Thousand gallons and thousand dollars)

Year	Natural gasoline and cycle products		LP gases		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	480,605	$29,447	699,893	$27,453	1,180,498	$56,900
1962	552,795	35,764	838,903	25,223	1,391,698	60,987
1963	555,467	35,131	810,894	28,981	1,366,361	64,112
1964	554,053	34,011	880,804	28,055	1,434,857	62,066
1965	570,129	34,561	894,665	32,208	1,464,794	66,769
1966	576,124	35,715	986,254	44,381	1,562,378	80,096

Texas Petroleum Division completed its 90-million-cubic-foot-per-day Chaney Dell plant in Major County. At yearend, Service Gas Products Co. completed its 15-million-cubic-foot-per-day refrigeration-absorption Aline plant in Alfalfa County. Sunray DX Oil Co. purchased Universoil, Inc.'s Dibble field plant, McClain County, and Warren Petroleum Corp, acquired British-American Producing Co.'s Knox field cycling plant Grady County.

In Carter County, Mack Oil Co. closed its Joiner City field plant, and Mobil Oil Corp. its Fox-Graham field plant. Gas from the latter field will be processed at Mobil's Sholem Alechem field plant in Stephens County. Wunderlich Development Co. discontinued operations at its Noble field plant near Billings, Noble County.

The American Gas Association reported proved recoverable reserves of natural gas liquids in Oklahoma were estimated to be 475.6 million 42-gallon barrels at yearend, about 6 percent of the total U.S. reserve. Exploratory drilling added almost 13 million barrels to the recoverable reserve; development drilling added over 147 million barrels through extensions and revisions.

Yearend underground storage capacity for natural gas liquids totaled 2,459,000 barrels at 13 sites, The Oil and Gas Journal reported. Five new sites, completed in a salt layer in Grant County and placed into service in 1966, increased total storage by 1.2 million barrels compared with 1965 figures.

Petroleum.—Crude petroleum production totaled 224.8 million barrels from 80,583 oil wells, compared with 203.4 million barrels from 80,947 oil wells in 1965. Daily average production of crude oil was 616,079 barrels, or 7.6 barrels per well. The average indicated demand for crude oil was 600,975 barrels, 7 percent greater than in 1965.

The Oklahoma Corporation Commission, under the Interstate Oil Compact, prorated petroleum production to maintain a closer balance with demand. The daily petroleum production allowable set by the State regulatory body in January was 34 percent of

the depth-acreage formula. From March through June, the daily rate was 38 percent followed by a decrease to 34 percent until September; in October, the rate was increased to 42 percent; and for December the rate was placed at 50 percent—highest since adoption of the depth-acreage formula in 1961. The permitted increase in the last 3 months was attributed to a stronger market and to reduced stocks.

Petroleum production was reported from 64 counties, of which Stephens, Osage, Carter, Garvin, and Creek Counties led in the order named. Unallocated fields, including secondary recovery projects and stripper wells, accounted for 48 percent of total output.

In cooperation with the National Stripper Well Association, the Interstate Oil Compact Commission reported that on January 1 Oklahoma had 67,019 stripper wells which produced 181.3 million barrels of oil in 1965. Reserves of stripper wells totaled 1,033 million barrels, or 68.1 percent of overall proved oil reserves, in Oklahoma on January 1, 1966.

Estimated proved recoverable reserves of crude oil on December 31, 1966, amounted to 1,518.2 million barrels, equivalent to 6.8 barrels of recoverable crude underground for each barrel of oil produced in 1966. During the year, extensions and revisions added 214.7 million barrels and new discoveries added 3.7 million barrels to reserves. Oklahoma had more than 4.8 percent of the total domestic crude oil reserve and more than 5 percent of the total liquid fuel reserve, including natural gas liquids.

Table 8.—Crude petroleum production

(Thousand 42-gallon barrels and thousand dollars)

Year	Quantity	Value
1957–61 (average)	199,889	$589,617
1962	202,732	591,977
1963	201,962	587,709
1964	202,524	587,320
1965	203,441	587,944
1966	224,839	654,281

Average wellhead price of crude petroleum per barrel was $2.91, up from $2.89 in 1965. By the end of 1966, crude oil prices in Oklahoma and several adjoining States rose as most purchasers posted a 5-cent-per-barrel increase in the midcontinent region.

On January 1, 1966, the 14 refineries in the State had a total daily operating capacity of 421,830 barrels of crude oil and 158,790 barrels of cracked gasoline, and processed 67 percent of the State's production. Crude oil runs to stills, receipts, and stocks for 1965 and 1966, in thousand barrels, are shown in the tabulation that follows.

Year	Runs to stills	Total receipts	Intrastate receipts	Stocks December 31
1965	139,965	139,960	102,977	1,584
1966	149,817	149,588	109,850	1,352

Apco Oil Corp. was erecting a 1,645-barrel-per-day hydrofluoric acid alkylation unit at the company's Cyril, Caddo County, refinery. Completion was scheduled for February 1967.

Table 9.—Crude petroleum production, indicated demand, and stocks, in 1966, by months

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Oklahoma
January	18,178	18,233	15,052
February	16,987	17,229	14,810
March	19,290	17,983	16,117
April	18,484	17,447	17,154
May	19,374	18,370	18,158
June	18,754	18,042	18,870
July	19,039	19,394	18,515
August	18,863	20,207	17,171
September	18,218	19,044	16,345
October	19,088	18,569	16,864
November	18,618	18,065	17,417
December	19,946	19,567	17,796
Total: 1966	224,839	222,150	XX
Total: 1965	203,441	205,150	XX

XX Not applicable.

Table 10.—Oil and gas wells drilled in 1966, by counties

County	Proved field wells			Exploratory wells			Total
	Oil	Gas	Dry	Oil	Gas	Dry	
Alfalfa	7	3	4	-----	1	9	24
Atoka	-----	-----	1	-----	-----	2	3
Beaver	36	36	46	11	4	13	146
Beckham	1	4	3	-----	-----	4	12
Blaine	4	38	17	-----	3	12	74
Bryan	-----	-----	1	-----	-----	2	3
Caddo	6	-----	4	1	2	1	14
Canadian	-----	11	6	-----	5	2	24
Carter	80	1	26	6	-----	3	116
Cimarron	8	7	4	-----	-----	3	22
Cleveland	17	1	13	1	-----	5	37
Coal	1	-----	3	1	-----	5	10
Comanche	30	-----	8	-----	1	2	41
Cotton	29	-----	17	-----	-----	1	47
Craig	1	-----	2	-----	-----	3	6
Creek	113	6	24	-----	-----	5	148
Custer	4	1	1	-----	-----	1	7
Dewey	14	12	18	3	1	7	55
Ellis	19	33	13	4	5	9	83
Garfield	159	50	12	6	-----	3	230
Garvin	65	5	47	1	-----	21	139
Grady	8	2	3	1	2	4	20
Grant	29	5	13	1	-----	7	55
Greer	-----	-----	4	-----	-----	3	7
Harper	1	33	18	-----	1	1	54
Haskell	-----	25	18	-----	1	1	45
Hughes	10	14	20	2	2	3	51
Jackson	1	-----	1	-----	-----	3	5
Jefferson	8	1	24	2	-----	14	49
Johnston	-----	-----	-----	-----	-----	1	1
Kay	19	5	24	-----	-----	7	55
Kingfisher	147	2	6	4	1	5	165
Kiowa	3	-----	8	1	-----	3	15
Latimer	-----	27	12	-----	1	4	44
Le Flore	-----	20	13	-----	9	4	46
Lincoln	19	3	17	2	-----	13	54
Logan	40	4	16	3	1	7	71
Love	7	2	10	1	-----	6	26
Major	57	21	16	1	3	5	103
Marshall	2	-----	5	-----	-----	3	10
Mayes	-----	-----	2	-----	-----	5	7
McClain	18	6	12	1	-----	8	45
McCurtain	-----	-----	-----	-----	-----	2	2
McIntosh	-----	-----	3	-----	1	1	5
Murray	2	-----	8	-----	-----	8	18
Muskogee	30	1	14	-----	-----	5	50
Noble	15	5	22	2	-----	12	56
Nowata	19	-----	8	-----	-----	-----	27
Okfuskee	31	11	38	-----	-----	7	87
Oklahoma	4	1	2	-----	-----	4	11
Okmulgee	49	2	17	-----	-----	2	70
Osage	169	1	40	5	-----	8	223
Pawnee	16	-----	12	-----	-----	6	34
Payne	37	2	33	3	-----	10	85
Pittsburg	-----	10	9	-----	3	5	27
Pontotoc	67	4	14	-----	-----	5	90
Pottawatomie	38	3	22	2	1	12	78
Roger Mills	5	7	3	2	3	12	32
Rogers	43	-----	16	-----	-----	3	62
Seminole	47	6	34	-----	-----	2	89
Sequoyah	-----	2	2	-----	2	2	8
Stephens	48	5	27	2	1	13	96
Texas	39	19	33	1	3	16	111
Tillman	4	-----	3	1	-----	-----	8
Tulsa	44	-----	6	-----	-----	-----	50
Wagoner	4	-----	23	-----	-----	1	28
Washington	71	-----	8	-----	-----	1	80
Washita	-----	3	-----	-----	1	2	6
Woods	24	23	23	1	4	11	86
Woodward	1	13	14	1	2	13	44
Total: 1966	1,770	496	946	73	64	383	3,732
1965	2,127	506	958	56	43	319	4,009

Source: American Association of Petroleum Geologists (AAPG).

Table 11.—Production of crude petroleum, by fields

(Thousand 42-gallon barrels)

Field [1]	1962	1963	1964	1965	1966
Allen	1,390	1,445	2,150	2,192	2,636
Atlantic	1,462	1,450	1,363	1,190	998
Bowlegs	1,240	1,110	1,208	1,048	952
Burbank	14,290	13,685	13,417	12,017	10,655
Camrick	2,175	2,322	2,225	2,166	1,881
Cement	3,533	3,340	3,040	2,831	2,671
Cumberland	1,142	1,133	1,141	1,039	990
Cushing	2,629	2,828	3,075	3,110	3,499
Dover-Hennessey	8,945	9,010	8,667	(2)	----
Edmond, West	1,179	1,150	1,052	1,605	1,961
Enid, Northeast	157	1,460	2,148	2,143	2,196
Eola-Robberson	3,444	3,384	3,433	3,473	3,632
Garber	657	751	730	1,096	1,258
Glenn Pool	3,490	3,303	3,851	4,092	4,153
Golden Trend	10,730	13,427	14,292	13,544	13,440
Healdton	2,513	2,506	2,600	2,677	3,036
Hewitt	2,550	2,461	2,895	2,974	3,764
Knox	1,390	1,838	1,887	1,687	1,612
Loco	1,738	1,848	1,734	1,788	2,138
Moore, West	1,066	685	1,129	1,014	921
Muskogee	702	1,101	1,047	1,089	1,454
Naval Reserve	2,367	2,170	1,702	1,686	1,587
Oklahoma City	2,381	2,300	2,112	1,978	1,922
Payne	2,350	2,274	1,969	1,722	2,076
Postle	391	470	1,752	2,105	3,307
Putnam	900	912	2,076	3,081	4,879
Ringwood	268	1,340	1,814	1,074	5,583
Seminole	726	785	968	1,122	1,115
Sho-Vel-Tum	24,350	24,995	26,660	28,769	30,712
Slick	797	1,129	1,114	1,180	1,147
Sooner Trend	----	----	----	9,680	11,496
St. Louis	1,440	1,535	1,470	1,454	1,406
Stroud	682	702	1,161	1,151	1,220
Other fields	99,658	98,113	87,142	85,664	94,592
Total	202,732	201,962	202,524	203,441	224,839

[1] Based on Oil & Gas Journal data adjusted to Bureau of Mines total.
[2] Consolidated into the Sooner Trend field in April 1965.

NONMETALS

In 1966 the nine nonmetals produced were valued at $50.6 million, about 5 percent of the State's total mineral production value. Compared with the previous year, declines were registered in most of the major mineral commodities—cement, clays, gypsum, and stone—due largely to reduced construction activity.

Cement.—The quantity of cement produced dropped 8 percent and the value 6 percent. Plants were operated throughout the year by Ideal Cement Co. at Ada, Pontotoc County; Dewey Portland Cement Co., Division of Martin Marietta Corp., east of Tulsa in Rogers County; and Oklahoma Cement Co., southeast of Pryor in Mayes County. Dewey Portland Cement Co. announced that reopening of its plant at Dewey was postponed indefinitely.

Clays.—Clay and shale, mined from 17 pits by 12 producers operating in 12 counties, were used primarily in manufacturing

Table 12.—Shipments of portland cement to Oklahoma consumers

Year	Thousand barrels
1957–61 (average)	5,127
1962	5,941
1963	7,105
1964	6,163
1965	6,884
1966	5,366

Table 13.—Clays sold or used by producers [1]

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	742	$746
1962	737	756
1963	898	911
1964	835	854
1965	794	806
1966	745	754

[1] Excludes bentonite.

brick and tile, and to a lesser extent in expanded clay products and portland cement. Brick and structural clay tile were produced in eight counties; expanded clay aggregate was produced in Oklahoma and Rogers Counties; pottery was manufactured in Creek County. Bentonite was mined in Dewey County for filter and absorbent uses.

Gypsum.—In 1966, output of crude gypsum increased more than 3 percent, but value decreased nearly 6 percent compared with 1965. Eight producers in six counties, mined gypsum, most of which was used to manufacture wallboard, plaster, and other building materials. The remainder was used as a retarder in portland cement and as a soil conditioner.

Lime.—The tonnage of lime produced in Sequoyah County increased 10 percent, and value also increased compared with the previous year. Most of the output was used by chemical plants in the Pryor area and by municipal water plants; other uses included steel manufacture, oil refining, waste disposal, building material, and paper manufacture.

Pumicite (Volcanic Ash).—Quantity and value of volcanic ash production increased substantially. Fran-O-Lite Minerals Co. began mining a volcanic ash deposit 6 miles north of Custer City, Custer County, about midyear. Principal use was for abrasive-type cleaners.

Salt.—Total value of salt produced in 1966 increased over that of 1965. Flowers Salt Co. produced salt by solar evaporation of brine from springs in northern Harmon County, and Ezra S. Blackmon produced salt by solar evaporation from water basins adjacent to the Cimarron River west of Freedom, Woods County. Principal uses were for stockfeed and recharging of water softeners; other uses included herbicides and salinity control of oil well drilling fluid.

Sand and Gravel.—Total output of commercial and government-and-contractor sand and gravel increased about 16 percent above that of 1965, and value increased about 26 percent. Five counties—Johnston, McClain, Oklahoma, Pushmataha, and Tulsa—accounted for nearly 50 percent of the quantity and 60 percent of the value. Seventy-two percent of the output was furnished by commercial operators at an average price of $1.42 per short ton. Commercial producers shipped 89 percent of the sand and gravel by truck, with the remaining 11 percent transported by rail. Sand was used mostly for building, paving, fill, and high-purity glass sand. Gravel was used for paving and building.

Stone.—Stone output, including limestone used to manufacture cement and lime, was 7 percent less in quantity and 4 percent less in value in 1966. More than 50 percent of the output and value was supplied by producers in five counties—Comanche, Murray, Pontotoc, Sequoyah, and Tulsa. Limestone accounted for more than 86 percent of the stone produced, chat (miscellaneous stone) for 9 percent, sandstone for 4 percent, and granite for less than 1 percent. Crushed stone comprised more than 99 percent of total output, and crushed limestone accounted for nearly 87 percent. Virtually all the production came from open pit operations, except for two underground mines in eastern Oklahoma. Ninety-three percent of the crushed limestone produced commercially was shipped by truck and 7 percent by rail.

Idabel Stone Co. opened a limestone quarry north of Hugo, Choctaw County, and one northeast of Idabel, McCurtain County.

Principal uses for crushed stone were roadstone, concrete aggregate, cement, and lime. Dimension limestone was used primarily for architectural veneer and dimension granite for monuments and headstones.

Tripoli.—Output of tripoli in eastern Ottawa County was almost 20 percent greater in quantity and 18 percent higher in value than in 1965. Principal use was in buffing compounds and, to a lesser extent, for foundry use.

Vermiculite.—Crude vermiculite produced in Western States was exfoliated by Texas Vermiculite Co. at its Oklahoma City plant. The amount of exfoliated vermiculite sold for loose fill insulation and as lightweight aggregate in plaster and concrete increased 73 percent in quantity and 62 percent in value compared with 1965 figures.

METALS

Copper.—A substantial iscrease in copper produced from a strip mine in the Per-

Table 14.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total sand and gravel	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	4,154	$4,815	1,832	$1,040	5,986	$5,855
1962	3,802	4,355	634	381	4,436	4,736
1963	4,644	5,756	776	360	5,420	6,116
1964	5,032	6,031	1,648	972	6,680	7,003
1965	4,570	5,614	648	409	5,218	6,023
1966	4,329	6,151	1,711	1,414	6,040	7,565

Table 15.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	1,758	$1,628	1,487	$1,437
Paving	812	785	742	715
Fill	525	209	414	177
Other [1]	1,119	2,534	951	2,624
Total	4,214	5,156	3,594	4,953
Gravel:				
Building	101	174	430	785
Paving	154	128	181	241
Other [2]	101	156	124	172
Total	356	458	735	1,198
Total sand and gravel	4,570	5,614	4,329	6,151
Government-and-contractor operations:				
Sand:				
Building	-----	-----	12	16
Paving	263	119	704	665
Fill	61	45	-----	-----
Other	-----	-----	10	5
Total	324	164	726	686
Gravel:				
Building	-----	-----	203	215
Paving	310	214	782	513
Fill	14	31	-----	-----
Total	324	245	985	728
Total sand and gravel	648	409	1,711	1,414
Grand total	5,218	6,023	6,040	7,565

[1] Includes other construction sand and industrial sand (unground and ground).
[2] Includes miscellaneous gravel, railroad ballast, fill, and other gravel.

mian red beds of southwestern Jackson County was reported by The Eagle-Picher Co. The ore was beneficiated at the company mill, and the concentrate shipped to El Paso, Tex., for smelting.

Germanium.—Germanium was recovered, in zinc smelter residue by The Eagle-Picher Co. at Henryetta, Okmulgee County, and by National Zinc Co. at Bartlesville, Washington County. The residue was shipped to The Eagle-Picher Co.'s germanium-processing plant north of Quapaw, Ottawa County.

Lead.—Output of lead from 71 operations was reported by 32 producers, compared with 61 operations by 32 producers in 1965. Recoverable lead output in 1966 increased 7 percent while value increased 3 percent. Price of lead at New York was 16 cents per pound from January 1 until May 5, then decreased to 15 cents and, on October 10, decreased again 14 cents.

Table 16.—Sand and gravel production in 1966, by counties
(Thousand short tons and thousand dollars)

County	Quantity	Value
Beaver	5	$5
Bryan	35	37
Cleveland	199	102
Comanche	61	53
Cotton	37	30
Custer	189	237
Garfield	51	51
Harmon	8	10
Hughes	3	4
Kay	124	86
Latimer	4	5
Le Flore	179	182
McClain	542	501
McCurtain	287	249
Murray	98	118
Okfuskee	17	22
Payne	7	7
Pittsburg	18	9
Pottawatomie	10	11
Seminole	1	2
Sequoyah	1	1
Texas	1	1
Tillman	73	91
Tulsa	636	452
Woodward	28	19
Other counties [1]	3,426	5,280
Total	6,040	7,565

[1] Includes Alfalfa, Caddo, Canadian, Grady, Greer, Jackson, Johnston, Kingfisher, Kiowa, Logan, Major, Muskogee, Oklahoma, Pawnee, Pontotoc, and Pushmataha Counties, combined to avoid disclosing individual company confidential data. Undistributed amounts from various counties are also included.

Silver.—Silver was recovered from copper concentrate produced near Creta. Output increased appreciably, as a result of the greater output of copper during the year.

Zinc.—Output of zinc from 70 operations was reported by 32 producers, compared with 64 operations by 36 producers in 1965. Recoverable zinc output and value in 1966 were 12 percent less than in 1965. Price of zinc at East St. Louis was unchanged at 14.5 cents per pound throughout 1966.

Custom Mills and Smelters.—In 1966, American Metal Climax, Inc., at Blackwell, Kay County; The Eagle-Picher Co. at Henryetta, Okmulgee County; and National Zinc Co. at Bartlesville, Washington County, operated horizontal retort zinc smelters where both domestic and foreign ores and concentrates were treated. A secondary zinc plant was operated by Federated Metals Division of American Smelting and Refining Co. at Sand Springs, Tulsa County.

Tri-State District.—Output of lead and zinc in the southwest Missouri segment of the district was reported in 1966 after an 8-year period in which there was no production. The quantity and value of output

Table 17.—Stone sold or used by producers, by kinds
(Thousand short tons and thousand dollars)

Year	granite		Limestone		Sandstone		Miscellaneous stone		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1962	15	$1,043	12,579	$15,793	1,040	$1,351	1,032	$632	14,666	$18,819
1963	7	832	12,437	14,537	135	214	1,238	577	13,817	16,160
1964	3	219	11,375	12,669	1,271	1,552	1,338	647	13,987	15,087
1965	6	503	13,121	14,771	2,057	2,092	1,233	705	16,417	18,071
1966	7	687	13,339	15,141	631	745	1,357	820	15,334	17,393

Table 18.—Mine production of lead and zinc, in terms of concentrate and recoverable metals [1]

Year	Lead concentrate (galena)		Zinc concentrate (sphalerite)		Recoverable metal content [2]			
					Lead		Zinc	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1957–61 (average)	3,867	$598	10,047	$753	2,678	$695	5,349	$1,222
1962	3,600	343	18,327	1,278	2,710	499	10,013	2,303
1963	4,317	432	24,329	1,757	3,192	689	13,245	3,046
1964	3,730	505	22,592	1,963	2,781	729	12,159	3,307
1965	3,896	651	23,668	2,277	2,813	878	12,715	3,713
1966	4,181	649	21,086	2,002	2,999	907	11,237	3,259
Total 1891–1966	1,696,455	165,544	9,854,303	492,292	1,300,163	198,315	5,197,013	788,934

[1] Based on Oklahoma ore (dirt) and old tailing treated at mills during calendar year indicated.
[2] In calculating metal content of the ores from assays, allowance made for smelting losses of both lead and zinc. In comparing values of concentrate (ore) and metal, it should be noted that value given for concentrate is that actually received by producer, whereas value of lead and zinc is calculated from average price for all grades.

Table 19.—Tenor of lead-zinc ore milled and concentrates produced

	1965	1966
Total material milled short tons	595,205	549,313
Recovery of concentrate and metal from quantity milled:		
Galena short tons	3,896	4,181
Sphalerite do	23,668	21,086
Galena percent	0.65	0.76
Sphalerite do	3.98	3.84
Lead [1] do	.47	.55
Zinc [1] do	2.14	2.05
Average lead content of galena concentrate do	73.54	73.16
Average zinc content of sphalerite concentrate do	59.74	59.21
Average value per ton:		
Galena concentrate	$167.15	$155.26
Sphalerite concentrate	$96.22	$94.94

[1] Figures represent metal content of crude ore (dirt) as recovered in concentrate. Data on tailing losses not available.

Table 20.—Mine production of lead and zinc in 1966, by months, in terms of recoverable metals
(Short tons)

Month	Lead	Zinc
January	280	803
February	213	910
March	239	1,058
April	223	1,074
May	263	1,037
June	236	1,028
July	219	960
August	209	823
September	271	827
October	280	906
November	247	906
December	319	905
Total	2,999	11,237

for this segment are included wih cenral and souheastern Missouri lead and zinc production data. In the Kansas and Oklahoma portion of the district, overall lead and zinc production decreased 8 and 17 percent, respectively, in tonnage and 11 and 17 percent, respectively, in value. Lead and zinc concentrates recovered decreased 7 and 16 percent, respectively, in tonnage, and 14 and 17 percent, respectively, in value of concentrates in the same period. American Zinc Lead & Smelting Co. closed its Barbara J. Mill near Cardin, leaving The Eagle-Picher Co. as the district's principal producer. The price of lead dropped to 14 cents per pound on October 10 thus falling below the 14½ cent price which payment is made under the Lead-Zinc Mining Stabilization Program. No payment was made in 1966 but payments on production in the last quarter of 1966 were made in the first quarter of 1967. The price of zinc was 14½ cents per pound throughout the year and zinc production was not eligible during the year.

Prices quoted in the E&MJ Metal & Mineral Markets on 60 percent zinc concentrates at Joplin, Mo., were unchanged at $92 per ton throughout 1966.

Table 21.—Mine production of lead and zinc concentrates in Tri-State District, in terms of concentrate and recoverable metals

Year	Lead concentrate (galena)		Zinc concentrate (sphalerite)		Recoverable metal content			
					Lead		Zinc	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1957–61 (average)	6,184	$941	19,731	$1,471	4,336	$1,119	10,538	$2,411
1962	4,890	481	25,564	1,771	3,680	677	13,956	3,210
1963	5,719	604	30,762	2,271	4,219	911	16,753	3,853
1964	5,333	733	31,228	2,732	3,966	1,039	16,824	4,576
1965	6,200	1,031	35,671	3,434	4,457	1,391	19,223	5,613
1966:								
Kansas	1,574	242	8,911	849	1,109	335	4,769	1,383
Oklahoma	4,181	649	21,086	2,002	2,999	907	11,237	3,259
Total 1966 [1]	5,755	891	29,997	2,851	4,108	1,242	16,006	4,642

[1] Excludes Southwest Missouri.

Table 22.—Tenor of lead and zinc ore milled and concentrates produced in the Tri-State District

	1962	1963	1964	1965	[1] 1966
Total material milled:					
Crude ore—short tons	474,219	612,862	691,798	905,973	818,410
Recovery of concentrate and metal from material milled:					
Galena—percent	1.03	0.93	0.77	0.68	0.70
Sphalerite—do	5.39	5.02	4.51	3.94	3.67
Lead [2]—do	.78	.69	.57	.49	.50
Zinc [2]—do	2.94	2.73	2.43	2.12	1.96
Average lead content of galena concentrate—do	76.75	75.21	75.77	73.27	72.81
Average zinc content of sphalerite concentrate—do	60.64	60.52	59.86	59.91	59.29
Average value per ton:					
Galena concentrate	$98.24	$105.68	$137.52	$166.32	$154.84
Sphalerite concentrate	$69.30	$73.82	$87.48	$96.28	$95.03

[1] Excludes Southwest Missouri; included in Missouri total.
[2] Metal content of the crude ore (dirt) as recovered in concentrate.

REVIEW BY COUNTIES

Seventy-five of the State's 77 counties reported mineral production; however, 52 percent of Oklahoma's total mineral production value was supplied by Stephens, Garvin. Carter, Osage, Beaver, Texas, Kingfisher, Creek, Garfield, and Seminole Counties, in descending order of value. Crude oil was reported from 64 counties, natural gas from 64, and natural gas liquids from 29. Nonmetals were produced in 61 counties and metals in two counties.

Beaver.—Mineral output value increased 15 percent as all segments of the industry registered significant gains. Camrick field in Beaver and Texas Counties yielded nearly 1.9 million barrels of crude oil. Natural gas liquids were recovered at the Cabot Corp. Beaver plant, El Paso Natural Gas Co. Beaver plant, Northern Natural Gas Co. Cabot-Highland plant, Texaco Inc. Camrick plant, and Warren Petroleum Corp. Mocane plant. Texaco Inc. operated a 40,000-barrel underground propane storage reservoir in a salt layer near its processing plant; Warren Petroleum Corp. near its gas liquids plant maintained a 140,000-barrel LP-gas storage reservoir also in an underground salt layer. Volcanic ash (pumicite) was mined north of Gate by Axtell Mining Corp.

Table 23.—Value of mineral production in Oklahoma by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Alfalfa	$6,348,631	$11,512,771	Petroleum, natural gas, sand and gravel.
Atoka	W	W	Stone, petroleum.
Beaver	45,081,361	52,042,109	Natural gas, petroleum, natural gas liquids, volcanic ash, sand and gravel.
Beckham	16,531,428	14,934,924	Natural gas, natural gas liquids, petroleum.
Blaine	6,132,567	7,655,151	Petroleum, natural gas, gypsum, natural gas liquids.
Bryan	2,291,519	2,221,107	Petroleum, natural gas, sand and gravel, stone.
Caddo	12,846,922	17,081,550	Petroleum, natural gas, sand and gravel, gypsum, stone.
Canadian	1,275,916	1,867,118	Natural gas, petroleum, sand and gravel, clays, gypsum.
Carter	53,150,080	60,666,354	Petroleum, natural gas, natural gas liquids, stone.
Cherokee	1,264,650	W	Stone.
Choctaw	185,109	W	Do.
Cimarron	r 14,431,429	16,664,337	Helium, natural gas, petroleum, natural gas liquids, stone.
Cleveland	12,915,330	15,647,415	Petroleum, natural gas liquids, natural gas, sand and gravel.
Coal	2,650,143	2,548,121	Petroleum, natural gas, stone.
Comanche	3,234,044	3,007,119	Stone, natural gas, petroleum, gypsum, sand and gravel.
Cotton	5,752,493	6,145,720	Petroleum, sand and gravel, natural gas.
Craig	998,481	707,838	Coal, petroleum, natural gas.
Creek	31,817,109	35,663,972	Petroleum, natural gas liquids, natural gas, clays.
Custer	3,251,797	3,897,022	Petroleum, natural gas, sand and gravel, clays, volcanic ash.
Deleware	2,000	-----	
Dewey	15,999,908	18,813,698	Petroleum, natural gas, natural gas liquids, clays.
Ellis	3,053,349	4,631,100	Natural gas, petroleum.

See footnotes at end of table.

Table 23.—Value of mineral production in Oklahoma by counties[1]—Continued

County	1965	1966	Minerals produced in 1966 in order of value
Garfield	$21,907,542	$33,333,902	Petroleum, natural gas, natural gas liquids, sand and gravel.
Garvin	73,677,170	69,091,882	Petroleum, natural gas liquids, natural gas.
Grady	24,221,131	24,681,415	Petroleum, natural gas, natural gas liquids, sand and gravel.
Grant	6,991,496	6,782,108	Petroleum, natural gas, natural gas liquids.
Greer	260,817	211,971	Stone, petroleum, sand and gravel, clays, natural gas.
Harmon	56,600	W	Salt, sand and gravel.
Harper	21,492,949	22,387,297	Natural gas, natural gas liquids, petroleum, stone.
Haskell	7,970,372	7,929,859	Natural gas, coal.
Hughes	5,183,587	5,420,348	Petroleum, natural gas, sand and gravel.
Jackson	1,059,325	2,733,668	Copper, petroleum, gypsum, sand and gravel, silver, stone.
Jefferson	2,856,986	3,247,641	Petroleum, natural gas.
Johnston	W	W	Sand and gravel, stone.
Kay	12,852,299	14,172,520	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Kingfisher	38,456,041	44,655,626	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kiowa	1,139,340	1,381,634	Stone, petroleum, sand and gravel, natural gas.
Latimer	5,239,199	6,107,964	Natural gas, sand and gravel.
Le Flore	1,462,135	1,616,703	Natural gas, sand and gravel, stone, coal.
Lincoln	17,710,086	15,761,755	Petroleum, natural gas liquids, natural gas,
Logan	8,897,308	12,416,712	Petroleum, natural gas, natural gas liquids, sand and gravel.
Love	10,746,178	10,238,198	Petroleum, natural gas, natural gas liquids.
Major	17,881,017	23,093,682	Petroleum, natural gas, natural gas liquids, sand and gravel.
Marshall	4,965,961	6,267,545	Petroleum, natural gas liquids, natural gas.
Mayes	6,040,111	6,079,801	Cement, stone, clays, petroleum.
McClain	25,273,299	23,931,866	Petroleum, natural gas, natural gas liquids, sand and gravel.
McCurtain	134,236	874,393	Stone, sand and gravel, petroleum.
McIntosh	2,804,704	276,195	Natural gas, stone.
Murray	3,198,166	3,502,318	Stone, petroleum, sand and gravel, natural gas.
Muskogee	4,633,746	5,566,334	Petroleum, sand and gravel, stone, coal, natural gas.
Noble	7,048,256	7,189,327	Petroleum, natural gas, natural gas liquids.
Nowata	3,167,786	3,219,263	Petroleum, stone, natural gas.
Okfuskee	6,933,778	7,070,429	Petroleum, natural gas, sand and gravel, natural gas liquids.
Oklahoma	18,049,700	19,163,630	Petroleum, natural gas liquids, natural gas, sand and gravel, clays.
Okmulgee	4,639,407	5,371,994	Petroleum, natural gas, coal.
Osage	67,012,515	59,739,432	Petroleum, stone, natural gas.
Ottawa	5,429,885	5,094,928	Zinc, lead, stone, tripoli.
Pawnee	4,270,391	5,075,807	Petroleum, sand and gravel, natural gas, stone.
Payne	7,324,074	7,876,257	Petroleum, natural gas, stone, sand and gravel.
Pittsburg	695,374	1,334,632	Natural gas, stone, sand and gravel, clays, petroleum.
Pontotoc	20,207,677	20,691,874	Petroleum, cement, stone, sand and gravel, natural gas liquids, clays, natural gas.
Pottawatomie	9,857,358	13,115,389	Petroleum, natural gas, sand and gravel.
Pushmataha	W	W	Sand and gravel, stone.
Roger Mills	38,107	236,985	Natural gas, petroleum.
Rogers	12,656,108	11,941,902	Cement, petroleum, coal, stone, clays, natural gas.
Seminole	25,644,574	26,931,227	Petroleum, natural gas liquids, natural gas, stone, clays, sand and gravel.
Sequoyah	W	2,739,218	Lime, stone, natural gas, sand and gravel.
Stephens	69,879,363	76,368,396	Petroleum, natural gas, natural gas liquids.
Texas	47,212,433	51,693,044	Natural gas, petroleum, natural gas liquids, sand and gravel.
Tillman	917,439	1,005,800	Petroleum, sand and gravel, stone.
Tulsa	8,953,422	9,322,096	Petroleum, stone, sand and gravel, clays, natural gas.
Wagoner	440,239	544,565	Petroleum, stone, natural gas.
Washington	8,069,140	7,756,059	Do.
Washita	1,089,245	963,577	Natural gas, petroleum, gypsum.
Woods	4,269,675	5,401,694	Natural gas, petroleum, salt.
Woodward	4,127,458	4,723,602	Natural gas, natural gas liquids, petroleum, sand and gravel.
Undistributed	r 4,996,529	15,349,120	
Total	r 909,256,000	997,391,000	

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Adair County is not listed because no production was reported.

Beckham.—Total mineral production value decreased 10 percent as lower sales were noted in petroleum and natural gas. Natural gas and petroleum were produced mainly from Elk City field. Natural gas liquids were extracted from natural gas at the Elk City cycling plant of Shell Oil Co. Near Sayre, Oklahoma Natural Gas Co. maintained an underground natural gas storage reservoir, part of which was leased to the Natural Gas Pipeline Company of America. Shell Oil Co. maintained a 17,000-barrel propane storage resevoir in a salt layer near Sayre.

Blaine.—Mineral production value increased 24 percent because of increased sales of petroleum, natural gas, and natural gas liquids that offset a decline in gypsum. Natural gas from fields in Blaine and Major Counties was processed at Pan American Petroleum Corp. Okeene Plant, and natural gas from fields in Blaine and Kingfisher Counties was processed at its Star-Lacey plant. Universal Atlas Cement Co. quarried gypsum northeast of Watonga for use as portland cement retarder, and Walton Gypsum Co. quarried and crushed gypsum west of Okeene for agricultural uses. United States Gypsum Co. quarried and crushed gypsum and operated a large calcining, sheetrock, and plaster-products plant at Southard.

Caddo.—Mineral production value increased 33 percent compared with 1965. Petroleum and natural gas were produced from several fields; the largest field, Cement, produced nearly 2.7 million barrels of petroleum. Crude oil was processed at the Cyril refinery of Apco Oil Corp. Harrison Gypsum Co., Inc., strip-mined gypsum near Cement for use in agriculture and as a retarder in portland cement. Dimension and crushed limestone were produced by J. W. McPhearson and Bernard Thiessen, southeast of Hydro. Roosevelt Materials Co., Inc., quarried and crushed limestone near Carnegie and Cyril for concrete aggregate. Sand for building purposes was produced by Karlin Sand & Gravel Co. from the Canadian River.

Canadian.—Value of mineral production was 46 percent greater as increased sales of natural gas, petroleum, sand and gravel, and gypsum offset a decline in clays. Oklahoma Brick Corp. mined clay northwest of Union City for making brick and tile. Gypsum for agricultural purposes was strip mined near Okarche by Raymond Schweitzer. Sand and gravel for construction was produced by Tindel Materials Co. from pits in the western section of the county and by The Dolese Co. near Banner.

Carter.—The county ranked third in the State both in total mineral production value and in value of petroleum produced. Petroleum and natural gas were produced from many fields. Fox-Graham, Healdton, Hewitt, and Sho-Vel-Tum fields were the largest. Sho-Vel-tum, the Nation's third largest field, produced more than 30.7 million barrels of petroleum. The Hewitt and Healdton fields produced more than 3.7 million barrels and 3 million barrels of petroleum, respectively. Natural gas liquids were stripped from natural gas at plants operated by Apache Gasoline Co. near Ardmore, Harry Ells, Inc., at Healdton, Shell Oil Co. near Wilson, Signal Oil & Gas Co. near Fox, Sinclair Oil & Gas Co., Healdton, and Union Oil Company of California near Springer. Limestone was quarried and crushed by Sooner Crushed Stone Co.

Cimarron.—Total mineral production value was 15 percent greater than in 1965 because of improved sales of helium, natural gas, natural gas liquids, and petroleum. Helium was extracted at the Federal Bureau of Mines Keyes plant from natural gas supplied by Colorado Interstate Gas Co. Natural gas and petroleum were produced from several fields in the Keyes area. Natural gas liquids were recovered from natural gas by Colorado Interstate Gas Co. at its Keyes plant.

Comanche.—Total mineral output value decreased 7 percent as reduced production as stone, natural gas, and petroleum more than offset increased output of gypsum and sand and gravel. Limestone was quarried and crushed by Dolese Bros. Co. at its Richards Spur quarry north of Lawton. Gypsum was mined near Fletcher by Castile Mining Co. for wallboard manufactured by Texas Gypsum Co., Inc., at its Irving, Tex., plant. Sand and gravel for paving and building was produced for the U.S. Army Corps of Engineers. Natural gas and petroleum were produced from a group of small fields (comprising three districts) and the Fort Sill Reservation field.

Craig.—Total mineral value decreased 29

percent because of lower coal and natural gas output. Craig County ranked third among coal producing counties. Four operators strip-mined coal at 12 pits. Another operator—not subject to Bureau of Mines canvass of coal producers—was active at one additional pit.

Creek.—Production gains in petroleum and natural gas liquids were responsible for a 12 percent increase in total mineral value. The prolific Cushing and Glenn Pool fields produced almost 3.5 million and 4.2 million barrels of petroleum, respectively. Natural gas liquids were recovered by Kerr-McGee Corp. at its plant near Milfay and by Sinclair Oil & Gas Co. at its Drumright plant. Near Depew, Oklahoma Natural Gas Co. maintained an underground natural gas storage reservoir. A mined cavern in shale, capable of storing 200,000 barrels of butane, was operated by Service Pipe Line Co. Clay used for brick and tile was mined by Sapulpa Brick & Tile Corp. and for pottery by Frankoma Pottery Co.

Dewey.—Mineral production value increased 18 percent. The rise resulted from large gains in production of petroleum and natural gas liquids; output of natural gas and bentonite decreased. Putnam field produced more than 4.8 million barrels of petroleum. Natural gas liquids were extracted from natural gas by Humble Oil & Refining Co. at its Camargo plant and by Mobil Oil Co. at its Thomas plant. Bentonite was produced south of Vici by Filtrol Corp. for filter and absorbent uses.

Garfield.—A 52 percent gain in total mineral value resulted from increased production of petroleum and natural gas liquids. The northeast Enid field produced nearly 2.2 million barrels of petroleum. Natural gas liquids were stripped from natural gas at the Champlin Petroleum Co. Enid plant, Livingston Oil Co. Northeast Enid field plant, and Sinclair Oil & Gas Co. Covington plant. Sand for paving was produced for the Oklahoma State Highway Department.

Garvin.—Garvin County ranked second in the State in total value of minerals produced, fourth in petroleum, fifth in natural gas production value, and first in natural gas liquids. The county dropped from first place in total value because of a 40-percent decrease in natural gas value. The Eola-Robberson field yielded more than 3.6 million barrels of petroleum, and the Golden Trend, second largest field in the State, yielded more than 13.4 million barrels of crude oil. Natural gas liquids were recovered at the O.H. Grimes Pauls Valley field plant, Lone Star Gas Co. plant near Katie, Phillips Petroleum Co. Bradley field plant, Service Gas Products Co. Hoover field plant, Sohio Petroleum Co. Elmore plant, and Warren Petroleum Corp. Maysville plant. Kerr-McGee Corp. processed crude oil at its Wynnewood refinery.

Grady.—Production losses in natural gas and sand and gravel were offset by gains in petroleum and natural gas liquids resulting in a 2 percent increase in total mineral value. Natural gas liquids were recovered by the Mobil Oil Co. Chitwood cycling plant and by the Warren Petroleum Corp. Knox cycling plant (formerly operated by British-American Oil Producing Co.). Sand for building and paving was obtained from pits near Tuttle by The Dolese Co.

Grant.—Total mineral value declined 3 percent as decreased output of natural gas and natural gas liquids offset an increase in petroleum. Natural gas liquids were extracted from natural gas in the Continental Oil Co. Medford plant and CRA, Inc., Lamont field plant. An underground reservoir in Webb field was used to store natural gas for peak demand by Cities Service Gas Co. Near Medford, Continental Oil Co. maintained in a salt layer a 150,000-barrel butane storage reservoir, a 450,000-barrel normal butane reservoir, a 50,000-barrel natural gasoline reservoir, a 150,000-barrel field butane reservoir, and a 50,000-barrel isobutane reservoir.

Haskell.—The county again led the State in coal output. Decreased output of coal however, reduced the total mineral value slightly from the previous year despite an increase in natural gas production. Garland Coal & Mining Co. and Evans Coal Co., largest producers in the county, mined coal from open pits. One other producer (less than a thousand short tons mined annually) also was active at an open pit operation.

Jackson.—Increased output of copper, silver, petroleum, sand and gravel, and stone resulted in a substantial gain in total mineral value and offset losses in gypsum and natural gas. Gypsum was strip-mined south of Duke for manufacturing wall-

board and other gypsum products at the Republic Gypsum Co. Duke plant. Copper ore was strip-mined by The Eagle-Picher Co. from Permian red beds southeast of Creta. Dimension limestone was produced by Oklahoma Stone Co. Sand and gravel for construction was produced by Pitts Sand & Gravel Co.

Johnston.—Total mineral value was 1 percent greater in 1966 because of an increased output in glass sand. Pennsylvania Glass Sand Corp. of Oklahoma produced sand for glass and ground silica from pits north of Mill Creek. Dimension limestone for building construction was produced near Pontotoc by Richburg Stone Co. Near Troy, Rock Products Mfg. Corp. sold crushed dolomite for use in agriculture. Dimension granite was produced by The Century Granite Co., Inc., south of Mill Creek, and by Taylor Granite Co.

Kay.—Total value of mineral production was 10 percent above the previous year as gains were noted in natural gas liquids, petroleum, and stone. Petroleum and natural gas were produced from numerous fields. Natural gas liquids were recovered from the Cities Service Oil Co. Ambrose plant and Wunderlich Development Co. Newkirk plant. A 300,000-barrel propane storage cavern in limestone was maintained near Ponca City by Continental Oil Co. Crude petroleum was processed at refineries operated by Continental Oil Co. and Sequoia Refining Corp. (formerly operated by Cities Service Oil Co.) at Ponca City. Petrochemical units of the Continental Oil Co. refinery produced benzene, toluene, propylene hydrocarbons, and carbon black. Limestone was quarried and crushed by Standard Industries, Inc., at its Delodge and Uncas quarries near Ponca City. Sand for paving and fill was produced by Sober Brothers Sand & Gravel Co., and sand for paving was produced by the Oklahoma State Highway Department. Blackwell Zinc Co., Inc., a division of American Metal Climax, Inc., operated a zinc smelter.

Kingfisher.—An increase of 16 percent in total mineral value was attributed to a rise in petroleum and natural gas liquids output. Value of petroleum produced was 17 percent over that of 1965; natural gas liquids value was 51 percent over that of 1965. The Sooner Trend field of Kingfisher and adjoining counties produced almost 11.5 million barrels of oil. Natural gas liquids were recovered at the Continental Oil Co. Hennessey plant, Humble Oil & Refining Co. Dover-Hennessey plant, Pan American Petroleum Corp. North Okarche plant, and Sohio Petroleum Co. Trindle plant. Oklahoma Natural Gas Co. maintained an underground natural gas storage reservoir in the West Edmond field of Kingfisher and Logan Counties. The Dolese Co. produced sand for building and paving from pits near Dover.

Kiowa.—Output of stone, sand and gravel, and natural gas was responsible for a 21-percent increase in mineral value while petroleum declined. Limestone was quarried and crushed for use as concrete aggregate and roadstone by Roosevelt Materials Co. at its Cooperton quarry and by Dolese Brothers Co. at its Gotebo quarry. Dimension granite was quarried near Snyder by Roosevelt Granite Co., Inc., Fairfax Granite, Inc., and Wichita Granite Co. Southwest Sand Co. processed sand and gravel from the North Fork Red River west of Snyder for paving purposes.

Le Flore.—Increased production of stone and sand and gravel accounted for an 11-percent increase in mineral value despite a decline in production values for coal and natural gas. Coal was produced from underground mines by three operators. Sandstone was quarried and crushed by contractors for use by Oklahoma State Highway Department as roadstone, and as riprap by U.S. Army Corps of Engineers.

Lincoln.—Mineral value decreased 11 percent from the previous year as production losses were registered in petroleum and natural gas. These two commodities were produced from numerous fields; Stroud field, a portion of which extends into Creek County, yielded more than 1.2 million barrels of oil. Natural gas liquids were stripped from natural gas at plants operated by Apache Gas Products Corp. northwest of Kendrick, Sunray DX Oil Co. west of Carney, and Texaco Inc. east of Davenport. Crude oil was processed at the Stroud refinery of Allied Materials Corp.

Logan.—Increased output of petroleum, natural gas liquids, and sand and gravel increased total mineral production value 40 percent. Natural gas liquids were stripped from natural gas at the Eason Oil Co. No.

3 plant, south of Crescent. Sand for building and paving was produced by The Dolese Co. near Guthrie and by John McConnel near Crescent; sand for paving was produced by The Oklahoma State Highway Department.

Major.—Total mineral production value recorded an increase of 29 percent, although value of natural gas liquids and sand and gravel was lower than the previous year. More than 5.5 million barrels of petroleum was produced by the Ringwood field. Natural gas liquids were stripped from natural gas at the National Fuels, Inc., Ringwood plant, and at the Union Texas Petroleum, a division of Allied Chemical Corp., Chaney-Dell plant. Sand for paving was produced by Orin Law.

Mayes.—Limestone and clay were produced for cement by Oklahoma Cement Co. at its plant southeast of Pryor. Northeast of Pryor, Standard Industries, Inc., quarried and crushed limestone for roadstone, concrete aggregate, and agricultural uses.

McClain.—Value of minerals produced decreased 5 percent because natural gas output declined sufficiently to offset gains in petroleum, natural gas liquids, and sand and gravel. Natural gas liquids were recovered at the Sohio Petroleum Co. Norman plant, Sunray DX Oil Co. Criner plant and Dibble field plant (formerly operated by Universoil, Inc.) near Blanchard. The Dolese Co. and Lamar Lawson produced sand and gravel for building, and The Dolese Co. produced sand for paving.

Murray.—Mineral production value increased slightly due to gains in petroleum, stone, and sand and gravel. Limestone was quarried and crushed at Rayford and Big Canyon quarries by The Dolese Bros. Co. and by Sooner Rock & Sand Co. Sand and gravel for paving and building was produced by Joe Brown Sand & Gravel Co., Inc. Two fields produced petroleum and natural gas.

Muskogee.—Value of minerals produced was 20 percent above the previous year as all segments of the mineral industry reported increases. Petroleum was produced from several fields; Muskogee field, the largest, yielded nearly 1.5 million barrels of petroleum. Mustang Fuel Corp. maintained an underground natural gas storage reservoir in Butler Creek field, and Oklahoma Natural Gas Co. maintained an underground natural gas storage reservoir near Haskell. One operator, not subject to Bureau of Mines coal producers canvass, strip-mined coal. Sand for building, paving, and fill was dredged from Arkansas River by Yahola Sand Plant. Fansteel Metallurgical Corp. operated its columbium-tantalum plant at Muskogee.

Oklahoma.—The 6-percent increase in total mineral value resulted from higher production in all segments of the mineral industry except that of natural gas. Largest of the many fields, Oklahoma City field, yielded more than 1.9 million barrels of petroleum. Natural gas liquids were extracted from natural gas at the Champlin Petroleum Co. Witcher field plant, Cities Service Oil Co. Bodine plant in the Oklahoma City field, and Phillips Petroleum Co. Edmond field plant and Oklahoma City field plant. Sand for building, paving, and fill was produced by Shoffner Sand & Gravel Co., Sizemore Sand & Gravel, and Sand Products, Inc. Clay for brick and tile products was obtained from pits in the western part of Oklahoma County by Acme Brick Co. Near Choctaw, Chandler Materials Co. mined and expanded clay for lightweight aggregate.

Okmulgee.—Total mineral value was 16 percent above the previous year as a result of increased crude oil and coal output. Petroleum and natural gas were produced from numerous fields; Bald Hill, the largest, produced nearly 400,000 barrels of petroleum. Crude oil was processed at the Phillips Petroleum Co. refinery in Okmulgee. On November 1, the refinery was sold to Okmulgee Refining Co., a subsidiary of Oklahoma Cement Co. Carbon Hill Coal Co. strip-mined coal near Henryetta. The Eagle-Picher Co. operated its horizontal retort zinc plant at Henryetta.

Osage.—Osage County ranked fourth in total mineral production value and second in petroleum. Mineral value decreased 11 percent because of production losses in petroleum and natural gas. Numerous fields produced petroleum and natural gas. Under extensive waterflooding, Burbank field yielded almost 10.7 million barrels of crude oil. Naval Reserve field produced about 1.6 million barrels of crude oil. Limestone was quarried and prepared by Sedan Limestone Co., Inc., Standard Indus-

tries, Inc., and others for concrete aggregate and roadstone. Contractors also quarried and prepared limestone for the U.S. Army Corps of Engineers.

Ottawa.—Oklahoma's entire lead and zinc production—a major part of the Tri-State District—was supplied from mines in Ottawa County. In terms of recoverable content of ores, output increased almost 7 percent for lead and decreased more than 11 percent for zinc; the value, however, increased more than 3 percent for lead and decreased more than 12 percent for zinc. The Eagle-Picher Co. Rare Metals plant was operated north of Miami. Chat, a waste product of lead and zinc milling, was supplied by five producers from six locations. Tripoli was quarried in east-central Ottawa County by American Tripoli Division, The Carborundum Co., and processed at its plant in Seneca, Mo.

Payne.—Numerous fields produced petroleum and natural gas. Yale-Quay, the largest, which extends northward into Pawnee County, produced 648,000 barrels of petroleum. Crude oil was processed into gasoline, asphalt, and lubricating greases at the Cushing refinery of Kerr-McGee Corp. and into gasoline at Midland Cooperative, Inc., Cushing refinery.

Pontotoc.—Mineral production value was 2 percent above that of 1965 because of gains in petroleum and sand and gravel. The Allen field, portions of which are in Hughes and Seminole Counties, yielded more than 2.6 million barrels of oil; Fitts field produced more than 1.3 million barrels. Natural gas liquids were removed from natural gas at Humble Oil & Refining Co. Fitts field plant. An underground natural gas storage reservoir in the North Ada field was operated by Arkansas-Louisiana Gas Co. Clay, limestone, and shale quarried near Lawrence were used in cement by Ideal Cement Co. at its Ada plant. Dimension limestone was quarried near Fittstown by Townsend Brothers Quarry. Mid-Continent Glass Sand Co. produced sand for glass and molding purposes from its quarry near Roff.

Rogers.—Increases in production of petroleum and stone failed to offset losses in cement, clays, coal, and natural gas. Petroleum and natural gas were produced from three fields; Chelsea district produced most of the crude petroleum. The quantity of coal strip-mined by Sinclair Coal Co. placed the county second among the State's coal producing counties. Dewey Portland Cement Co., Division of Martin Marietta Corp., quarried limestone and shale for cement northeast of Tulsa.

Seminole.—A 5-percent increase in total mineral value was noted as the gains registered in petroleum and natural gas liquids compensated for losses in natural gas, stone, and clays. Petroleum and natural gas were produced from many fields; most notable was the Seminole field which produced more than 1.1 million barrels of petroleum. Natural gas liquids were extracted from natural gas by Redco Corp. at its Seminole plant and by Sinclair Oil & Gas Co. at its Seminole plant. A 112,000-barrel propane storage cavern in shale was maintained by Sinclair Oil & Gas Co. near its Seminole plant. Limestone was quarried and crushed by The Dolese Bros. Co. for concrete aggregate and roadstone. Shale for brick and tile was quarried west of Wewoka for Wewoka Brick & Tile Co.

Sequoyah.—Limestone was mined and crushed at an underground mine north of Marble City by St. Clair Lime Co. Part of the crushed limestone was burned to make lime in the company kilns at Sallisaw and at Marble City. The remainder was used for concrete aggregate, agricultural purposes, glass manufacturing, papermills, fertilizers, and coal mine dust. The lime was used in steel manufacturing, carbide manufacturing, oil refining, water purification, waste disposal, building materials, and paper manufacturing.

Stephens.—The combined production of petroleum, natural gas, and natural gas liquids placed the county first in the State for mineral output value in 1966, which was 9 percent above the previous year. The county ranked first in value of petroleum, seventh in natural gas, and sixth in natural gas liquids. The county, as did Carter and Garvin Counties, shared in production of crude oil from the giant Sho-Vel-Tum field, which in 1966, produced more than 30.7 million barrels of oil. Loco field produced more than 2.1 million barrels of crude oil; Knox field, partly in Grady County, yielded more than 1.6 million barrels of oil under a pressure maintenance and cycling program. Natural gas liquids were stripped from natural gas at the Mo-

bil Oil Co. plant in the Sholem-Alechem field, Service Gas Products Co. Doyle field plant, Skelly Oil Co. Marlow and Velma plants, and Warren Petroleum Corp. Duncan plant. Crude oil was processed by Sunray DX Oil Co. at its Duncan refinery.

Texas.—The county ranked sixth in total mineral value; it ranked first in natural gas and third in natural gas liquids. Petroleum and natural gas liquids made significant gains raising the total 1966 value 9 percent above that of 1965. Natural gas liquids were recovered by the Anadarko Production Co. North Richland Center plant, Cities Service Oil Co. Murdock plant, Dorchester Gas Producing Co. Panoma plant, Excelsior Oil Corp. Tyrone plant, Mapco Production Co. Tyrone plant, and Mobil Oil Co. Postle-Hugh plant.

Tulsa.—A 4-percent increase in total mineral value was attributed to increased output of petroleum, stone, and clays which offset losses in natural gas and sand and gravel. Crude oil was processed at the Sunray DX Oil Co. and The Texas Co. refineries in west Tulsa. Sunray DX Oil Co. was scheduled to complete in April 1967 a 250,000-barrel propane storage cavern in shale beneath its refinery. Linestone was quarried and crushed by plants operated by Anchor Stone Co.; Standard Industries, Inc., at three locations; and Tulsa Rock Co. for concrete aggregate, roadstone, agriculture, riprap, and other uses. Sand for building, paving, fill, and other uses, and gravel for fill were processed by seven producers. The largest producers were Bagby-Harris Sand Co., Chandler Materials Co., Tulsa Sand Co., Inc., and Standard Industries, Inc. Brick and tile products were made in Tulsa by Acme Brick Co.

Woodward.—Increased production of all commodities except sand and gravel, resulted in a 14-percent increase in total mineral value. Natural gas liquids were stripped from natural gas at Mobil Oil Corp.'s new 12-million-cubic-foot-per-day refrigeration plant near Seiling and at Pan American Petroleum Corp.'s Mooreland plant. Sand for building and fill was produced northeast of Woodward by Klines Sand Pit.

The Mineral Industry of Oregon

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

By Ronald P. Collins,[1] Jerry J. Gray [2] and Gary A. Kingston [2]

The value of Oregon's 1966 mineral production was a record-setting $107.5 million, an increase of 30 percent compared with that of 1965. During the previous 2 years, the value of mineral production had risen nearly 70 percent primarily because of sand and gravel, stone, and cement usage for construction purposes. These mineral commodities were dominant because of large dam construction projects undertaken by the U.S. Army Corps of Engineers which also involved extensive relocation of highways and railroads. In contrast was the metal mining sector, where closure of the Oregon King mine in Jefferson County and the Buffalo mine in Grant County was largely responsible for very strong declines in gold, silver, copper, lead, and zinc output. The Bretz mine in Southern Malheur County, a long-time mercury producer first operated in 1931, closed after depleting available low-grade surface ore. Hanna Nickel Smelting Co., the only nickel ore producer in the United States, indicated that production had declined slightly from the record-breaking output of 1965.

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[2] Mineral specialist, Bureau of Mines, Albany, Oreg.

Table 1.—Mineral production in Oregon [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	291	$359	361	$362
Gem stones	NA	750	NA	750
Gold (recoverable content of ores, etc.)—troy ounces	499	17	281	10
Lime—thousand short tons	98	1,853	116	2,283
Mercury—76-pound flasks	1,364	779	700	309
Nickel (content of ore and concentrate)—short tons	16,188	W	15,036	W
Peat—do	------	------	900	17
Pumice and volcanic cinder—thousand short tons	657	1,181	714	1,256
Sand and gravel—do	21,800	32,849	35,327	34,986
Silver (recoverable content of ores, etc.)—troy ounces	8,801	11	343	(2)
Stone—thousand short tons	21,212	27,301	33,288	48,335
Value of items that cannot be disclosed: Cement, copper, diatomite, iron ore, lead, perlite (1966), zinc (1965), and values indicated by symbol W	XX	r 17,866	XX	19,176
Total	XX	r 82,966	XX	107,484

r Revised. NA Not available. XX Not applicable. W Withheld to avoid disclosing individual company confidential data.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Less than ½ unit.

Shell Chemical Co. located an $11-million complex to produce anhydrous ammonia and urea for fertilizer manufacture at Deer Island, Columbia County, 35 miles northwest of Portland on the Columbia River.

Oil exploration by Shell Oil Co., Union Oil Co., and the Standard-Union-Pan American group was conducted with no apparent success at several offshore sites between 15 and 25 miles from the coast.

Statistical data from Oregon's mineral industry indicated that the construction sector was the major user of its output, consequently much of the State's mineral production was sold or used locally. Depite continued increases in the personal and per capita income indicators, reductions were reflected in many construction activity indicators. This resulted from high interest rates that limited the flow of money into the construction activity sector. Because the construction industry remained the employer paying the highest weekly and hourly earnings in 1966, the lagged effects of the tight money policy were cause for some concern in the upcoming year.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]
1961	$51,807
1962	51,125
1963	61,391
1964	62,535
1965	81,683
1966	104,998

[1] Data for 1961–65 revised.

Employment and Injuries.—In general, 1966 was one of the State's best years with annual average employment up nearly 4 percent and unemployment at the lowest average rate (4.3 percent) in 15 years. The Oregon Employment Department reported that employment in mining, primary metals, stone, clay, and glass products averaged 12,758 compared with 11,821 in 1965. Record employment figures were set in midyear when total employment reached nearly 868,000. The average employment for the year was estimated at an alltime high of 805,000.

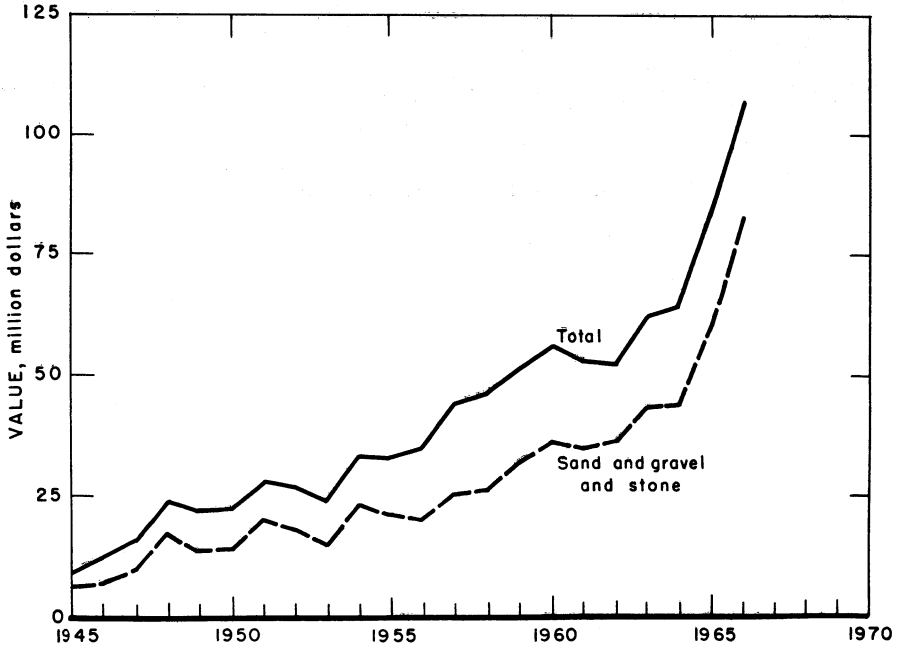

Figure 1.—Value of sand and gravel and stone, and total value of mineral production in Oregon.

Table 3.—Indicators of Oregon business activity

		1965	1966 p	Change, percent
Personal income:				
Total	millions	$5,350.0	$5,744.0	+7.4
Per capita		$2,761.0	$2,938.0	+6.4
Construction activity:				
Building permits	millions	$243.0	$233.9	−3.8
Heavy engineering awards	do.	$273.5	$211.0	−22.9
Value of highway contracts awarded	do.	$79.6	$78.5	−1.4
Expenditures on highway contract work	do.	$89.1	$85.6	−3.9
Cement shipments to and within Oregon, thousand 376-pound barrels		4,309.4	4,330.4	+0.5
Cash receipts from farm marketings	millions	$476.5	$514.0	+7.9
Factory payrolls	do.	$1,012.5	$1,107.8	+9.4
Annual average labor force and employment:				
Total labor force	thousands	813.6	941.5	+15.7
Unemployment	do.	37.3	35.9	−3.8
Construction	do.	33.4	33.6	+0.6
Lumber and wood products	do.	74.2	72.7	−2.0
Food products	do.	20.9	22.2	+6.2
All manufacturing	do.	158.2	166.2	+5.1
All industries	do.	775.8	804.8	+3.7

p Preliminary.

Sources: Survey of Current Business, Construction Review, Pacific Builder & Engineer, State Highway Commission, State Employment Department, and Bureau of Mines.

Table 4.—Employment and payrolls in mineral-industry establishments subject to Oregon unemployment-compensation law, by industries

Industry	1965		1966	
	Employment	Payrolls (thousands)	Employment	Payrolls (thousands)
Mining	1,670	$12,129	1,680	$12,901
Stone, clay, and glass products:				
Glass products	364	2,661	419	3,112
Hydraulic cement	412	3,104	421	3,233
Structural clay products	146	750	132	696
Concrete, gypsum, and plaster products	2,090	14,969	2,159	16,109
Cut-stone, stone, and pottery products	72	386	84	443
Miscellaneous	71	402	102	615
Total	3,155	22,272	3,317	24,208
Primary metals:				
Blast furnaces, steelworks, rolling and finishing mills	954	8,661	1,101	10,185
Primary smelting and refining of nonferrous metals	2,357	17,672	2,619	20,834
Iron and steel foundries	2,031	14,661	2,211	16,537
Nonferrous foundries	558	3,740	707	4,983
Secondary smelting and refining of nonferrous metals and miscellaneous industries	208	1,458	184	1,353
Total	6,108	46,192	6,822	53,892
Industrial chemicals	506	3,671	568	4,102
Petroleum refining and related products	382	2,486	371	2,533
Grand total	11,821	86,750	12,758	97,636

Source: Oregon Employment Department. Industries may vary from those in the Bureau of Mines canvass.

Table 5.—Employment 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
1965:								
Coal and peat	6	111	1	5	---	---	---	---
Metal	194	195	38	303	1	13	46.18	21,642
Nonmetal	166	219	36	291	---	19	65.22	1,703
Sand and gravel	2,634	226	596	4,777	---	97	20.30	451
Stone	1,578	209	329	2,643	---	64	24.22	392
Total	4,578	218	1,000	8,019	1	193	24.19	1,278
1966: p								
Coal and peat	5	112	1	6	---	---	---	---
Metal	165	221	36	292	---	7	23.97	729
Nonmetal	160	181	29	232	---	14	60.34	1,039
Sand and gravel	3,290	218	716	5,827	---	124	21.28	636
Stone	1,595	206	329	2,615	---	74	28.30	467
Total	5,215	213	1,111	8,972	---	219	24.41	600

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasives and Roofing Granules.—Pacific Abrasives Supply, a branch of Pacific Marine Service, Inc., Portland, completed a plant to dry, screen, and bag granulated slag for airblasting purposes, especially for cleaning ship hulls. The unprocessed slag was obtained from an abandoned copper smelter site at Grand Forks, British Columbia, Canada, which was active around the turn of the century. Mining-Mineral Manufacturing Co. continued to process granulated slag, from the Riddle operation of Hanna Nickel Smelting Co., for use as an airblasting abrasive. Flintkote Co., Pioneer Division, increased shipments of natural and artificially-colored roofing granules 12 and 22 percent, respectively, compared with the 1965 totals.

Cement.—Production and shipments of cement were 11 and 17 percent greater than those of 1965. Output was from plants of Oregon Portland Cement Co. at Lake Oswego (Clackamas County) and at Lime (Baker County), and from the Ideal Cement Co. plant at Gold Hill (Jackson County). Destinations of shipments were chiefly within the State; out-of-State shipments were made to Washington, Idaho, and northern California. Shipments of portland cement were distributed to ready-mixed concrete companies, 57.9 percent; to general contractors, 27.2 percent; to concrete-product manufacturers, 8.9 percent; to building-material dealers, 3.2 percent; and to highway contractors and to Federal, State, and local government agencies, 2.8 percent. Trucking, the principal method of transportation, accounted for 85.4 percent of the portland cement shipped; 14.5 percent went by rail, and less than 1 percent by boat. The ratio of bulk to paper-bag shipments was about 12:1.

Production from four cement plants in Oregon and Nevada totaled 4.3 million barrels (376 pounds each) of finished portland cement in 1966 compared with 3.5 million barrels in 1965. Data for Oregon are combined with Nevada to avoid disclosing individual company confidential data. The average value of portland cement shipped from these plants was $3.61 per barrel, f.o.b. plant, compared with $3.57 in 1965. A $5.75-million construction and modernization program was started by Oregon Portland Cement Co. to raise the rated annual capacity of the Lake Oswego plant.

Clay and Shale.—Clay and shale, sold or used, increased 24 percent, primarily because of greater demand for expanded shale. Contributing also to the increase was a slightly larger demand at cement plants. Production of miscellaneous clay (used for making heavy-clay products) from 10 counties and bentonitic clay from Crook County declined 12 and 13 percent, respectively.

Keasey shale, bloated and used as lightweight-concrete aggregate or finely reground for pozzolan, was shipped from two quarries in Washington County. The plant of Cloverleaf Mines, Ltd., was idle, shipments being from stocks. Material for two cement firms came from two shale quarries (Baker and Jackson Counties) and from one clay pit (Baker County).

Miscellaneous clay was produced by 12 companies in Benton, Clackamas, Klamath, Marion, Multnomah, Polk, Tillamook, Union, Washington, and Yamhill Counties. In Clackamas County carbonaceous shale was mined, dried, processed, and packaged for use as a soil conditioner. A small coal seam within the shale bed was handpicked to fire a drier.

Diatomite.—Total production and shipments of prepared diatomite were double those of 1965. The only producer, A. M. Matlock, mined crude diatomaceous earth from a deposit near Silver Lake in Lake County and trucked it to Eugene for processing into pet litter.

Gem and Gem Materials.—Gem and gem materials were recovered in small amounts by a large number of amateur collectors. The Bureau of Mines production-value estimate ($750,000) was based mainly on a 100,000-visitor-day rock-hounding count by the Prineville Chamber of Commerce. The town of Nyssa proclaimed itself the Thunderegg (Oregon's official State rock) Capital of Oregon and had a 3-day rockhound celebration which drew 3,000 collectors from 42 States. A newly opened fee-digging agate near Lebanon, Linn County, had a total of 1,750 visitor-days.

Harney County was the site of a blue and green obsidian (volcanic glass) find.[3]

Lime.—A record high output, was registered, with a gain of 18 percent over that of 1965. Quicklime and hydrated lime were produced by four companies. The major markets for quicklime were the calcium carbide, sugar, pulp and paper, and metallurgical industries. Hydrated lime was supplied for plywood manufacture and water purification. Lime for commercial markets was produced by Ash Grove Lime & Portland Cement Co., Portland, and Chemical Lime Co., Baker. Pacific Carbide & Alloys Co., Portland, and Amalgamated Sugar Co., Nyssa, produced and used lime for calcium-carbide manufacturing and sugar refining, respectively. The two Portland plants were supplied with limestone barged from Texada Island, British Columbia, Canada, and the other two were supplied from local limestone quarries. Lime (190,000 tons) was regenerated from recycled calcium-carbonate sludge at four pulp mills.

Perlite.—Crude perlite from Nevada was expanded at the Portland plant of Supreme Perlite Co. The expanded product was used mainly as a lightweight-plaster aggregate; smaller quantities were sold as filler and for soil conditioning.

Pumice and Volcanic Cinder.—Output of pumice and volcanic cinder (largely from Deschutes County) increased 9 percent compared with that of 1965. The material was used, mainly unprocessed, for road construction and maintenance by Governmental agencies; smaller amounts were processed and used for lightweight-concrete aggregate, concrete admixture (pozzolan), and as an abrasive.

Two operators in Deschutes County, Graystone Corp., Cascade Pumice Division, and Central Oregon Pumice Co., produced pumice which was processed and sold to concrete-products plants in the Northwestern States, California, and Canada.

Two firms mined volcanic material for its pozzolanic properties; Oregon Portland Cement Co. crushed volcanic cinder from Baker County, and Kaiser Cement & Gypsum Corp. mined and processed volcanic ash from Gilliam County. The finished material was shipped by truck and rail to dam projects in Oregon and Washington.

Sand and Gravel.—The principal reason sand and gravel output reached a record of 35.3 million tons, an increase of 62 percent over the 1965 total, was the relocation of highways and railroads around the John Day dam project of the U.S. Army Corps of Engineers. Commercial output declined 2 percent from that of 1965, reflecting a slowdown in the light construction industry. Production was reported from all 36 counties.

Government-and-contractor production rose 13.7 million tons. Under this classification, output for Federal agencies increased from 4.0 million tons (1965) to 20.2 million tons; output for State agencies decreased from 6.5 million tons to 3.1 million tons; and output for the counties increased from 1.0 million tons to 1.9 million tons.

Output exceeding 15 million tons was reported from Gilliam County, over 4 million

[3] Lapidary Journal. Harney County Obsidian. April 1966, pp. 107–112.

Table 6.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	3,618	$4,733	3,006	$3,923
Railroad ballast	80	74	145	116
Road material	5,629	7,113	5,617	7,309
Fill	728	544	1,081	790
Other [1]	198	353	205	314
Total	10,253	12,817	10,054	12,452
Government-and-contractor operations:				
Building	143	226	168	245
Road material	10,489	18,649	7,140	11,425
Fill	299	205	17,395	10,456
Other [1]	616	952	570	408
Total	11,547	20,032	25,273	22,584
All operations:				
Building	3,761	4,959	3,174	4,168
Railroad ballast	80	74	145	116
Road material	16,118	25,762	12,757	18,734
Fill	1,027	749	18,476	11,246
Other [1]	814	1,305	775	722
Grand total	21,800	32,849	35,327	34,986

[1] Includes special sands and sand and gravel used for miscellaneous purposes.

tons from Lane County, over 2 million tons was reported from both Morrow and Multnomah Counties, and over 1 million tons was reported from both Douglas and Linn Counties.

Stone.—Output of stone reached a record 33.3 million tons, an increase of 57 percent over that of 1965. The large increase, as was the case with sand and gravel, was due to the requirements for fill material of the John Day dam project. Stone output for the Government-and-contractor market increased 67 percent from 17.7 million (1965) tons to 29.6 million. Commercial stone increased 6 percent from 3.5 million tons (1965) to 3.7 million. Basalt continued to be the principal stone quarried, accounting for 97 percent of total. Output of limestone totaled 627,000 tons compared with 626,000 tons for 1965. The largest limestone market was the cement industry, followed by the sugar, lime, paper, metallurgical, and agricultural industries. Limestone was quarried in Baker, Josephine, and Polk Counties. Quartz (silica), produced by Bristol Silica Co., Jackson County, was marketed for use in making ferrosilicon, silicon carbide, cement, and roofing granules. Stone was yielded from all 36 counties; output exceeded 15 million tons in Gilliam County and over 1 million tons in each of Douglas, Lane, Linn, and Washington Counties.

Talc and Soapstone.—Soapstone, obtained from mines in Skagit County, Wash., was ground and prepared at Portland plants of Stauffer Chemical Co. and Miller Products Co., a division of W. R. Grace & Co. Output of finished product, used as a carrier in insecticides, decreased 12 percent compared with that of 1965.

Table 7.—Stone sold or used by producers by uses

(Thousand short tons and thousand dollars)

Use	1965		1966	
	Quantity	Value	Quantity	Value
Concrete and roadstone	13,293	$19,886	14,277	$20,883
Railroad ballast	263	366	244	349
Riprap	2,364	3,321	1,380	2,894
Other [1]	5,292	3,728	17,387	24,209
Total	21,212	27,301	33,288	48,335

[1] Includes building stone (dimension), stone used at cement, paper, and chemical plants; sugar refineries; rock fill; dam embankment; and for miscellaneous unspecified purposes.

Vermiculite (Exfoliated).—Production and shipments of exfoliated vermiculite remained about the same as in 1965. Crude vermiculite from the Republic of South Africa and Montana was exfoliated at Portland plants of Supreme Perlite Co. and Vermiculite Northwest, Inc., respectively. Expanded material was marketed as loose-fill insulation, as a lightweight aggregate for plaster and concrete, and for soil conditioning.

Water.—The new $2.5-million Pacific Northwest Water Laboratory on the Oregon State University campus was dedicated in October. The laboratory was to be used for research on the prevention and control of water pollution and would serve Oregon, Washington, Montana, Idaho, Wyoming, and Utah. The laboratory was to have a staff of approximately 150 when in full operation.

METALS

Aluminum.—Harvey Aluminum, Inc., The Dalles, and Reynolds Metals Co., Troutdale, produced a record output of ingot, exceeding that of 1965 by 3.5 percent.

Reynolds Metals Co. announced plans for construction of a $25-million potline at its Troutdale plant. When completed in 1968, this fifth potline would add 40,000 tons of annual capacity to the existing 100,000 tons.

Copper.—A small tonnage of copper ore was shipped from the Standard mine, Grant County.

A study of the copper, lead, and zinc industries of the Pacific Northwest, prepared by the Bureau of Mines for the Bonneville Power Administration, was published.[4]

Ferroalloys.—A strike at the Union Carbide Co. Portland plant halted ferromanganese, silicomanganese, and ferrosilicon production from August 28 through December. Manganese ore was received from numerous foreign sources; silica rock was obtained from a company mine in Montana.

Gold and Silver.—Small lode and placer operations in southwestern and eastern Oregon yielded minor quantities of these metals. Most of the output value was recorded from Josephine, Jackson, and Grant Counties. The largest producer was the Goff placer in Josephine County. The Buffalo mine, Grant County, was idle, as was the Oregon King mine, Jefferson County. Active gold-silver mines were listed in a State publication.[5]

Mercury.—The average price for mercury decreased from the 1965 figure of $570 to $442. Production was 700 flasks (76 pounds of mercury per flask), 49 percent below that of 1965.

The Black Butte mine near Cottage Grove, Lane County, led production in the State. The mine was acquired in May by Allegheny Mining & Explorations Co., Ltd., Toronto, Canada, from American Mercury Corp., also of Canada. The Bretz mine, Malheur County, closed in September after all ore available by surface mining was depleted.

Nickel.—Hanna Mining Co., Riddle, delivered 9 percent less ore than in 1965 from its Nickel Mountain deposit to the adjacent Hanna Nickel Smelting Co. smelter. The latter company produced 50.5 million pounds of ferronickel (24.5 million pounds of contained nickel) and purchased a similar quantity from the Federal stockpile to meet customer demand. The price of ferronickel rose during the year from $0.7525 per pound of contained nickel to $0.8275 per pound. Dropped from the new price was a charge of $0.0075 per pound of nickel previously added to cover the value of contained cobalt. Exploration of southern Oregon-northern California nickel prospects by Hanna Mining Co. continued.

Titanium.—Oregon Metallurgical Corp., (Oremet) Albany, began production of titanium sponge metal from titanium tetrachloride using a proprietary process, thereby becoming one of three fully integrated titanium plants in the United States. At yearend, the new installation was approaching capacity output of 3.6 million pounds annually. Additional capital expenditure programs were planned to increase sponge capacity to 6,000 tons per year. The company had a 6,000-ton annual titanium sponge melting plant which was supplied primarily with purchased sponge. At yearend, Armco Steel Corp. purchased a major share of the company, making Armco a principal owner along with Ladish Co. of Wisconsin.

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[4] Knostman, Richard W., and Gary A. Kingston. Copper, Lead, and Zinc Industries in the Pacific Northwest. Bonneville Power Administration Pacific Northwest Economic Base Study for Power Markets, v. 2, pt. 7C, 1966, 139 pp.

[5] Mason, Ralph S. Oregon's Mineral Industry in 1966. Ore Bin, v. 29, No. 1, January 1967, p. 4.

Uranium.—Lakeview area uranium properties and the idle uranium processing mill were to be reactivated according to an announcement made by Continental Mining & Milling Co., Chicago, but the proposed plan failed to materialize. The White King group uranium claims near Lakeview were leased for 11 years with an option to purchase by Western Nuclear, Inc., Denver, Colo. The Denver firm was to explore and possibly develop the property.

Zirconium.—Zirconium and hafnium mill products produced by Wah Chang Corp., Linn County, were in good demand because of an increase in nuclear reactor construction. Wah Chang extracted zirconium from Australian zircon ore at the Albany plant.

MINERAL FUELS

Carbon.—Koppers Co., Inc., Tar and Chemical Division, began producing carbon pitch at its new $1-million Portland plant. The pitch, for use in making carbon anodes for the aluminum industry, was derived from coal tar obtained from California steel producers.

Natural Gas.—Northwest Natural Gas Co. announced plans to build a $3.5-million gas liquefaction plant in Portland. Natural gas was to be converted into the liquid state during the slack summer months and stored for use in winter months.

Peat.—A peat bog near Enterprise, Wallowa County, was brought into production by Wes Cruikshank.

Petroleum.[6]—Three wells were drilled and one deepened off the Oregon coast for a total of 29,408 feet. All drilling was by the Blue Water II, a floating drilling platform. Two holes were for Shell Oil Co.; one located 26 miles off the coast from Seaside had a total depth 8,219 feet, and the other, 17 miles off, the mouth of the Columbia River, was drilled to a depth 10,160 feet. The Union Oil Co. hole, 25 miles offshore from Heceta Head, reached a total depth 12,221 feet. The Standard-Union-Pan American group deepened a 5,600-foot test hole, 16 miles off the coast from Waldport, to 10,010 feet. Near the lease renewal deadline in December, the oil companies quitclaimed approximately 20 percent of the Federal Outer Continental Shelf leases. To date, seven offshore wells have been drilled with no apparent success.

The Oregon Department of Geology and Mineral Industries issued four drilling permits; two were for reentry of old holes. The Butte Oil of Oregon, Inc., drillsite was approximately 1 mile southeast of Forest Grove, Washington County. The well was to test Oligocene marine sediments below the Columbia River basalt, but the drill stem was lost at 959 feet. At yearend, the company was trying to recover the drill pipe. Marvin Lewis, Salem, drilled a 2,100-foot well in northern Polk County; however work was suspended in August. Central Oils, Inc., Seattle, Wash., obtained permission to re-enter a 3,300 foot deep well it abandoned in December 1960. No work was done however at the site, approximately 10 miles southeast of Madras, Deschutes County. The firm was to test pre-Tertiary marine rocks underlying younger volcanics. Ivan Vojvada, associated with Supreme Oil Corp., California, re-entered the Barr No. 1, drilled near Lacomb, Linn County, several years ago, to obtain a new test of gas-bearing sand at about 4,300 feet. The drilling was whipstocked out of the old hole at 3,937 feet, continued for 31 feet, and terminated after loss of tools. Total footage drilled onshore was 3,090 feet.

REVIEW BY COUNTIES

Mineral production was reported from all 36 counties in 1966. With certain important exceptions, output was principally from nonmetallic deposits. Only selected counties with significant metal and nonmetal developments are discussed in the following review.

Baker.—The Oregon Portland Cement Co. plant at Lime continued, in terms of value, to be the principal mineral industry activity in the county. Company shipments increased sharply during 1966, principally because of increased production and transfers from stocks. The cement operation utilized limestone from the Limerock quarry and shale from the Nelson quarry, both company owned.

Chemical Lime Co. produced quicklime and hydrated lime at a plant north of Baker. Limestone for the plant was obtained from a quarry on Baboon Creek.

[6] Oil-well drilling data were obtained from the Ore Bin, a monthly publication of the Oregon Department of Geology and Mineral Industry.

Table 8.—Value of mineral production in Oregon, by counties
(Thousand dollars)

County	1965	1966	Minerals produced in 1966 in order of value
Baker	$5,429	$6,499	Cement, stone, lime, clays, sand and gravel, pumice, perlite.
Benton	1,323	907	Sand and gravel, stone, clays.
Clackamas	9,024	7,474	Cement, sand and gravel, stone, clays.
Clatsop	203	900	Stone, sand and gravel.
Columbia	266	258	Sand and gravel, stone, iron ore (mineral pigment).
Coos	652	1,112	Stone, sand and gravel.
Crook	331	247	Sand and gravel, stone, clays, mercury.
Curry	351	188	Sand and gravel, stone, gold.
Deschutes	888	1,003	Pumice, stone, sand and gravel.
Douglas	11,483	9,929	Nickel, stone, sand and gravel, mercury, gold, silver.
Gilliam	1,930	31,950	Stone, sand and gravel, pumice.
Grant	142	367	Stone, sand and gravel, copper, mercury, gold, silver.
Harney	261	275	Stone, sand and gravel.
Hood River	1,168	1,465	Sand and gravel, stone.
Jackson	6,772	3,402	Cement, stone, sand and gravel, clays, pumice, gold, silver.
Jefferson	269	217	Sand and gravel, stone, pumice.
Josephine	2,034	1,146	Sand and gravel, stone, gold, silver, lead.
Klamath	911	2,124	Stone, sand and gravel, pumice, clays.
Lake	1,167	1,020	Stone, sand and gravel, pumice, diatomite, mercury, perlite.
Lane	10,046	8,500	Sand and gravel, stone, mercury.
Lincoln	1,050	W	Stone, sand and gravel.
Linn	3,250	3,429	Stone, sand and gravel, pumice.
Malheur	1,690	1,091	Lime, stone, sand and gravel, mercury.
Marion	1,537	1,145	Sand and gravel, stone, clays.
Morrow	556	W	Sand and gravel, stone.
Multnomah	5,198	6,200	Sand and gravel, lime, stone, clays.
Polk	879	482	Sand and gravel, stone, clays.
Sherman	3,527	1,424	Sand and gravel, stone.
Tillamook	511	753	Stone, sand and gravel, clays.
Umatilla	665	1,820	Sand and gravel, stone.
Union	632	461	Stone, sand and gravel, clays.
Wallowa	138	330	Stone, sand and gravel, peat.
Wasco	1,947	374	Stone, sand and gravel.
Washington	1,309	2,466	Stone, sand and gravel, clays.
Wheeler	120	247	Stone, sand and gravel, mercury.
Yamhill	144	366	Stone, sand and gravel, clays.
Undistributed [1]	r 5,163	7,913	
Total	r 82,966	107,484	

r Revised.
W Withheld to avoid disclosing individual company confidential data.
[1] Includes value of mineral production that cannot be assigned to specific counties and values indicated by symbol W.

Union Pacific Railroad halted exploration at the Buffalo mine in September. The mine, previously a principal gold and silver producer in the State, was leased later in the year to A. W. Brandenthaler, Baker. Union Pacific work at the Buffalo mine included crosscutting of the No. 3 vein on both the 500 and 600 levels.

Omega Mines, Ltd., Vancouver, British Columbia, Canada, explored the E and E and North Pole gold properties.

Benton.—A retort was operated by Robert Lyman to recover mercury from concentrate produced in Alaska.

Clackamas.—Lower yield of sand and gravel caused a $1.5-million decrease in output value compared with that of 1965. A $5.75-million expansion and modernization program scheduled for the Lake Oswego cement plant of Oregon Portland Cement Co. would raise capacity 1.5 million barrels to a total of 3.5 million barrels. Planned were a 12- by 13.5-by 450-foot kiln, a 12- by 34-foot finish grinding mill, a 12,000-barrel slurry basin, and a raw materials handling and feeding system. All equipment was to be highly automated and centrally controlled. Completion was scheduled for mid-1967. Limestone for the operation was transported by barge from Texada Island, British Columbia, Canada.

Crook.—Central Oregon Bentonite Co. decreased production from its Silver Wells pit because of lessened demand for bentonite as a forest fire retardant, a binder in making stock-feed pellets, a sealer for irrigation canals, and as a carrier in insecticides. Crude bentonitic clay was trucked

from the pit to a beneficiating plant at Bend, Deschutes County, owned by Anderson Mining & Development Co.

Selby Towner recovered 1 flask of mercury from 5 tons of ore mined at the Lost Cinnabar Mines No. 1 property.

Curry.—The Hanna Mining Co. continued exploration of the Red Flats nickel prospect.

Douglas.—Ten flasks of mercury were produced at the Elkhead mine by Alcona Mining, Inc. Four hundred tons of ore were processed in a rotary kiln. A cleanup of materials available around the surface plant of the Bonanza mine yielded 2 flasks of mercury. The Hanna Mining Co., Riddle, enlarged crushing and screening capacity at its nickel mine. Ore mined for processing totaled 1,044,138 tons; waste material handled was slightly over 400,000 tons. Mining, conducted on 30 surface benches, required drilling and blasting for 27 percent of the material moved.

Gilliam.—This county led the State in value of mineral production in 1966 accounting for 30 percent of the State total. Gilliam County mineral output value jumped from $1.9 million in 1965 to $31.9 million, because of increased sand and gravel and stone production used mainly for fill. The fill was needed for relocating highways, railroads, and towns around the John Day dam project.

Grant.—Canyon Creek Mercury Mines retorted concentrate produced from 100 tons of ore and recovered 2 flasks of mercury at the Canyon Creek mine. Late in the year, the mine was leased to Standard Slag Co., Reno; exploration work included mapping, a magnetometer survey, and surface trenching.

Harney.—The Bureau of Land Management released 2,383 acres of an original 2,810 acres that had been withdrawn in Harney County to appropriation under the general mining laws. The remaining 427 acres were to be developed as a "unique petrified wood area."

Jackson.—Ideal Cement Co.'s production of cement at Gold Hill was lower than that of 1965. Yields of sand and gravel and stone were also lower. Limestone used at the cement plant was obtained from the company-owned Marble Mountain quarry in Josephine County, and shale was supplied from the company Gold Hill quarry. Silica (quartz) from a quarry near Rogue River was mined by Bristol Silica Co. The material, trucked 4 miles to a screening plant at Gold Hill, was sized and sold for industrial uses.

A retort was constructed at the Doodlebug mercury mine, and development of the property continued.

Lake.—One flask of mercury was recovered by retorting from ore mined at the Polaris property by John McManmon. Jackson Mountain-Mining Co. was completing a flotation mill and retort plant to process ore from a new mine in the Glass Buttes area. Production was expected to commence in 1967. An open-pit bench operation was planned to mine ore running 2 to 3 pounds of mercury per ton.

The White King uranium mine was leased and explored by Western Nuclear, Inc. Diamond drilling was begun, and the flooded pit adjacent to the underground workings was being pumped.

Lane.—The Black Butte mine, largest producing mercury mine in the State, was operated by American Mercury Corp. until May when the operation was taken over by Black Butte Mining, Inc., a subsidiary of Allegheny Mining & Explorations Co., Ltd., Toronto, Canada. The Black Butte workings yielded approximately 18,000 tons of ore from which 542 flasks of mercury were recovered. Employment at the mine was approximately 20 to 25 men.

Linn.—Stephen M. Shelton, president of Oregon Metallurgical Corp., Albany, producer of titanium castings and other metal products, reported sales at $8.84 million. The firm announced the sale of 700,000 shares of stock to Albany Enterprises, Inc., a wholly owned subsidiary of Armco Steel Corp. The sale was made as a means of financing an expansion program, particularly for manufacturing titanium sponge.

Malheur.—The Bretz mercury mine and mill were closed in September after available surface ore had been exhausted. The property was mined under a lease from Minerals & Chemicals Philipp Corp., New York, by Bretz Mining Co., Salt Lake City.

Morrow.—Output value increased substantially becacse of fill materials, sand and gravel and stone, needed for the John Day dam project.

Multnomah.—Although mineral production value (sand and gravel, lime, stone, and clay produced) ranks fourth in the State, no other county approached it in

complexity of mineral commodity consumption. Chemical, metallurgical, and other processing plants furnished calcium carbide, ferrosilicon, ferromanganese, silicomanganese, caustic soda, chlorine, rolled- and cast-steel products, roofing granules, lightweight-plaster aggregate, loose-fill insulation, and an inert carrier for insecticides.

Pacific Carbide & Alloys Co. and Ash Grove Lime & Portland Cement Co. calcined Texada Island, British Columbia, limestone to lime for use by the metallurgical, chemical, and construction industries. Salt barged from Baja California, Mexico, was reduced to caustic soda and chlorine by Pennsalt Chemicals Corp. The firm modernized and expanded its Portland chlorine plant to meet increased needs of Pacific Northwest and California pulp and paper manufacturers. Capacity was increased from 200 tons to 250 tons per day, with a proportionate rise in caustic soda output. A 250-foot ocean-going barge, designed to carry a cargo of 1,200 tons of liquid chlorine, 2,000 tons of caustic soda, and 600 tons of sodium chlorate, was to operate between the Portland plant and other west coast ports.

Silica from Jackson County and river sand from Multnomah County were used for manufacturing roofing granules. Vermiculite from Montana and the Republic of South Africa was expanded for use in loose-fill insulation, as plaster and concrete aggregate, as fertilizer conditioner, and for soil conditioning. Soapstone for use as a carrier material in insecticides was ground from crude ore obtained from Washington. Crude perlite from Nevada was expended for use mainly as a lightweight-plaster aggregate.

Ferroalloy production at the Union Carbide Co. plant in the St. Johns district was halted for the last 4 months of the year by a labor strike.

Sherman.—Reduced requirements for sand and gravel and stone at the John Day dam project caused a 60-percent drop in mineral production value.

Wasco.—Completion of the county's section of Interstate Highway 80 caused an 81-percent drop in mineral production value, compared with that of 1965.

The Mineral Industry of Pennsylvania

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

By Charles C. Yeloushan [1]

Commodities produced by the mineral industry of Pennsylvania in 1966 were valued at $903.4 million, a $10.4 million decrease from that of 1965. Anthracite accounted for the greatest decrease of a single commodity with a $21.4 million loss from that of 1965. Bituminous coal continued to be the backbone of the mineral industry in Pennsylvania, accounting for 47 percent of the total value and increasing $17.9 million over that of 1965. Production of stone continued to rise but the total value fell slightly. Cement, clays, and sand and gravel output remained relatively stable, but total values declined slightly. Peat, petroleum, lime, and zinc production increased while total values remained relatively constant.

[1] Mining engineer, Bureau of Mines, Pittsburgh, Pa.

Table 1.—Mineral production in Pennsylvania [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Portland, 376-pound barrels	40,153,219	$116,925	40,003,833	$114,357
Masonry, 280-pound barrels	3,005,105	7,991	2,960,110	7,860
Clays [2], short tons	3,394,222	17,697	3,293,114	17,033
Coal:				
Anthracite, do.	14,865,955	122,021	12,941,264	100,663
Bituminous, do.	80,308,449	407,267	81,442,801	425,168
Copper, do.	4,354	3,083	3,178	2,299
Gem stones	NA	4	NA	4
Lime, short tons	1,568,492	22,496	1,585,088	22,816
Natural gas, million cubic feet	84,461	22,551	90,914	25,820
Natural gas liquids:				
Natural gasoline and cycle products, thousand gallons	1,022	55	3,211	186
LP gases, do.	1,683	109	1,863	121
Peat, short tons	45,600	527	52,912	562
Petroleum (crude), thousand 42-gallon barrels	4,922	21,263	4,337	19,300
Sand and gravel, short tons	18,502,000	29,606	17,567,000	29,562
Stone, do.	56,806,160	99,627	59,087,619	99,233
Zinc [3] (recoverable content of ores, etc.), short tons	27,635	8,014	28,080	8,143
Value of items that cannot be disclosed: Clays (kaolin), cobalt, gold, iron ore, mica, pyrites, sericite-schist, silver, and tripoli	XX	34,587	XX	30,281
Total	XX	913,823	XX	903,408

NA Not available. XX Not applicable.

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

[2] Excludes kaolin; included with "Value of items that cannot be disclosed."

[3] Recoverable zinc valued at the yearly 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.

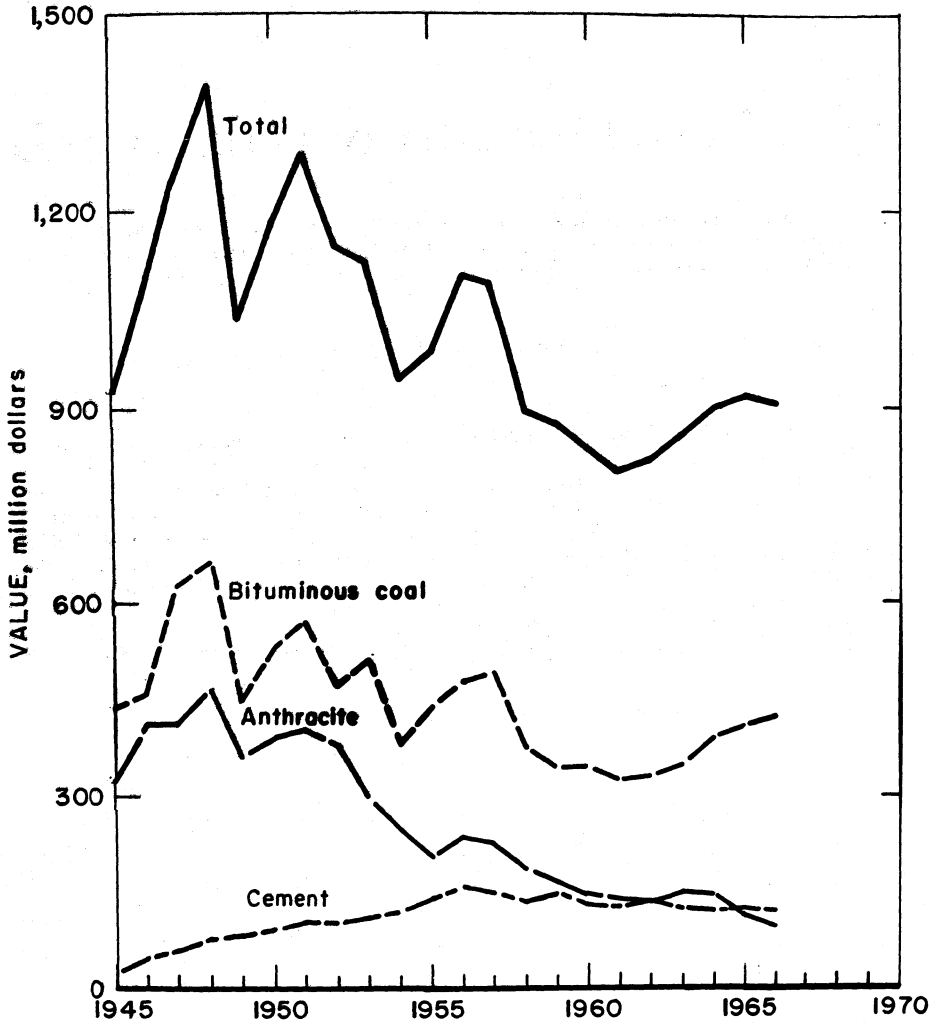

Figure 1.—Value of bituminous coal, anthracite, cement and total of mineral production in Pennsylvania.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Millions)

Year	Value [1]	Year	Value [1]
1957	$1,056	1962	$860
1958	889	1963	908
1959	892	1964	946
1960	856	1965	960
1961	833	1966	[p] 929

[p] Preliminary.
[1] Data for 1957, 1959–65 revised.

Table 3.—Employment 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
1965:								
Bituminous coal	24,893	228	5,558	44,690	35	1,025	23.72	6,338
Anthracite	11,132	204	2,271	16,375	8	1,067	65.65	4,936
Metal	1,473	285	420	3,475	---	27	7.77	420
Nonmetal	1,601	252	404	3,309	2	135	41.41	4,421
Sand and gravel	1,157	237	275	2,300	---	46	20.00	328
Stone	8,393	271	2,273	18,582	6	303	16.63	2,674
Peat	59	194	11	90	---	1	11.05	309
Total	48,208	233	11,212	88,821	51	2,604	29.89	4,348
1966: p								
Bituminous coal	24,000	224	5,369	43,270	28	880	20.98	5,327
Anthracite	9,292	203	1,883	13,672	6	829	61.07	4,477
Metal	1,550	282	437	3,497	---	33	9.44	852
Nonmetal	1,750	251	439	3,578	---	137	38.29	766
Sand and gravel	1,210	228	277	2,351	1	49	21.27	3,869
Stone	8,260	268	2,216	18,217	7	320	17.95	3,375
Peat	60	225	14	109	---	---	---	---
Total	46,122	231	10,635	84,694	42	2,248	27.04	4,345

p Preliminary.

REVIEW BY MINERAL COMMODITIES

FUELS

Coal (Anthracite).—Anthracite production continued to decrease, a 1.9-million-ton loss from that of 1965. The average value of anthracite was $7.78 per ton, 43-cents below that of 1965. Of total shipments 6.9 million tons was by truck, 5.9 million tons by rail, and 141,000 tons used as colliery fuel. Underground production totaled 4.1 million tons of which 2.6 million tons was mechanically loaded by 383 conveyors and pit-car loaders (including duckbills and other self-loading conveyors), 151 scraper loaders, and 30 mobile loaders. Strip pits supplied 5.3 million tons, culm banks 2.9 million tons, and river dredging 662,000 tons.

By regions, Schuylkill accounted for 6.5 million tons, Wyoming for 3.5 million tons, and Lehigh for 2.9 million tons. Wyoming region led in value per ton with $8.85, followed by Lehigh with $7.98 and Schuylkill with $7.12. Schuylkill region included all the dredging at $3.46 per ton, of which 605,000 tons were dredged from the Susquehanna River and tributaries at $3.48 per ton and 57,000 tons from the Schuylkill River and tributaries at $3.16 per ton.

Men employed in the anthracite industry averaged 9,292 working daily (1,840 men less than in 1965). Productivity from all operations except dredges averaged 6.6 tons per man-day, while dredge operations reported 31.3 tons per man-day for an overall average of 6.87 tons per man-day (0.3 ton better than in 1965).

Luzerne County continued to be the leading producer with 4.6 million tons, followed by Schuylkill County with 4.5 million tons and Northumberland with 1.4 million tons.

Retail dealer deliveries accounted for 2.7 million tons followed by electric utility consumption with 2.2 million tons. Exports, not including shipments to military forces, accounted for 766,000 tons, a decrease of 85,000 tons from that of 1965.

Six deaths were recorded in the anthracite industry at a frequency rate of 0.44 per million man-hours exposure. Of the six deaths, five occurred underground and one at a strip mine; three of the fatalities were at a mine employing four persons underground and two at mines employing 15 or more persons underground. All of the fatalities occurring underground were charged to falls of roof near the face and the strip mine fatality was the result of a fall from a payloader. Nonfatal injuries totaled 829 at a frequency rate of 61.07 per million man-hours exposure.

Coal (Bituminous).—Production of bituminous coal totaled 81.4 million tons at an

average price of $5.22 per ton. The 50.9 million tons sold in the open market had an average price of $4.23 per ton, whereas the 30.5 million tons not sold in the open market was valued at $6.86 per ton. Of the total output, 63.2 million tons were shipped by rail or water, 16.4 million tons by truck and 1.8 million tons by other means.

Mine count totaled 1,088, of which 410 underground mines accounted for 55.8 million tons, 618 strip mines for 24.8 million tons, and 60 auger mines for 826,000 tons.

According to the Keystone Coal Buyers Manual, 16 coal companies produced over 1 million tons each in 1966: (1) Consolidation Coal Co. (including Pittsburgh, Mathies and Harmar Coal Companies), 7.7 million tons; (2) U.S. Steel Corp., 6.4 million tons; (3) Bethlehem Mines Corp., 6.2 million tons; (4) Republic Steel Corp., 3.5 million tons; (5) Jones & Laughlin Steel Corp., 3.0 million tons; (6) Barnes & Tucker Co., 3.0 million tons; (7) Duquesne Light Co., 2.5 million tons; (8) Gateway Coal Co., 2.1 million tons; (9) Rochester & Pittsburgh Coal Co., 1.8 million tons; (10) Eastern Associated Coal Corp., 1.7 million tons; (11) Imperial Coal Corp., 1.4 million tons; (12) North American Coal Corp., 1.3 million tons; (13) Benjamin Coal Co., 1.1 million tons; (14) C & K Coal Co., 1.2 million tons; (15) Buckeye Coal Co., 1.2 million tons; and (16) National Mines Corp., 1.1 million tons. These 16 companies accounted for 56 percent of the total production.

Underground mines in district 1 totaled 301 and accounted for 20.7 million tons, of which 17.6 million tons sold in the open market for $4.64 per ton; 299 cutting machines cut 3.3 million tons; 171 mines loaded 20 million tons mechanically with 238 continuous miners, 66 mobile loaders (14 of which were used with continuous miners), and 105 hand-loaded face conveyors. District 2 had 109 underground mines accounting for 35.1 million tons, of which 8.0 million tons sold in the open market for $4.99 per ton; 126 cutting machines cut 7.4 million tons; 68 mines loaded 34.9 million tons mechanically with 197 continuous miners, 170 mobile loaders (73 of which were used with continuous miners), and 8 hand-loaded face conveyors.

The 427 strip mines in district 1 accounted for 18.1 million tons, virtually all of which was sold in the open market for $3.69 per ton. Stripping was accomplished by 506 power shovels, 288 draglines (11 of which had over 12 cubic yards of capacity), 6 carryall scrapers (2 of which had over 12 cubic yards of capacity), 509 bulldozers, 155 power drills and 1,026 trucks. The 191 strip mines in district 2 recovered 6.7 million tons of coal with 220 power shovels (1 of which had a capacity over 12 cubic yards), 108 draglines (6 of which had over 12 cubic yards of capacity), 9 carryall scrapers (7 of which had over 12 cubic yards of capacity), 258 bulldozers, 81 power drills, and 448 trucks.

The 42 auger mines in district 1 produced 528,000 tons at an average price of $3.64 per ton with 40 augers, 7 bulldozers, 12 power drills, and 73 trucks. District 2 had 18 auger mines which produced 298,000 tons at $3.76 per ton with 24 augers, 4 bulldozers, 1 power drill, and 22 trucks.

Ninety-four preparation plants mechanically cleaned 55.3 million tons of coal, of which 47.2 million tons came from underground mines, 7.9 million tons from strip mines, and 159,000 tons from auger mines; 33.2 million tons cleaned by wetwashing other than jigs, 11.5 million tons by jigs, and 10.6 million tons by pneumatic methods. Coal was crushed at 210 plants for a total of 41.4 million tons with 63 plants treating 7.4 million tons with calcium chloride, oil, or other materials. Thermal drying was conducted at 15 plants with a total of 20 thermal units drying 6.9 million tons.

Twenty-eight fatal and 880 nonfatal injuries occurred during the year. Of the 28 fatalities, 25 occurred underground (11 from falls of rock, 5 on haulage, 4 on machinery, and 5 others), 1 on the surface (haulage), and 2 in strip mines (machinery). Injury rates per million man-hours exposure were 0.65 fatal and 20.34 nonfatal; per million short tons, 0.34 fatal and 10.84 nonfatal.

Mineral Industry's 1966 "Sentinels of Safety" was won by the Karen Mine of U.S. Steel Corp. at Fredericktown, Washington County, for operating 454,079 manhours without a disabling injury. Participating in the contest since 1951, this operation won once before in 1963. Decker No. 4, Powell Coal Co., Kittanning, re-

Table 4.—Coal (bituminous) production, by counties

County	Number of mines				Production, thousand tons	Average price per ton
	Underground	Strip	Auger	Total		
Allegheny	14	17	2	33	5,301	$6.01
Armstrong	40	42	9	91	5,383	4.08
Beaver	1	7	2	10	299	4.11
Bedford	7	3	---	10	286	4.75
Blair	2	1	1	4	77	3.82
Butler	11	40	5	56	2,163	4.39
Cambria	67	25	4	96	8,110	5.80
Centre	4	15	---	19	709	3.68
Clarion	3	77	1	81	3,334	3.73
Clearfield	38	97	9	144	7,273	3.64
Clinton	---	14	---	14	684	3.78
Elk	9	8	5	22	471	3.73
Fayette	16	21	1	38	859	5.36
Greene	20	5	---	25	12,123	6.67
Huntingdon	4	2	1	7	52	3.31
Indiana	54	29	5	88	7,660	4.39
Jefferson	23	43	9	75	1,664	3.89
Lawrence	---	27	2	29	1,149	2.60
Mercer	---	9	1	10	424	4.19
Somerset	58	70	1	129	4,129	4.33
Tioga	---	9	---	9	610	4.00
Venango	---	15	---	15	494	3.26
Washington	15	12	1	28	14,139	6.49
Westmoreland	24	24	1	49	3,909	5.47
Other counties [1]	---	6	---	6	141	3.77
Total	410	618	60	1,088	81,443	5.22

[1] Includes data for Bradford, Lycoming, and McKean Counties.

ceived recognition in the Underground-Coal Group of the National Safety Competition for its outstanding safety record in 1966 with 36,850 man-hours worked without a disabling work injury.

Coke and Coal Chemicals.—Oven-coke production totaled 18.7 million tons, a 1-percent decrease from that of 1965, and beehive-coke production totaled 609,600 tons, a 31-percent decrease from that of 1965. Oven-coke had an average value of $15.80 per ton at the ovens ($0.35 a ton more than in 1965); beehive coke averaged $13.51 per ton at the ovens ($0.43 per ton less than in 1965). Twelve oven-coke plants with 3,437 ovens (18 more than in 1965) were in operation at yearend. Oven-coke plants carbonized 26.8 million tons of coal and had a 69.75 percent yield of coke from coal. Seven beehive-coke plants, (five less than in 1965) with 1,284 ovens at yearend, carbonized 989,000 tons of coal and had a 61.64 percent coke yield.

Of the total oven-coke output, producing companies used 17.8 million tons in blast furnaces and 19,000 tons for other purposes and sold 867,000 tons to blast-furnace plants, foundries, other industrial plants and retail dealers for residential heating both in and out of the State. Of the 15.5 million tons of oven and beehive coke distributed in Pennsylvania, 15 million tons went to blast-furnace plants, 181,000 tons to foundries, 276,000 tons to other industrial plants, and 13,500 tons for residential heating.

Breeze recovered at coke plants totaled 819,400 tons at an average of $6.31 per ton. Of the breeze used by producers, 528,800 tons were used in agglomerating plants, 80,800 tons in steam plants, and 85,600 tons for other industrial uses. Breeze sold on the open market totaled 102,700 tons at an average of $6.95 per ton. Stocks of breeze on hand at yearend totaled 281,400 tons.

Coal chemicals produced at the oven-coke plants included 256,500 tons of ammonium sulfate equivalent; 244.1 million gallons of tar; and 80.2 million gallons of crude light-oil, from which were derived 50.8 million gallons of benzene, 11.1 million gallons of toluene, 3.4 million gallons of xylene, and 2 million gallons of solvent naphtha.

Natural Gas Liquids.—Production of natural gas liquids totaled 5.1 million gallons of which 3.2 million gallons was natural gasoline and cycle products and 1.9 million gallons was liquefied petroleum (LP) gases and ethane. Natural gasoline and cycle products were listed at 5.8 cents per gallon (5.4 cents in 1965) and LP gases and eth-

ane at 6.5 cents per gallon (same as 1965). Natural gas processing plants were located in Elk, Venango, Warren, and Allegheny Counties. Estimated proved recoverable reserves of natural gas liquids totaled 1.2 million (42-gallon) barrels at yearend, a decrease equal to the production of natural gasoline and cycle products.

Underground-storage capacity for LP gas was 1.1 million barrels located in four mined granite caverns in Delaware County and a mined shale cavern in Westmoreland County. An inground frozen earth cavity is being constructed in Philadelphia County by Philadelphia Gas Works (completion 1970) with a capacity of 1.2 million barrels.

Peat.—Peat production totaled 49,900 tons from 13 operations located in seven counties. Sales totaled 52,900 tons at an average price of $10.61 per ton. Of the total sold, 62 percent was reported as humus, 33 percent reed-sedge, and 5 percent moss; 86 percent was sold in bulk for $10.70 per ton and 14 percent packaged for $10.10 per ton. Peat producers reported working on deposits totaling 1,051 acres (average depth of 52 feet) with 10.9 million tons of reserves. Processing equipment reported included 14 shredders, 4 hammermills, 1 grinder, and 10 screens. Lackawanna County was the leading producer followed by Luzerne and Lawrence Counties.

Petroleum and Natural Gas.—Production of crude oil totaled 4.3 million (42-gallon) barrels, a 12-percent decrease from that of 1965. The average value per barrel increased from $4.32 in 1965 to $4.45 in 1966. Productive oil wells decreased from 52,731 in 1965 to 48,000 in 1966.

Crude-oil operating capacity of 13 refineries on January 1, 1966 was 610,100 barrels per calendar day. Estimated proved reserves of crude oil at yearend totaled 72.4 million barrels.

Natural gas production totaled 91 billion cubic feet, an 8-percent increase from that of 1965. Productive gas wells increased from 17,516 in 1965 to 17,808 in 1966. Estimated proved recoverable reserves of natural gas at yearend totaled 1,351 billion cubic feet, an increase of 94 billion cubic feet from that of 1965. Of the total reserves at yearend, 501 billion cubic feet was held in underground reservoirs for storage purposes.

According to the Oil and Gas Section, Pennsylvania Bureau of Topographic and Geologic Survey, a total of 705 wells were drilled and 34 wells were deepened. Of the 705 wells, 277 were oil wells, 272 gas wells, 52 service wells, and 104 were dry holes. Of the 34 wells drilled deeper, 1 was an oil well, 29 were gas wells, and 4 were dry holes. The total footage of all wells drilled was 1,736,952 feet, of which 1,371,762 was development footage, 255,557 was exploratory footage, and 109,633 feet was service well and miscellaneous drilling. Of the 111 deep wells, 73 were drilled in Erie and Crawford Counties; and of the 73 wells, 68 produce gas from the Medina and 1 produced from the Oriskany. There were 40 gas wells drilled in the Bushnell-Lexington pool and 17 gas wells in the Pierce pool. Of the 583 new shallow wells, 504 were drilled for purposes other than underground storage and secondary-recovery projects, 73 were drilled in secondary-recovery projects, and 4 were drilled for gas storage; 2 wells were stratigraphic tests. Of the 504 wells drilled, 245 were oil wells, 167 gas wells, and 92 dry holes. The total shallow-well footage drilled was 1,088,605 feet, including 24,582 feet of the 34 wells deepened.

Warren County continued to be the most active area with 168 new wells completed in the Glade and Clarendon Sandstones, including 151 oil wells and 17 dry holes. The second most active area was Indiana County with 66 gas wells and 11 dry holes. The Bradford Sandstone zones were the primary objectives. A third area of drilling activity was the Tionesta-Pleasantville area, where the Red Valley was the objective. One steam-flood project is active near Franklin in Venango County, where steam injection has been continued for more than 2 years. Seismic crews logged 68 crew-weeks during the year compared with 65 crew-weeks in 1965. Geological field parties were active in several areas.

NONMETALS

Cement.—Portland cement shipments decreased less than 1 percent from that of 1965 while the average price per 376 pound barrel decreased $0.05 to $2.86. Masonry cement shipments decreased 2 percent from that of 1965 while the average

price per 280 pound barrel remained constant at $2.66. Portland cement was produced at 22 plants during 1966 with a total production capacity of 55.8 million barrels per year, an increase of one plant and 10 percent in total capacity from that of 1965. Masonry cement was produced at 16 plants during 1966.

Shipments of all types of portland cement from the 5 plants in western Pennsylvania totaled 10.8 million barrels at an average price of $3.11 per barrel, of which 91 percent was types I-II (general use and moderate heat) and 3 percent was type III (high-early-strength); 50 percent was shipped to locations in western Pennsylvania, 38 percent to Ohio, 11 percent to West Virginia. Of the total shipped, 9.9 million barrels was by truck, 606,000 barrels by rail, and 263,000 barrels by boat. Shipments of all types of portland cement from the 17 plants in eastern Pennsylvania totaled 29.2 million barrels at an average price of $2.77 per barrel, of which 87 percent was types I-II, 7 percent type III, and 3 percent white cement; 33 percent was shipped to locations in eastern Pennsylvania, 28 percent to New Jersey, 15 percent to New York, 6 percent to Connecticut, and 6 percent to Maryland. Shipments by truck totaled 18.4 million barrels and rail shipments 10.8 million barrels. Portland cement stocks at yearend totaled 1.9 million barrels in western Pennsylvania and 3.7 million barrels in eastern Pennsylvania. Of 11.4 million barrels of portland cement produced in western Pennsylvania, 6.1 million barrels was air-entrained; of 30.8 million barrels produced in eastern Pennsylvania, 6.0 million barrels was air-entrained.

Ready-mixed concrete companies purchased 6.5 million barrels of portland cement shipped from western Pennsylvania and 16.7 million barrels from eastern Pennsylvania; concrete product manufacturers accounted for 1.5 million barrels from the west and 6.5 million barrels from the east; building material dealers for 854,000 barrels from the west and 3.5 million barrels from the east, and highway contractors for 1.4 million barrels from the west and 1.6 million barrels from the east.

Shipments of masonry cement from 5 plants in western Pennsylvania totaled 1.1 million barrels at an average price of $2.77 per barrel, of which 52 percent was shipped to locations in western Pennsylvania, 41 percent to Ohio, 4 percent to West Virginia, and 3 percent to Michigan. Shipments of masonry cement from 11 plants in eastern Pennsylvania totaled 1.9 million barrels at $2.59 per barrel, of which 22 percent was shipped to locations in eastern Pennsylvania, 32 percent to New Jersey, 17 percent to New York, 6 percent to Virginia, 5 percent to Maryland, 4 percent to Connecticut, 4 percent to District of Columbia, 2 percent to Delaware, 1 percent to Ohio, and 1 percent to Wisconsin.

Chief raw materials used for the manufacture of portland cement in western Pennsylvania were limestone and cement rock (3.0 million tons), shale (198,000 tons), blast-furnace slag (143,000 tons), gypsum (88,000 tons) sand (87,000 tons), and diatomite (39,000 tons); in eastern Pennsylvania were limestone and cement rock (8.9 million tons), gypsum (269,000 tons), sand (123,000 tons), clay (95,000 tons), iron ore (20,000 tons), and blast-furnace slag (17,000 tons).

Cement industry in western Pennsylvania purchased 299 million kilowatt-hours of electrical energy and in eastern Pennsylvania purchased 700 million kilowatt-hours in addition to 85 million kilowatt-hours generated.

Northampton County was the leading portland cement producer. Other counties producing cement were Allegheny, Berks, Butler, Lawrence, Lehigh, Montgomery, and York.

Clays.—Production of fire clay totaled 1.6 million tons of which 1.1 million tons was used by producers and 88,000 tons were sold. Total clay production (excluding kaolin) decreased 3 percent in tonnage and 4 percent in value from that of 1965.

Lawrence County continued to be the leading clay producer followed by Clearfield, Beaver, and Berks Counties. Of the total fire clay produced, 46 percent was used for firebrick and block and 39 percent for building brick and other heavy clay products. Of the total miscellaneous clay and shale produced, 84 percent was used for building brick and other heavy clay products and 14 percent was used for portland and other hydraulic cements.

Kaolin was produced in Blair County for firebrick and block and in Cumberland County for white cement.

Table 5.—Clays sold or used by producers, by kinds and uses [1]

(Short tons)

Use	Fire clay		Miscellaneous clay	
	1965	1966	1965	1966
Refractories:				
Firebrick and block	821,411	738,262	-----	-----
Fire clay and mortar	41,125	W	-----	-----
Heavy clay products	612,191	627,370	1,373,089	1,404,763
Portland and other hydraulic cements	-----	-----	221,122	227,120
Undistributed	[2] 232,492	[2] 254,609	[3] 92,792	[3] 40,990
Total	1,707,219	1,620,241	1,687,003	1,672,873

W Withheld to avoid disclosing individual company confidential data.

[1] Excludes kaolin.

[2] Includes exports, art pottery (1966), floor and wall tile, high-alumina brick, mortar (1966), clay crucibles, foundries and steelworks (bulk), other refractories, insecticides and fungicides, other filler, absorbent uses, and other uses.

[3] Includes art pottery, flowerpots, and glaze slip; floor and wall tile; foundries and steelworks (bulk); lightweight aggregate; and linoleum and oilcloth.

Gem Stones.—Mineral specimens were collected chiefly by hobbyists and amateur lapidarists at scattered locations throughout the State.

Graphite.—Production of manufactured (artificial) graphite was discontinued in Pennsylvania.

Iron-Oxide Pigments.—Crude iron-oxide pigments were mined in the form of sulfur mud in Cambria County. Finished iron-oxide pigments were produced and shipped from two plants in Northampton County and one plant in Carbon County. Finished pigments included natural and manufactured black, brown, red, and yellow pigments and mixtures of natural and manufactured red iron oxides.

Lime.—Quicklime and hydrated lime production increased 1 percent in tonnage and value from that of 1965. Of the 1.3 million tons of quicklime produced, only 32,000 tons were for agricultural purposes, and the rest for chemical, refractory, and construction uses. Of the 279,000 tons of hydrated lime produced, 249,000 tons were for chemical and construction and 30,000 tons for agricultural purposes. Quicklime averaged $13.86 per ton and hydrated lime $16.92 per ton. Sixteen plants were operated in 14 counties with Centre County again ranking first in production with three large plants producing quicklime and hydrated lime accounting for 46 percent of the total lime tonnage and 41 percent of the total value. Of the 16 plants, 3 plants sold quicklime, 1 plant used quicklime, 4 plants sold hydrated lime and 8 plants sold quicklime and hydrated lime. Regenerated quicklime was consumed at a pulp and paper plant in Blair County. Of the total lime sold, 61 percent was consumed in Pennsylvania, 12 percent in Maryland, 7 percent in Ohio, 6 percent each in New Jersey and New York, and the remaining 8 percent in 16 other States, District of Columbia, Argentina, Canada, Chile, Jamaica, and Venezuela.

Mica.—Crude scrap mica was produced at a mine in York County for use in paint, roofing, rubber (mold lubricant), welding rods, textile coating, and other.

Perlite (Expanded).—Crude perlite from out-of-State sources was expanded at two plants in Allegheny County, and one plant each in Delaware, Lehigh, Montgomery, and York Counties. Lehigh County again led in expanded perlite production. Most of the expanded perlite was used for building plaster with the remainder for loose fill insulation, concrete aggregate, soil conditioning, fines, cryogenic applications, and filler.

Pyrites.—Pyrite concentrate was recovered by flotation in the milling process for magnetite iron ore in Berks and Lebanon Counties. The concentrate was then shipped to Sparrows Point, Md., for further processing.

Sand and Gravel.—Total sand and gravel production decreased 5 percent in tonnage from that of 1965. Of the total output 50 percent was sand for construction (building, paving, fill, and other uses), 41 percent was gravel for construction (building, paving, railroad ballast, fill, and other uses) and almost 9 percent was unground sand for industrial uses (glass, molding, grinding and polishing, blast, fire or fur-

nace, engine, and other uses). A small amount of ground sand was used for abrasives, chemicals, enamel, filler, glass, pottery, porcelain, tile, foundry, and other uses. The average price per ton for the total sand and gravel production increased from $1.60 in 1965 to $1.68 in 1966.

The leading producing county was Bucks County followed by Erie, Westmoreland, Beaver, Luzerne, and Huntingdon Counties. Company reports on 106 commercial operations in 43 counties showed that 51 percent of the operations produced less than 100,000 tons each for 12 percent of the total tonnage, 24 percent of the operations produced between 100,000 and 200,000 tons each for 21 percent of the total tonnage, 21 percent of the operations produced between 200,000 and 500,000 tons each for 39 percent of the total, 2 percent of the operations produced between 500,000 and 1,000,000 tons each for 7 percent of the total tonnage, and 2 percent of the operations produced over 1,000,000 tons each for 21 percent of the total tonnage.

Of total production, 97 percent was processed; 67 percent was trucked to markets, 26 percent by waterways, and the balance by railroads.

Certificates for outstanding safety records were awarded by the National Safety Competition to the following companies for working without a disabling injury: Tionesta Sand & Gravel, Inc., Tionesta, 27,324 man-hours; General Concrete Products Corp., Warren, 26,344 man-hours; Shippingport Sand & Gravel Co., Shippingport and Georgetown, 25,234 and 24,350 man-hours, respectively; Houdaille Construction Materials, Inc., Portland, 26,297 man-hours; and Milton Grove Sand, Inc., Milton Grove, 21,230 man-hours.

Sericite-Schist.—Two mines in Adams County produced crude sericite-schist, which after processing, was used chiefly for a filler in asphalt and joint cement.

Table 6.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Molding	234	$581	185	$526
Building	5,566	7,575	5,228	7,698
Paving	3,374	4,902	3,362	5,183
Fire or furnace	140	406	87	270
Fill	42	43	20	19
Undistributed [1]	1,492	5,094	1,490	5,054
Total	10,848	18,601	10,372	18,750
Gravel:				
Building	3,522	4,987	3,005	4,346
Paving	3,418	5,241	3,522	5,758
Fill	321	200	328	163
Undistributed [2]	361	511	292	472
Total	7,622	10,939	7,147	10,739
Total sand and gravel	18,470	29,540	17,519	29,489
Government-and-contractor operations:				
Sand: Paving	---	---	7	10
Gravel:				
Paving	32	66	---	---
Other	---	---	41	63
Total sand and gravel	32	66	48	73
All operations:				
Sand	10,848	18,601	10,379	18,760
Gravel	7,654	11,005	7,188	10,802
Total	18,502	29,606	17,567	29,562

[1] Includes glass, grinding and polishing, blast, engine, ground, and other sand.
[2] Includes railroad ballast, miscellaneous, and other gravel.

Stone.—Stone production increased 4 percent in total tonnage from that of 1965 while total value remained almost the same. Crushed stone totaled 58.9 million tons, of which 85 percent was limestone, 7 percent basalt, 4 percent sandstone, and the remaining 4 percent granite, slate, and miscellaneous stone; 58 percent was used for concrete aggregate and roadstone, 11 percent for furnace flux, 2 percent for agricultural purposes, 1 percent for railroad ballast, and the remaining 28 percent for other uses, including cement and lime manufacture, riprap, and limestone dust for coal mines.

Production of dimension stone increased slightly but the value decreased slightly. (See table 7.) Slate accounted for 30 percent of the dimension stone tonnage and 67 percent of its value while sandstone accounted for 37 percent of the tonnage and only 18 percent of the total value.

Northampton County continued to be the leading stone producer followed by Montgomery, Berks, and Lancaster Counties. Stone was also produced in 47 other counties.

Sulfur.—Sulfur was recovered in Delaware County at one refinery using the Claus-type process and at another refinery using single-stage catalytic oxidation of hydrogen sulfide. Hydrogen sulfide was recovered by the Gerbotol process using diethanolamine and monethanolamine, and molten sulfur was recovered by the improved Claus-type process at a plant in Philadelphia County. Another refinery in Philadelphia County recovered sulfur by the Claus process.

Tripoli (Rottenstone).—Tripoli was mined and processed by two companies in Lycoming County for use as an abrasive compound and as a filler material.

Vermiculite (Exfoliated).—Two plants, one in Bucks County and one in Lawrence County, processed crude vermiculite and sold the exfoliated product for a variety of uses, chiefly for insulation, concrete aggregate, and agricultural use.

METALS

Cadmium.—Cadmium was recovered by St. Joseph Lead Co. at its Josephtown plant in Beaver County and by New Jersey Zinc Co. at its Palmerton plant in Carbon County.

Cobalt.—The cobalt content of pyrite concentrate shipments from the magnetite iron ore mines in Berks and Lebanon Counties again showed a slight increase over the previous year.

Columbium and Tantalum.—Columbium and tantalum compounds and metals were produced by Kawecki Chemical Co. in Berks County and Kennametal, Inc., in Westmoreland County from imported ore.

Copper, Gold, and Silver.—Copper concentrate was recovered by flotation of magnetite iron ore mined in Lebanon County and shipped to western refineries for processing. The concentrate also contained gold and silver.

Table 7.—Stone sold or used by producers, by uses

Use	1965		1966	
	Short tons	Value	Short tons	Value
Dimension stone:				
Building stone	90,378	$1,334,311	108,023	$1,471,731
Curbing and flagging	54,623	1,222,054	39,672	803,210
Other uses [1]	29,884	3,536,583	27,233	3,424,837
Total	174,885	6,092,948	174,928	5,699,778
Crushed and broken stone:				
Riprap	535,545	690,514	261,867	460,348
Concrete and roadstone	31,388,647	46,597,053	34,341,170	49,371,631
Furnace flux (limestone)	6,289,387	11,197,022	6,300,021	12,063,633
Railroad ballast	609,816	929,114	620,375	931,310
Agricultural	1,236,490	3,731,886	1,266,862	3,865,644
Other uses [2]	16,571,390	30,388,830	16,122,396	26,840,487
Total	56,631,275	93,534,419	58,912,691	93,533,053
Grand total	56,806,160	99,627,367	59,087,619	99,232,831

[1] Includes roofing slate and millstock.
[2] Includes refractory.

Table 8.—Stone sold or used by producers, by counties

County	1965		1966	
	Short tons	Value	Short tons	Value
Adams, Cumberland	4,558,149	$11,516,082	[1] 1,022,042	[1] $1,493,026
Allegheny, Clarion, Washington	648,356	1,282,643	505,685	1,016,852
Armstrong	326,222	688,284	374,865	783,240
Bedford, Franklin, Fulton	1,926,973	3,696,569	2,008,284	3,874,442
Berks	3,535,373	4,917,995	4,193,398	5,156,998
Blair, Huntingdon	1,751,989	3,864,976	[2] 1,548,793	[2] 2,413,892
Bradford			622	14,130
Bucks	3,367,985	4,614,913	3,359,514	4,429,945
Butler	1,479,334	2,836,027	1,545,155	2,836,619
Cambria	3,000	9,000	13,000	29,750
Carbon, Monroe, Schuylkill	846,089	2,222,169	1,001,854	2,215,703
Centre	2,803,809	4,798,857	2,735,923	4,405,167
Chester	2,665,405	5,671,473	2,390,644	4,910,888
Clearfield, Elk, McKean, Potter	126,582	348,721	[3] 63,799	[3] 249,773
Clinton, Lycoming, Tioga, Union	1,241,377	1,777,675	[4] 1,271,793	[4] 1,831,907
Dauphin	1,094,256	1,736,573	944,610	1,550,200
Fayette, Somerset	1,156,916	2,454,028	1,543,745	3,272,849
Jefferson	18,230	82,180	15,959	65,337
Juniata, Mifflin, Snyder	660,840	936,057	[5] 460,357	[5] 650,542
Lancaster	3,599,565	5,273,131	3,970,226	5,422,535
Lawrence	3,322,735	4,653,231	2,959,272	4,513,284
Lebanon	1,778,070	3,051,168	1,903,329	3,317,489
Lehigh	2,640,717	2,810,401	2,644,281	2,783,264
Luzerne	498,952	832,222	496,652	757,054
Montgomery	4,844,640	7,899,248	4,896,509	8,552,323
Northampton	5,503,516	8,772,578	5,783,588	9,116,035
Northumberland	58,700	95,700	68,840	111,840
Susquehanna	267,364	906,985	184,710	483,622
Wayne	163,756	331,085	123,329	263,696
Westmoreland	756,458	1,330,625	683,264	1,164,874
York	3,442,201	7,130,166	3,734,221	7,625,364
Other counties[6]	1,718,601	3,086,605	6,639,356	14,420,191
Total	56,806,160	99,627,367	59,087,619	99,232,831

[1] Excludes Adams County.
[2] Excludes Huntingdon County.
[3] No production in Clearfield County.
[4] No production in Tioga County.
[5] No production in Juniata County.
[6] Includes Adams (1966), Columbia, Delaware, Huntingdon (1966), Mercer, Montour, Perry, and Wyoming Counties.

Ferroalloys.—Production of ferroalloys decreased 28 percent from that of 1965 and totaled 501,000 tons. Shipments also decreased and amounted to 492,000 tons valued at $97.3 million. There were 10 types (2 less than in 1965) of ferroalloys produced in the State, of which ferromanganese was the most predominant. Other significant ferroalloys produced included ferromolybdenum and spiegeleisen.

Iron Ore.—Usable iron ore production and shipments decreased 12 percent in quantity and 13 percent in value from that of 1965. Shipments were in the form of pellets produced at agglomerating plants located at the magnetite mines in Berks and Lebanon Counties. Crude magnetite was mined underground by block-caving methods. Most of the iron ore pellets were shipped to company-owned iron and steel plants in Pennsylvania and Maryland.

Iron and Steel.—Production of pig iron totaled 21.7 million tons, of which 92 percent was basic, and the remainder Bessemer malleable, low phosphorus, foundry, direct castings, and an offgrade.

Receipts of iron ore totaled 28.3 million tons, 65 percent from foreign countries and 35 percent from domestic production. Consumption of iron ore totaled 26.8 million tons, 51 percent by agglomerating plants, 44 percent by blast furnaces, and the remainder by steel furnaces. Iron ore stock at beginning and end of year were 10.6 million tons and 11.2 million tons, respectively. Fluxes consumed by the iron and steel industry included 2.9 million tons of limestone, 3.2 million tons of dolomite and 980,000 tons of other type fluxes. Other materials consumed included 1.5 million tons of mill cinder and roll scale, 880,000 tons of raw flue dust, 1.5 million tons of steel furnace slag, 14.1 million tons of net coke, 690,000 tons of coke breeze, and 370,000 tons of anthracite. Steel furnaces consumed 18.7 million tons of pig iron and

hot metal, 11.2 million tons of home and purchased scrap, and 160,000 tons of slag scrap. Blast furnaces consumed 930,000 tons of home and purchased scrap, 230,000 tons of slag scrap, and 50,000 tons of pig iron and hot metal.

Agglomerates consumed in blast furnaces totaled 21.4 million tons, of which 67 percent was United States sinter (regular), and the remaining 33 percent was iron pellets (regular), semi-fluxing and self-fluxing sinter, foreign iron ore, and other agglomerates. Agglomerates consumed in steel furnaces totaled 400,000 tons, of which most were iron ore pellets (regular). Slag produced at blast furnaces totaled 6.4 million tons, scrap produced 160,000 tons, and flue dust recovered 940,000 tons.

Ten companies operated 20 plants. Fifty-one blast furnaces were operated at some time during the year, compared with 54 blast furnaces in 1965.

According to the American Iron and Steel Institute, steel production (ingots and steel for castings) totaled 32.1 million tons. Of the total steel production, 23.6 million tons were from open hearth and Bessemer, 5.2 million tons from basic oxygen process, and 3.3 million tons from electric furnaces. Production of hot-rolled steel products totaled 23.5 million tons; merchant bars and light shapes, 2.8 million tons; concrete reinforcing bars, 811,000 tons; wire rods, 962,000 tons; and blanks, tube rounds or pierced billets for seamless tubing, 1.9 million tons.

Smelters.—Zinc concentrates were shipped to smelters at Josephtown in Beaver County and at Palmerton in Carbon County. Zinc concentrates shipped to the Josephtown smelter came from New York, Missouri, Illinois, Tennessee, Canada, and Peru. Zinc concentrates and crude ore shipped to the Palmerton smelter came from New Jersey, New York, Pennsylvania, Tennessee, Indiana, Virginia, Colorado, and various foreign countries. Products from the Josephtown smelter included zinc metal, lead-free zinc oxide, cadmium metal, and sulfuric acid, which were used in such consumer items as galvanized ware, die castings, and brass in the case of zinc; paint, rubber, ceramics, and pharmaceuticals in the case of zinc oxide; and protective coatings, bearings, and atomic uses in the case of cadmium. Products from the Plamerton smelter included slab zinc, zinc base die casting alloys, zinc oxide, rolled zinc, dry-battery shells, cadmium, and spiegeleisen.

The Josephtown smelter increased its output of zinc equivalent in 1966 to a record 216,910 tons from 202,657 tons in 1965. Slab zinc production and zinc oxide sales increased significantly in 1966. Industry use of zinc in brass and galvanizing increased. Galvanizing, which provides a zinc skin on steel for many years of maintenance-free protection, has recently been adopted in bridge construction. The Josephtown smelter, which operated at capacity throughout the year, increased that capacity in late March with installation of a new furnace able to produce 100 tons of zinc metal per 24-hour period. Zinc oxide production facilities were also increased, and the company developed a new method for shipping zinc oxide in airtight, 5-ton-capacity rubber containers, ensuring purity of the product on delivery. A new 250-ton-per-day sulfuric acid unit, to replace one of the original ones, is now under construction.

Zinc.—Production of zinc ore (based on the recoverable zinc metal tonnage and value as metal established after transportation, smelting, and manufacturing charges have been added to the value of the ore at the mine) increased slightly over that of 1965. The zinc ore was concentrated at the mine in Lehigh County and the concentrates were shipped to the company's smelter in Carbon County.

REVIEW BY COUNTIES

Adams.—Bethlehem Mines Corp.'s new 600-ton-per-day lime plant located at the firms Hanover limestone quarry was in full-scale production. Stone from the quarry is calcined by three calcimatic kilns and the lime shipped 55 miles to the Sparrows Point steel plant. The Dravo Corp. has overall responsibility for the project. In addition to supplying the lime plant, limestone produced at the quarry was sold for use as flux, concrete aggregate, roadstone, railroad ballast, agricultural purposes, clay filler, and stone sand. Limestone also was produced near Gettysburg by

Table 9.—Value of mineral production in Pennsylvania by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value [2]
Adams	W	W	Lime, stone, sericite schist, clays.
Allegheny [3]	$28,042,471	$32,983,953	Coal, cement, clays, sand and gravel, stone.
Armstrong	22,687,658	25,138,199	Coal, clays, sand and gravel, stone, lime.
Beaver	4,449,172	3,639,419	Sand and gravel, coal, clays.
Bedford	W	W	Stone, coal, lime, sand and gravel.
Berks	W	W	Iron ore, cement, stone, clays, cobalt, coal, pyrites, sand and gravel.
Blair	2,180,478	W	Stone, coal, clays.
Bradford	389,510	664,920	Sand and gravel, coal, stone.
Bucks	W	W	Sand and gravel, stone, clays.
Butler [4]	11,218,902	12,480,210	Coal, cement, stone, lime, sand and gravel.
Cambria	51,336,952	W	Coal, clays, stone, iron ore (pigment material).
Cameron	W		
Carbon	4,624,670	4,885,309	Coal, stone, sand and gravel, peat.
Centre	W	16,396,017	Lime, stone, coal, sand and gravel, clays.
Chester [5]	5,791,473	5,036,388	Stone, lime, clays.
Clarion	12,993,341	13,745,918	Coal, stone, sand and gravel, clays.
Clearfield	29,679,981	29,232,088	Coal, clays, sand and gravel.
Clinton	W	2,942,513	Coal, stone, clays.
Columbia	W	3,850,214	Coal, sand and gravel, lime, peat, stone.
Crawford	308,000	429,000	Sand and gravel.
Cumberland	W	W	Stone, sand and gravel, clays.
Dauphin	3,591,208	3,611,118	Stone, coal, clays, sand and gravel, lime.
Delaware	W	W	Stone.
Elk	W	W	Coal, stone.
Erie	W	W	Sand and gravel, peat.
Fayette	10,640,146	8,993,792	Coal, stone, clays, sand and gravel.
Forest	W	310,000	Sand and gravel.
Franklin	1,402,981	1,636,365	Stone, sand and gravel.
Fulton	W	W	Stone, sand and gravel.
Greene	W	W	Coal, clays.
Huntingdon	5,578,588	W	Sand and gravel, stone, coal, clays.
Indiana	W	W	Coal, clays.
Jefferson	8,400,759	W	Coal, clays, stone, sand and gravel.
Juniata	W		
Lackawanna	W	W	Coal, sand and gravel, peat.
Lancaster	7,926,777	8,245,104	Stone, coal, clays, sand and gravel.
Lawrence	W	W	Cement, stone, coal, clays, sand and gravel.
Lebanon	22,776,493	21,571,924	Iron ore, stone, lime, copper, cobalt, coal, pyrites, gold, silver.
Lehigh	[3] 10,824,551	29,017,306	Cement, zinc, stone.
Luzerne	W	40,677,402	Coal, sand and gravel, stone, peat, clays.
Lycoming	2,083,702	2,091,560	Stone, sand and gravel, coal, tripoli.
McKean	392,657	407,675	Clays, stone, coal, sand and gravel.
Mercer	W	2,476,343	Coal, sand and gravel, stone.
Mifflin	W	W	Sand and gravel, stone, lime.
Monroe	655,616	771,072	Stone, clays, sand and gravel, peat.
Montgomery	W	W	Stone, cement, lime, clays, sand and gravel.
Montour	W	W	Stone.
Northampton	60,458,181	57,326,162	Cement, stone, sand and gravel.
Northumberland	12,458,825	W	Coal, clays, stone, lime.
Perry	W	W	Stone.
Philadelphia	W	W	Sand and gravel.
Potter	W	W	Stone.
Schuylkill	43,796,225	37,123,723	Coal, stone, sand and gravel, clays.
Snyder	455,499	477,304	Stone, sand and gravel, coal.
Somerset	18,054,987	19,403,385	Coal, clays, stone, sand and gravel.
Sullivan	127,095	114,975	Coal.
Susquehanna	927,083	492,787	Stone, coal.
Tioga	1,764,081	2,504,665	Coal, sand and gravel.
Union	W	W	Stone.
Venango	W	2,359,860	Coal, sand and gravel.
Warren	470,000	644,000	Sand and gravel.
Washington	W	W	Coal, stone.
Wayne	713,085	W	Stone, sand and gravel.
Westmoreland	W	W	Coal, sand and gravel, stone, lime, clays.
Wyoming	758,817	720,319	Sand and gravel, stone.
York [4]	7,986,401	8,924,263	Cement, stone, lime, clays, sand and gravel, mica.
Undistributed [6]	517,876,635	502,082,440	
Total	913,823,000	903,408,000	

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

[1] Pike County is not listed because no production was reported.

[2] Excludes value of natural gas, natural gasoline, LP gases, petroleum, and gem stones unspecified by counties; included with "Undistributed."

[3] Excludes cement; included with "Undistributed."

[4] Excludes cement and lime; included with "Undistributed."

[5] Excludes lime; included with "Undistributed."

[6] Includes values indicated by symbol W.

Teeter Stone Division of H. T. Campbell Sons Corp. for use as concrete aggregate and roadstone. The Ruberoid Co. produced roofing granules and crushed stone for tennis court surfacing and asphalt filler from basalt rock quarried near Charmian. Summit Industries, Inc., mined crude sericite-schist from their Bendersville and Mount Hope mines, to be crushed, screened, and ground chiefly for use as an asphalt and joint cement filler at their plant near Aspers.

Undifferentiated clay and shale was produced for manufacturing building brick by Alwine Brick Co. near New Oxford.

Allegheny.—Bituminous coal production increased 6-percent over that of 1965. Underground production totaled 4.2 million tons, 3.6 million tons of which was not sold on the open market. Of the 14 underground operations, 11 loaded coal mechanically; 20 continuous miners with 14 mobile loaders produced 3.5 million tons; 22 mobile loaders produced 642,000 tons. Cutting machines cut 651,000 tons. Strip mines reported 27 power shovels, 9 draglines, 26 bulldozers, 11 power drills, and 37 trucks. Auger mines reported two augers, one bulldozer, and two trucks. Five preparation plants prepared 3.6 million tons of clean coal, 3.1 million tons of which was mined underground. Coal crushed totaled 4.2 million tons and coal treated totaled 2.4 million tons.

Portland and masonry cements were produced by Universal Atlas Cement Division, United States Steel Corp., near Universal and by Green Bag Cement Co., Division of Marquette Cement Manufacturing Co., near Pittsburgh. Most of the portland cement produced was of the general use and moderate heat type, but some high-early-strength type was also produced. Portland cement output was almost evenly divided between air-entrained and non-air-entrained. Most of the cement was shipped in bulk by truck. Primary customers were ready-mixed concrete companies.

Shale was produced near Wilkinsburg for manufacturing building brick by Milliken Brick Co., Inc., at its Wilkinsburg and Pitcairn plants. Undifferentiated clay and shale were produced near Creighton for building brick manufacture by Glassmere Brick & Tile Co. Sand and gravel was recovered near Harmarville by McCrady, Inc., for paving purposes and industrial sand for foundry uses. Foundry sand was also recovered by Sidwell Loam Sand Co. near Pittsburgh. Bank sand for paving purposes was recovered by Burrell Construction and Supply Co. near Natrona Heights. Sandstone was quarried by Malli's Stone Quarry near Finleyville for stone walls and patio flagging and by Nick Gioia near Elizabeth for irregular-shaped stone for construction work. Expanded perlite, mainly for use in building plaster and loose fill insulation, was produced by Panacalite Perlite Co. near Pittsburgh and Perlite Manufacturing Co. near Carnegie. Clover Chemical Co. again reported an increase in the production of organic and inorganic iodine compounds from out-of-State crude iodine at a plant near Pittsburgh. Satellite Alloy Corp. manufactured silicon carbide near Springdale for use as a metallurgical-grade abrasive.

Armstrong.—Bituminous coal production totaled 5.4 million tons, a 12-percent increase over that of 1965. Of the total, 3.7 million tons was from underground mines, 1.5 million tons from strip mines, and 200,000 tons from auger mines. Of the underground production almost all of the tonnage was loaded mechanically by 20 continuous miners and 38 mobile loaders at 35 operations; 56 cutting machines cut 2.1 million tons. Strip mines had 51 power shovels, 21 draglines, 54 bulldozers, 1 carryall scraper, 9 power drills and 114 trucks. Auger mines reported 12 augers, 4 bulldozers, 1 power drill, and 28 trucks. Seven preparation plants prepared 2.7 million tons of coal, most of which was produced from underground mines. Coal crushed totaled 2.5 million tons, and coal treated totaled 280,000 tons. Miscellaneous clay and shale was produced by Logan Clay Products Co. near Worthington for manufacturing vitrified sewer pipe at their Graff-Kittanning Division plant and drain tile at their Worthington Ceramics Division plant. Plastic fire clay was produced near Kittanning by both Howmet Corp. for the manufacture of firebrick and block, and Continental Clay Products Co. for building brick and other heavy clay products; near Adrian by Freeport Brick Co., Kittanning Brick Division, for pouring pit refractories; near Freeport, by Freeport Brick Co. for manufacturing firebrick; and near Templeton by Harbison-Walker Re-

fractories Co. for firebrick and block manufacture. Sand and gravel was recovered by Glacial Sand & Gravel Co. near Tarrtown; Manorville Sand Co., at Manorville; John Cihat, near Leechburg; and Emlenton Limestone Co., Inc., near Parker.

Limestone was produced near Kittanning by Manor Minerals, Inc.; in West Franklin Twp. by Black Limestone Co.; near Kittanning by C. D. McCanna; and near McWilliams and Girty by Mowrey & Good.

Beaver.—Building sand and gravel was recovered by a dredge in the Ohio River near Vanport by Dravo Corp., Keystone Division. Iron City Sand & Gravel Corp., dredged sand and gravel near Georgetown but ceased operations at this location at the end of June and moved to Hancock County, W. Va. Shippingport Sand & Gravel Co. recovered building sand and gravel at operations located near Georgetown and Shippingport. Shale was recovered near Darlington by Ralph A. Veon, Inc., for building brick manufacture. Plastic fire clay was produced for brick manufacture near New Brighton by Standard Clay Manufacturing Co. and by Colonial Clay Products Co. and Eastvale Clay Products Co. from respective underground mines near Fallston and Beaver Falls. Semiflint clay was produced by Darlington Brick Co., Division of General Dynamics Corp., at its Elsman and Cain mines near Darlington for brick manufacture.

Strip mines producing bituminous coal reported using 10 power shovels, 5 draglines, 11 bulldozers, 1 power drill, and 8 trucks. The underground operation reported two mobile loaders loading into shuttle cars and one cutting machine. Auger mines reported the use of three augers and four trucks.

Bedford.—Limestone was produced near Everett by New Enterprise Stone & Lime Co. and by Bedford County Stone & Lime Co. near New Paris for use as concrete aggregate, roadstone, lime manufacture, and dust for coal mines. Crushed quartzite was produced by Leap Ganister Rock Co. at their Leap No. 1 quarry near Madley for refractory purposes and abrasives. Crushed sandstone was produced by Detwilers Industries, Inc., near Imler for concrete aggregate and roadstone. All bituminous coal production was shipped by truck; one continuous miner and two hand-loaded face conveyor loaded coal mechanically. Five cutting machines cut 5,400 tons and 20,000 tons was shot from the solid or cut by hand. Strip mines reported six power shovels, two draglines, eight bulldozers, one power drill, and five trucks.

Berks.—Crude magnetite ore was mined by Bethlehem Mines Corp. at its Grace mine near Morgantown. At the mine site the ore was crushed and ground, magnetically separated and the fine-sized material pelletized. Pyrite and copper concentrates were recovered by flotation and shipped to the company's Sparrows Point, Md., plant for processing. Allentown Portland Cement Co., Division of National Gypsum Co., produced portland and masonry cements, most of which was non-air-entrained, general use and moderate-heat type portland cement. Limestone for the cement plant came from company quarries near Oley and Evansville. Limestone also was produced near Kutztown by Keystone Quarry Co.; near Oley and Kutztown by Eastern Industries, Inc.; and near South Temple by Berks Products Corp. Output was used principally for concrete aggregate, roadstone, agricultural purposes, and railroad ballast. Basalt was produced by The John T. Dyer Quarry Co., near Birdsboro and by Pottstown Trap Rock Quarries, Inc., near Douglassville for railroad ballast, concrete aggregate, roadstone, and riprap. Bradford Hills Quarry, Inc., crushed traprock from the Grace mine near Morgantown for concrete aggregate and roadstone.

Martin Stone Quarries produced sandstone near Bechtelsville for concrete aggregate and roadstone. Reading Poultry Food Co. processed oystershell near Reading for mineral food and poultry grit. Shale was produced by Glen-Gery Shale Brick Corp. near Shoemakersville and Wyomissing for the manufacture of building brick.

Sand was recovered by Berks Silica Sand Corp., near Kutztown and processed in a stationary plant for building purposes.

Blair.—Limestone for use principally as concrete aggregate, roadstone, agricultural purposes, and asphalt filler, was produced by the following firms: Seymore Bros., Inc., Duncansville; Sproul Lime & Stone Co., Claysburg; Narehood Bros., Inc., Tyrone; New Enterprise Stone & Lime Co., Canoe Creek and Roaring Spring; Grannas Bros. Stone & Asphalt Co., Inc., Hollidaysburg;

and Eldorado Stone Co., Altoona. Quartzite was produced by Basalt Traprock Co. near Williamsburg for railroad ballast and by J. L. Hartman near Sproul for the manufacture of silica brick. Silica pebble rock was produced by General Refractories Co. at its Frankstown quarry near Hollidaysburg for silica brick manufacture and sandstone was crushed by Frankstown Sand Supply near Hollidaysburg for mason sand and building purposes. Plastic fire clay was produced at the Butler Mine near Williamsburg for the manufacture of firebrick and block by Harbison-Walker Refractories Co. Kaolin was produced near Williamsburg by Grannas Brothers for the refractory firebrick manufacture. West Virginia Pulp & Paper Co. regenerated quicklime in secondary recovery operations for use in the manufacture of paper at its Tyrone plant.

All underground production of bituminous coal was shot from solid or cut by hand. The strip operation reported 1 power shovel, 1 dragline, and 2 bulldozers.

Bradford.—Sand and gravel was produced at two operations near Towanda by State Aggregates, Inc., for building, paving, fill, and antiskid uses. Martin Stone Quarries near Sugar Run quarried bluestone for flagging. Bituminous coal was produced at only one strip mine on Sand Run reporting 2 draglines, 1 power shovel, 1 bulldozer, and 2 trucks.

Bucks.—Warner Co. recovered sand and gravel at its Van Sciver plant near Tullytown, mostly for use in ready-mixed concrete. Sand and gravel, principally for building purposes also was recovered by: Penn Valley Crushed Stone Co. at a stationary plant near Levittown; A. L. Lewis, Inc., at its plant No. 1 near New Hope and at its new plant No. 4 near Uhlerstown; Frank Casilio & Sons, Inc., and Durnan & Good, Inc., at Upper Black Eddy; and Silvi Concrete Products near Tullytown. Limestone was produced by New Hope Crushed Stone & Lime Co., near New Hope; Eureka Stone Quarry, Inc., near Eureka; Lester L. & Jack L. Kauffman near Rushland; and Bituminous Service Co., near Buckingham for concrete aggregate and roadstone. Better Materials Corp., produced argillite near Penns Park for concrete aggregate and roadstone. Gill Quaries, Inc., crushed bluestone near Trevose for concrete aggregate and roadstone.

Basalt for concrete aggregate and roadstone was produced by Joseph Ciccone & Sons near Weisel; Vernon B. Horn near Chalfont; Edison Quarry near Edison; Bucks County Crushed Stone, Inc., near Ottsville; Derstine & Swartley near Telford; and The General Crushed Stone Co., near Quakertown. Coopersburg Granite Co. quarried basalt near Springfield which was finished for use as precision surface plates, architectural work and monuments. George Wiley crushed sandstone near Point Pleasant for concrete aggregate and roadstone. Dimension sandstone was quarried near Lumberville by Delaware Quarries for cut architectural stone and flagging. Shale was produced near Quakertown by Quakertown Brick & Tile Co., Inc., for the manufacture of building brick. Hyzer & Lewellen produced exfoliated vermiculite near South Hampton for use in home insulation, concrete aggregate, horticulture, plaster aggregate, and miscellaneous items.

Butler.—Underground production of bituminous coal totaled 556,000 tons cut by 17 cutting machines and 97-percent mechanically loaded by 8 mobile loaders and 3 hand-loaded face conveyors. Strip mines produced 1.5 million tons with 38 power shovels, 30 draglines, 3 carryall scrapers, 55 bulldozers, 22 power drills, and 125 trucks. Auger production totaled 133,000 tons with 8 augers and 9 trucks. Five preparation plants cleaned 805,000 tons of coal. Fourteen mine tipples crushed 1.2 million tons and two plants treated 94,000 tons of coal. Penn-Dixie Cement Corp. produced portland and masonry cements at its plant near West Winfield from limestone and industrial sand quarried nearby. Most of the portland cement was general use and moderate heat type, air-entrained and non-air-entrained, with a small amount of high-early-strength type also produced. Limestone also was produced by Sechan Limestone Co. near Portersville; Allegheny Mineral Corp., near Harrisville; Winfield Lime & Stone Co., Inc., near West Winfield; and Grove City Limestone Co., near Branchton. Output was used for concrete aggregate, roadstone, agricultural purposes, and blast furnace flux.

Mercer Lime & Stone Co. produced mostly quicklime for consumption in steel furnaces. Sandstone was quarried near Boyers by Annandale Sandstone Co., Division of

North Star Coal Co., for architectural purposes. Sand and gravel was recovered near Slippery Rock by Highway Sand & Gravel Co., Inc., and H. W. Cooper.

Cambria.—Underground mines produced 7.1 million tons of bituminous coal, 7.0 million tons of which was loaded mechanically at 35 mines with 89 continuous miners, 16 mobile loaders (of which 5 were used with continuous miners), and 32 hand-loaded face conveyors. Seventy-one cutting machines cut 873,000 tons. Strip mines reported 25 power shovels, 19 draglines, 27 bulldozers, 8 power drills, and 45 trucks. Auger mines reported 4 augers and 3 trucks. Ten preparation plants prepared 6.2 million tons of clean coal, most of which was mined underground. Twenty-two mine tipples crushed 4.2 million tons and eight plants treated 435,000 tons.

Miscellaneous clay was mined near Johnstown by Triangle Clay Products Co. for building brick manufacture. Plastic fire clay for use in manufacturing firebrick and block was mined from an underground coal mine near Patton by the Buck Hill Coal Co. and from the Frick mine near Blandburg by Harbison-Walker Refractories Co. Crushed sandstone was produced by Samuel Nicosia near Johnstown for silica brick manufacture and road sand. Sulfur mud for yellow iron oxide pigments was produced by Lanzendorfer Minerals Co. near Twin Rocks.

Carbon.—North American Refractories Co. produced quartzite for silica brick manufacture at its Little Gap quarry near Palmerton. Fauzio Brothers produced sandstone at its Red Rock quarry near Nesquehoning for concrete aggregate and roadstone. Sand for construction and industrial uses was recovered and processed by Alliance Sand Co., Division of Martin Marietta Corp., near Plamerton. Refractory Sand Co., Inc., processed sand for paving purposes near Andreas. Humus peat was produced by Blue Ridge Soil Pep (Hawk's Bog) near Weatherly and sold in bulk for general soil improvement. The Prince Manufacturing Co. reported production of finished natural black, brown, red, and a small amount of yellow pigments from its operation near Bowmanstown.

Centre.—The county continued as the leading lime-producing area. Most of the production was quicklime for chemical and other industrial uses, chiefly for steel furnaces and paper and pulp mills. Limestone for a variety of construction, industrial, and agricultural uses was produced by Neidigh Bros. Limestone Co., Inc., near State College; Standard Lime & Refractories Co. Division and Appalachian Stone Division, of Martin Marietta Corp., both near Pleasant Gap; National Gypsum Co., and Warner Co., both near Bellefonte; and Black Hawk Limestone, Inc., near Centre Hall. Plastic fire clay was produced from the Blair mine near Stormstown for manufacturing firebrick and block by Harbison-Walker Refractories Co.

Strip mines producing bituminous coal reported 17 power shovels, 10 draglines, 16 bulldozers, 7 power drills, and 37 trucks. Three of the 4 underground operations loaded 257,000 tons of coal mechanically with 1 mobile loader, 1 continuous miner, and 3 hand-loaded face conveyors. Four cutting machines cut 180,000 tons. Two preparation plants prepared 498,000 tons of clean coal. Four mine tipples reported 618,000 tons of coal crushed.

Chester.—Limestone was produced near Downingtown by Bradford Hills Quarry, Inc., near Paoli and Devault by Warner Co. and near Malvern by the Appalachian Stone Division, Martin Marietta Corp. Output was used for concrete aggregate, roadstone, lime manufacture, agricultural purposes, and other uses. Basalt was crushed by V. DiFrancesco & Sons near Devault for concrete aggregate and roadstone. Dimension basalt was quarried by French Creek Granite Co. near Saint Peters for rough and dressed building stone.

Sandstone was quarried by Albert Rotunno near Avondale for construction work, curbing and flagging; by Valley Forge Building Stone Co., near Malvern, for construction and architectural work; and by John Fecondo & Sons and Abram T. Minor, both near Avondale, for construction work and flagging. Warner Co. produced high-magnesium lime at its Cedar Hollow plant near Devault, mostly for sewage and trade-wastes treatment. Undifferentiated clay and shale was produced near Phoenixville by McAvoy Vitrified Brick Co. for manufacturing building brick.

Clarion.—Strip mines accounted for 3.2 million tons of bituminous coal produced

and reported 60 power shovels, 39 draglines, 62 bulldozers, 15 power drills, and 115 trucks. One of the 3 underground mines loaded coal mechanically with 1 continuous miner loading onto conveyors. Six preparation plants prepared 2.5 million tons of clean coal, most of which was strip coal. Twelve mine tipples crushed 2.9 million tons of coal and 5 plants treated 94,000 tons with calcium chloride or oil. Limestone was produced near Turkey City by Emlenton Limestone Co., Inc., and near Parker by Allegheny Mineral Corp. for concrete aggregate, roadstone, agricultural purposes, and cement manufacture.

Plastic fire clay was produced at the Mayport Clay Works near New Bethlehem by Frank B. Pope Co. for manufacture of mortar, and from various open pits near Corsica by W. P. Stahlman Coal Co., Inc., for manufacturing clay crucibles. New Bethlehem Tile Co. produced fire clay and shale near New Bethlehem for the manufacture of brick and other heavy clay products. Sand and gravel was processed near Parker for building, paving, fill, antiskid, and recreational purposes by Glacial Sand & Gravel Co.

Clearfield.—Strip mines accounted for 5.9 million tons of bituminous coal produced and reported 142 power shovels, 90 draglines, 132 bulldozers, 60 power drills, and 350 trucks. At 21 of the 38 underground mines 1,159,000 tons of coal was loaded mechanically with 14 continuous miners, 8 mobile loaders, and 17 hand-loaded conveyors. Forty-two cutting machines cut 486,000 tons. Auger mines reported 9 augers, 9 power drills, and 11 trucks. Eight preparation plants prepared 2.9 million tons of clean coal 2.2 million tons of which was from strip mines. Thirty-one mine tipples crushed 3.8 million tons and 8 plants treated 193,000 with oil or calcium chloride.

Fire clay for manufacturing firebrick and block, high alumina brick, and mortar was produced by Harbison-Walker Refractories Co. at the Shimmel underground and Bigler open-cut mines near Bigler, Korb open-cut mine near Grampian, Woodland open-pit near Woodland, and Passmore open-cut mine near West Decatur. Plastic fire clay was produced by Thomas Brothers near Curwensville, for use in manufacturing ladle brick by Falls Creek Refractories Co., Falls Creek; Clearfield Clay Products Co., Clearfield; and Blair Clay Products, Inc., Altoona. Other producers of plastic fire clay included: Hiram Swank's Sons, Inc., near Boardman; Lansberry Coal & Excavating Co. near Woodland; and A. P. Green Refractories Co., near West Decatur. Bartell Excavating, Inc., produced plastic fire clay in Knox Township for high-alumina brick but closed their pit early in the year. Williamsgrove Clay Products Co., Inc., produced plastic fire clay and some undifferentiated clay and shale for firebrick and block and building brick near Bigler. Reese Brothers Coal Co. produced flint and plastic fire clay near Osceola Mills for manufacturing firebrick and block. American Vitrified Products Co., produced undifferentiated clay and shale near Clearfield for manufacturing vitrified sewer pipe. Flint fire clay was produced near Curwensville by Union Clay Co., Inc., for use in manufacturing portland and other hydraulic cements.

Clinton.—Strip mines producing bituminous coal reported 12 power shovels, 4 draglines, 13 bulldozers, 2 power drills, and 30 trucks. Three tipples reported 534,000 tons of crushed coal. Limestone was produced near Salona by Lycoming Silica Sand Co. for concrete aggregate, roadstone, and railroad ballast. Flint fire clay was produced near Lock Haven by R. C. Gillen & Son and by Fink & Stackhouse near Farrandsville. Mill Hall Clay Products, Inc., produced shale near Castanea for the manufacture of heavy clay products.

Columbia.—Sand and gravel was recovered and processed by Bloomsburg Sand & Gravel Co., Inc., near Bloomsburg, and by A. Barletta & Sons near Mifflinville. Limestone was produced near Lime Ridge by Baker Stone Co., for lime manufacture. Moss and humus peat was produced by Benton Peat, Inc., near Benton for general soil improvement.

Cumberland. — Limestone, for concrete aggregate, roadstone and agricultural purposes, was produced by: Valley Quarries, Inc., near Shippensburg; Pennsy Supply, Inc., near Bowmansdale and in Silver Springs Township; Bonny Brook Quarries near Carlisle; Locust Point Quarries, Inc., near Mechanicsburg; and Hempt Bros., Inc., near Camp Hill. Sand and gravel for

building and paving purposes was recovered and processed by R. A. Bender & Son near Mt. Holly Springs; C. and L. Goodhart, at Walnut Bottom; and Hempt Bros., Inc., near Mt. Holly Springs. White kaolin was produced near Mt. Holly Springs by The Philadelphia Clay Co. for use in the manufacture of portland and other hydraulic cements. Stoneware clay was processed through kilns by Penn Products Corp. near Boiling Springs for black ceramic floor tile and art pottery.

Dauphin.—Limestone was produced near Hummelstown by George E. Ebersole & Sons; near Palmyra by H. E. Millard Lime & Stone Co.; and near Steelton and Harrisburg by Hempt, Bros., Inc. High-calcium hydrated lime for agricultural purposes was produced by H. E. Millard Lime & Stone Co., at its Swatara plant. Basalt was crushed by Faylor Lime & Stone Co., near Elizabethville for concrete aggregate and roadstone. Shale was produced at operations near Harrisburg and Middletown by Glen Gery Shale Brick Corp. for the manufacture of facebrick. Sand and gravel was recovered and processed at a stationary plant near Duncannon by Pennsy Supply, Inc.

Delaware.—Basalt was crushed for concrete aggregate and roadstone by The General Crushed Stone Co., near Glen Mills and by V. DiFrancesco & Sons near Havertown. Dimension sandstone was quarried by Media Quarry Co., near Media. Dimension granite was quarried at two locations near Marple by Carl Galantino, Inc., for use in construction and architectural work. Dimension mica schist was quarried by Di Bonaventura Quarries, Inc., near Springfield for rough building stone and by F. Cantono & Sons at their Foxcroft quarry near Broomall for dressed building stone and rubble.

The Insul-Fil Manufacturing Company, formerly known as Perlite Products Company, expanded perlite near Primos chiefly for use in building plaster. Sinclair Refining Co., at its Marcus Hook refinery, produced liquid sulfur as a byproduct, using a Claus-type process. Sun Oil Co., Marcus Hook, produced byproduct sulfur in single stage catalytic oxidation of hydrogen sulfide.

Elk.—Strip mines accounted for 325,000 tons of bituminous coal and reported 16 power shovels, 6 draglines, 17 bulldozers, 4 power drills, and 26 trucks. Six of the 9 underground mines loaded 102,000 tons mechanically with 1 continuous miner, 2 mobile loaders, and 7 hand-loaded face conveyors. Thirteen cutting machines cut 96,000 tons. Auger mines reported 4 augers, 1 bulldozer, and 7 trucks. No preparation plants were reported in operation, but 3 mine tipples crushed 172,000 tons of coal. Crushed sandstone for concrete aggregate and roadstone was produced by Clark Construction Co., near Johnsonburg.

Erie.—Sand was recovered by dredging near Erie for sale to wholesalers by Erie Sand Steamship Co. Sand and gravel also was recovered by Nickel Plate Sand & Gravel Co., near Fairview; Quirk Excavating at a stationary plant near Union City; Clark Construction Supply Co., Inc., at a stationary plant near Erie; North Girard Concrete Works at a plant near Lake City; and Peerless Mineral Products Co., near Springfield. Humus and reed-sedge peat was produced by Corry Peat Products Co., near Corry for general soil improvement.

Fayette.—Three of the 16 underground mines loaded 511,000 tons of bituminous coal mechanically with 7 continuous miners and 5 mobile loaders (of which 4 were used with continuous miners). Strip mines accounted for 283,000 tons and reported 25 power shovels, 3 draglines, 27 bulldozers, 10 power drills, and 19 trucks. The auger mine reported one auger, one power drill, and two trucks. Four preparation plants prepared 5.3 million, mostly from underground mines in Greene County. Five mines tipples crushed 858,000 tons.

Limestone was produced near Lake Lynn and Uniontown by Appalachian Stone Division, Martin Marietta Corp. for concrete aggregate, roadstone, agricultural purposes and for coal mine dust. Commercial Stone Corp., produced limestone near Belle Vernon for riprap, concrete aggregate, and roadstone. Bluestone was produced near Connellsville by Connellsville Bluestone Co. for concrete aggregate and roadstone. Quartzite ganister was produced by General Refractories Co., near Layton for the manufacture of silica brick. Shale was produced near Layton by Layton Fire Clay Co. for building brick manufacture. Flint and plastic fire clay for manufacturing firebrick and high alumina brick was produced at the Ohiopyle strip near Union-

town by Kaiser Refractories, Division of Kaiser Aluminum & Chemical Corp., and by Robert N. Matthews from his Gettemy strip near Uniontown. Flint fire clay was produced near Ohiopyle by Harbison-Walker Refractories Co. for the manufacture of firebrick and block. Sand and gravel was recovered by dredging near Point Marion for building and paving purposes by McClain Sand Co., Inc.

Franklin.—Limestone was produced near Chambersburg by Valley Quarries, Inc.; near Dry Run by New Enterprise Stone & Lime Co.; and near Williamson and Zullinger by Appalachian Stone Division, Martin Marietta Corp.; J. R. Zeek quarried dimension sandstone near Orrstown for construction work. Sand was recovered and processed for building purposes by Mt. Cydonia Sand Co., Inc., at a stationary plant near Fayetteville. Caledonia Sand Co. recovered bank-run sand for building purposes near Fayetteville.

Greene.—Most of the tonnage of bituminous coal produced was from underground mines and not sold in the open market. Seventeen of the 20 underground mines loaded 12.0 million tons of coal mechanically with 89 continuous miners and 49 mobile loaders (of which 42 were used with continuous miners). Eight cutting machines cut 156,000 tons. Strip mines reported 6 power shovels, 6 bulldozers, 1 dragline, 2 power drills, and 12 trucks. Four preparation plants prepared 6.4 million tons of clean coal, all of which was mined underground. Five plants crushed 5.0 million tons and two plants treated 451,000 tons with oil.

Huntingdon.—Industrial sand was recovered and processed by Pennsylvania Glass Sand Corp., at its Keystone Works near Mapleton Depot for a wide range of uses, including glass, molding, chemical, ceramics, abrasives, engine, metallurgical, and autoclave. Limestone was produced at the Shade Gap plant near Orbisonia by L. H. Parsons Stone & Lime Co.; near Orbisonia and McConnellstown by New Enterprise Stone & Lime Co.; and by Warner Co. at its Union Furnace operation near Tyrone. Quartzite was produced near Three Springs by North American Refractories Co., for silica brick manufacture.

Plastic fire clay was produced by Alexandria Fre Clay Co. near Alexandria for use in the manufacture of mortar. Strip mines producing bituminous coal reported 4 power shovels, 2 draglines, 3 bulldozers, 2 power drills, and 3 trucks. Of the 4 underground mines 1 loaded coal mechanically with one hand-loaded face conveyor. The auger mine reported one auger, one power drill, and one truck.

Indiana.—Thirty-eight of the 54 underground mines loaded 6.6 million tons of bituminous coal mechanically with 74 continuous miners, 13 mobile loaders (of which 5 were used with continuous miners), and 3 hand-loaded face conveyors. Thirty-six cutting machines cut 151,000 tons. Strip mines accounted for 871,000 tons and reported 36 power shovels, 11 draglines, 1 carryall scraper, 37 bulldozers, 7 power drills, and 78 trucks. Auger mines reported 5 augers, 1 bulldozer, and 6 trucks. Fourteen preparation plants prepared 5.4 million tons of clean coal, all of which was produced underground. Nineteen mine tipples crushed 2.7 million tons and seven plants treated 343,000 tons with oil and other materials.

Plastic fire clay was produced near Clymer by Roy E. Foehrenbach for firebrick and block manufacture. Hiram Swank's Sons, Inc., produced a small amount of plastic fire clay from their Swank No. 6 underground mine near Clymer but closed the mine during the year.

Jefferson.—Strip mines accounted for 916,000 tons of bituminous coal and reported 49 power shovels, 18 draglines, 52 bulldozers, 4 power drills, and 108 trucks. Sixteen of the 23 underground mines loaded 605,000 tons of coal mechanically with 14 continuous miners and 14 hand-loaded face conveyors. Twenty-nine cutting machines cut 121,000 tons. Auger mines reported 7 augers, 2 bulldozers, and 16 trucks. Four preparation plants prepared 844,000 tons of clean coal. Seventeen mine tipples crushed 863,000 tons and four plants treated 193,000 tons with calcium chloride. Plastic fire clay was produced at an underground mine near Summerville by Hanley Co. for building brick manufacture. Vitrified sewer pipe was manufactured from clay mined near Brockway by The Brockway Clay Co. Limestone was produced by Sugar Hill Limestone Co., near Brockway for concrete aggregate, roadstone and agricultural pur-

poses. Brockway Sand & Gravel recovered bank-run sand near Brockway for paving purposes.

Lackawanna.—Sand and gravel was recovered and processed at a stationary plant near Moscow by Contractors Sand & Gravel, Inc., mostly for ready-mixed cement. Peat was produced by Wayne Peat Humus Co., Inc., near Gouldsboro and by Lake Linda Peat Co., Inc., near Dalton for general soil improvement.

Lancaster.—Limestone was produced by A. G. Kurtz & Sons, Inc., near Denver; Belmont Limestone Co. near Paradise; Rohrer's Quarry, Inc., near Lititz; J. Miller Eshleman & Son, Inc., near Landisville; The Blue Ball Stone Co., Inc., near Blue Ball; D. M. Stoltzfus & Son, Inc., near Talmage, Quarryville and New Texas; H. R. Miller near Lancaster; Bradford Hills Quarry, Inc., near Morgantown; Heisey Brothers Quarries near Rheems; Binkley & Ober, Inc., near East Petersburg; and J. M. Brenner Co. near Lancaster; The J. E. Baker Co., near Bainbridge; Compass Quarries, Inc., near Gap; Ivan M. Martin, Inc., near Blue Ball; and David M. Burkholder, Inc., near Ephrata.

Shale was produced near Ephrata by Glen Gery Shale Brick Corp. for building brick manufacture. Plastic fire clay was produced near Narvon by Narvon Mines Ltd. for use in drywall joint cement, insecticides and fungicides, foundries, animal feed concentrates, and building brick. Lancaster Brick Co. produced miscellaneous clay near Lancaster and purchased shale from Roger E. Gerhart, Inc., near Lititz for the manufacture of building brick. Sand was recovered and processed at a stationary plant near Milton Grove by Milton Grove Sand, Inc., for building, paving, and antiskid purposes. Sand was also recovered near Honey Brook and Brownstown.

Lawrence.—Portland and masonry cements were produced by Bessemer Cement Company, Division of Diamond Alkali Co., near Bessemer and by Medusa Portland Cement Co., near Wampum. Most of the portland cement was general use and moderate heat, although both companies also produced some high-early-strength cement. Most of the shipments were made in bulk by trucks to ready-mixed concrete companies.

Limestone for use as a blast furnace flux and for cement manufacture was produced near Hillsville by United States Steel Corp.; for cement manufacture near Wampum by Medusa Portland Cement Co., and for concrete aggregate, roadstone, and cement manufacture by Bessemer Cement Co., Division of Diamond Alkali Co. Limestone also was produced by New Castle Lime & Stone Co., in Mahoning Township and by Mooney Bros. Supply Co., near West Pittsburg. Plastic fire clay for use in foundries, building brick and vitrified sewer pipe, was produced near Enon Valley by Ralph A. Veon, Inc.; The Negley Fire Clay Co. near New Galilee; and Jack Craig Coal & Clay Co., near Wampum. McQuiston Coal Co. produced plastic fire clay and shale near Bessemer for building brick manufacture. Shale was produced near New Castle by Fenati Brick Co., Inc., for manufacturing brick. Bessemer Cement Co., Division of Diamond Alkali Co., produced shale at their No. 7 quarry near Bessemer for use in portland and other hydraulic cements. Medusa Portland Cement Co. produced shale near Wampum for portland cement manufacture. Keystone Loam & Clay Co. produced miscellaneous clay near Edinburg for foundry use.

Sand and gravel was recovered and processed at a stationary plant near West Pittsburg by Mahoning Valley Sand Co. and by Superior Sand & Supply Co. near New Castle. Zonolite Division, W. R. Grace & Co. produced exfoliated vermiculite near Ellwood City chiefly for loose fill insulation and agricultural use. Strip mines accounted for 1,129,000 tons of bituminous coal and reported 30 power shovels, 25 draglines, 40 bulldozers, 9 power drills, and 49 trucks. Auger mines reported 2 augers and 3 trucks. Coal crushed at 6 mine tipples totaled 366,000 tons. Peat was produced by D. M. Boyd Co., and Welker Greenhouses, Inc., near Leesburg.

Lebanon.—Crude magnetite, containing valuable byproducts such as copper, gold and silver, pyrite, and cobalt was mined by Bethlehem Mines Corp. at Cornwall. The crude ore was processed at the Cornwall concentrator (1) by crushing and grinding, magnetic separation and cindering the fine-sized material to produce a concentrated iron cinder, and (2) by flotation and agglomeration to recover copper concentrates (containing gold and silver) and pyrite concentrates (containing cobalt).

Limestone was produced by Fiala, Inc., and H. E. Millard Lime & Stone Co., near Annville; and by Sheridan Slag Co., and Calcite Quarry Corp., near Lebanon. Output was used for blast furnace flux, concrete aggregate, roadstone, railroad ballast, agricultural purposes, cement, and lime manufacture. Whitmoyer Laboratories, Inc., reported consumption of crude iodine in manufacturing inorganic and organic compounds at its plant near Myerstown.

Lehigh.—Portland and masonry cements were produced by Coplay Cement Manufacturing Co., near Coplay, and by Lehigh Portland Cement Co., near Fogelsville. Portland cement was also produced by Giant Portland Cement Co., near Egypt and by The Whitehall Cement Manufacturing Co., near Cementon. Most of the portland cement was shipped in bulk by truck to ready-mixed concrete companies and concrete product manufactureres. A major portion of the portland cement production was of the general use and moderate heat type and non-air-entrained.

Each of the cement companies produced limestone for use in the manufacture of cement at operations near the plants. Limestone also was produced by Eastern Industries, Inc., near Stiles and by Lehigh Stone Co., near Ormrod for concrete aggregate, roadstone, and cement manufacture. Penn Big Bed Slate Co., Inc., quarried slate near Slatedale for use as roofing slate, structural and sanitary slabs, blackboards, flagging, and other cut stone uses. The Pennsylvania Perlite Corp. expanded perlite near Allentown chiefly for use in the manufacturing of building plaster and cryogenic applications. Zinc sulfide ore mined and concentrated at the Friedensville mine was shipped to a smelter at Palmerton for recovery of zinc metal.

Luzerne.—Sand and gravel was recovered by Airport Sand & Gravel Co., Inc., near Wyoming Glendale Sand & Stone Co. in Pittston Twp.; Frank B. Sgarlat Sand & Gravel Co., near Forty Fort; J. A. & W. A. Hess, Inc., near Nescopeck; No. 1 Contracting Corp. of Delaware at a stationary plant near West Pittston; and A. Barletta & Sons near Nescopeck. Sandstone for concrete aggregate and roadstone was produced by No. 1 Contracting Corp. of Delaware near Drums; American Asphalt Paving Co. near Shavertown; Coolbaugh Sand & Stone, Inc., near Dupont and The General Crushed Stone Co. near White Haven. Shale was recovered from refuse coal banks near Wilkes-Barre by the Bylite Corporation to produce light weight aggregate for use in building blocks and structural concrete. Hazleton Brick Co. produced miscellaneous clay near Hazleton and Pottsville for use in the manufacture of building brick. Peat was produced near White Haven by Blue Ridge Soil Pep Co., Inc. Pennsylvania Peat Moss, Inc., and Stiller's Blue Ridge Peat Co. and near Wilkes-Barre by Bald Mountain Peat Corp.

Lycoming.—Limestone was produced by Lycoming Silica Sand Co., at its Lime Bluff quarry near Muncy and at its Pine Creek quarry near Jersey Shore for concrete aggregate, roadstone, and agricultural purposes. Sand and gravel was recovered by Lycoming Silica Sand Co., near Montoursville. Irregular-shaped sandstone was quarried by Rummings Bluestone Co., near Slate Run for construction work. Slate flour was produced by Keystone Filler & Manufacturing Co. near Muncy. Penn Paint & Filler Company and Keystone Filler Manufacturing Co. produced tripoli (rottenstone) for sale as a filler and abrasive material. Bituminous coal was produced at 4 strip operations, which reported 3 power shovels, 3 draglines, 4 bulldozers, 2 power drills, and 5 trucks. Two tipples crushed 103,000 tons of coal.

McKean.—Shale was produced near Lewis Run by Hanley Co. for building brick and floor and wall tile manufacture. Kane Stone Co. produced sandstone near Kane for concrete aggregate, roadstone, and riprap. Sand for industrial purposes was recovered near Eldred. Bituminous coal was produced at one strip operation reporting 1 power shovel, 2 draglines, 2 bulldozers, and 4 trucks. Coal was crushed at one tipple.

Mercer.—Strip mines producing bituminous coal reported 12 power shovels, 9 draglines, 16 bulldozers, 2 power drills, and 20 trucks. One preparation plant was active and used pneumatic equipment. Four mine tipples reported 96,000 tons of crushed coal. Sand and gravel was recovered by Seidle Sand & Gravel, Inc., near Mercer; by Transfer Sand & Gravel Co. in Pymatuning Township; at a stationary plant near Big

Bend by Taylor Sand & Gravel Co., and near Hadley by Atlas Sand & Gravel, Inc. George Hazen recovered bankrun gravel for paving purposes near Clarks Mills. Crushed sandstone for concrete aggregate, roadstone, riprap, refractory furnace lining, ferrosilicon, filler, foundry, and recreation purposes was produced by White Rock Silica Sand Co., near Greenville.

Mifflin.—Industrial sand was recovered and processed by Pennsylvania Glass Sand Corp. at its Hatfield Works in McVeytown. James R. Kline's Sons recovered sand for building purposes near Lewistown. George E. Miller Coal Co. recovered sand for building purposes and gravel for paving purposes near McVeytown. Limestone was produced by Bethlehem Mines Corp. at its Naginey quarry for metallurgical flux, concrete aggregate, roadstone, stone sand, and pulverized stone; by Derry Limestone Co., near Lewistown and George E. Miller Coal Co., near McVeytown for concrete aggregate and roadstone; and by Honey Creek Lime Co., near Reedsville for lime manufacture. Haws Refractories Co. produced crushed quartzite near Hawstone for the manufacture of silica brick.

Monroe.—Hamilton Stone Co. produced limestone near Bossardsville for concrete aggregate, roadstone, and cement manufacture. Miscellaneous clay was produced near Kunkletown by Universal Atlas Division of United States Steel Corp. for portland and other hydraulic cement manufacture.

Sand and gravel was recovered and processed at a stationary plant near Stroudsburg by Javelyn Mobile Mix, Inc.; near Kunkletown by Sheesley Minerals, Inc.; and at a stationary plant near East Stroudsburg by Robert Lee & J. Stanley Hallett. Peat was produced by World Wide Peat Co., near Blakeslee and by Pocono Peat Co., near East Stroudsburg for general soil improvement.

Montgomery.—Limestone was produced by Glasgow Quarry, Inc., near Conshohocken; Bradford Hills Quarry, Inc., near Norristown; by G. & W. H. Corson, Inc., near Plymouth Meeting; by Allentown Portland Cement Co., near West Conshohocken; and by Bethlehem Mines Corp., at its McCoy quarry near King of Prussia, and at its Bridgeport quarry. Dimension granite was quarried at the Marcolina Bros., Inc., Hillcrest quarry near Laverock. Mignatti Construction Co., Inc., crushed granite near Bethayres for concrete aggregate and roadstone.

Basalt was crushed by Kibblehouse Quarries, Inc., near Perkiomenville and Pottstown Trap Rock Quarries, Inc., near Sanatoga for concrete aggregate, roadstone, and riprap. Montgomery Stone Co., Inc., quarried basalt near Montgomeryville for rough and dressed dimension stone and crushed stone for concrete aggregate and roadstone. Crushed quartzite was produced near Glenside by Firestone Products Co., Inc., for refractory furnace lining and irregular-shaped stone for construction and for furnace lining without further processing. Vecchione Brothers quarried dimension sandstone near Glenside for architectural work. Argillite stone was crushed by M & M Stone Co., near Harleysville for concrete aggregate and roadstone. Crushed bluestone was produced by Gill Quarries, Inc., near Spring House and Norristown for concrete aggregate and roadstone. Portland and masonry cements were produced by Allentown Portland Cement Co., near West Conshohocken and by G. & W. H. Corson, Inc., near Plymouth Meeting. Most of the portland cement was general use and moderate heat type, non-air-entrained. Shale was produced near Trappe by Philadelphia Brick Co. for the manufacture of heavy clay products. The Keller Pottery Co. produced common clay near North Wales for the manufacture of flower pots.

Sand and gravel for construction purposes was processed near Norristown by William Bambi & Sons, Inc., but this company went out of business at yearend. Refractory & Insulation Corp. expanded perlite near Port Kennedy for use as concrete aggregate and filler.

Northampton.—The county continued to be first in the production of cement, with 8 plants shipping almost 18 million barrels of portland and masonry cement. Ready-mixed concrete companies purchased most of the cement with a significant quantity purchased by concrete product manufacturers. Thirty-five kilns were used during the year. North Bangor Slate Co. produced slate near Bangor for roofing, flagging, and aquarium bottoms, and expanded slate for lightweight aggregates. Also near Bangor, D. Stoddard & Sons, Inc., processed raw slate for structural, sanitary, and blackboard uses, and Pennsylvania Lightweight

Aggregate, Inc., produced crushed slate for granules and expanded slate for lightweight aggregate. Near Pen Argyl slate was produced by Albion Vein Slate Co., Diamond Slate Co., Anthony Dally & Sons, Inc., Stephens-Jackson Co., and Doney Slate Co. Output was used for structural and sanitary work, blackboards, billiard table tops, roofing, flooring, and flagging. Emerald Slate Corp. produced slate near Wind Gap.

Limestone was produced by The Trumbower Co., Inc., near Nazareth and by Bethlehem Mines Corp. near Bethlehem for concrete aggregate, roadstone, railroad ballast, agricultural purposes, clay filler, stone sand, and riprap. Limestone for cement manufacture was produced by National Portland Cement Co. near Bethlehem; Dragon Cement Co., Inc., and Universal Atlas Cement Division of U.S. Steel near Northampton; Keystone Portland Cement Co. near Bath; Lone Star Cement Corp., Penn-Dixie Cement Corp., and Nazareth Cement Co. near Nazareth; and Hercules Cement Co., Division of American Cement Corp. near Stockertown. Gravel was recovered and processed at a stationary plant near Bangor by Steckel Concrete Co., formerly owned by W. J. Lowe & Sons, Inc. Sand and gravel was recovered by Houdaille Construction Materials, Inc., near Portland and Lehigh Valley Sand & Gravel Co., Inc., near Easton. Finished natural and manufactured pigments, mostly brown and red, were produced by Minerals, Pigments, & Metals Division, Chas. Pfizer & Co., Inc., near Easton and Reichard-Coulston, Inc., near Bethlehem.

Northumberland.—Shale from stock was used by Watsontown Products Co. in Watsontown for linoleum filler. Watsontown Brick Co. produced red shale, and Glen Gery Shale Brick Corp. produced shale both near Watsontown for building brick manufacture. Limestone for concrete aggregate, roadstone, and agricultural purposes was produced by Meckley's Limestone Products, Inc., near Herndon. Clyde Starook produced a small amount of burnt lime for agricultural use near Northumberland.

Philadelphia.—Sand and gravel for building purposes and for city use was dredged from the Delaware River by The Liberty Corp. Gulf Oil Corp. recovered byproduct sulfur from oil refinery gas at its Philadelphia plant using the Claus process. Atlantic Richfield Co. recovered hydrogen sulfide by the Girdler System, using diethanolamine and monethanolamine. United States Gypsum Co. produced calcined gypsum at its plant near Philadelphia.

Potter.—Sandstone was quarried for irregular-shaped stone and flagging by: Penn Kress Flagstone Co., Inc., M. D. Robinson Flagstone Co., Charles McCloskey near Austin; Lloyd A. Tyler near Odin; Carroll M. Winseck near Roulette; Arthur Coole near Coudersport; Moore & Purdy near Wharton; and John Majot near Bark Shanty.

Schuylkill.—Harbison-Walker Refractories Co. produced crushed quartzite near Andreas for silica brick manufacture. Crushed sandstone for concrete aggregate and roadstone was produced by Summit Quarries, Inc., near Summit Station. Huss Contracting Co. produced limestone near Andreas for concrete aggregate and roadstone. Industrial sand was recovered and processed at a stationary plant near Andreas by Refractory Sand Co., Inc. Shale was produced near Auburn by Auburn Brick Co. for the manufacture of building brick.

Somerset.—Strip mines producing bituminous coal reported 85 power shovels, 57 draglines, 82 bulldozers, 34 power drills, and 145 trucks. Twenty-two of the 58 underground mines loaded 1.1 million tons of coal mechanically with 17 continuous miners, 2 mobile loaders, and 24 hand-loaded face conveyors. Sixty-three cutting machines cut 328,000 tons. Eleven preparation plants prepared 2.2 million tons of clean coal, 1.2 million tons of which was strip coal and 1.0 million tons underground coal. Fifteen tipples crushed 1.5 million tons, and 8 plants treated 127,000 tons with oil. Plastic fire clay was produced near Somerset by C. Brant Mining Co., near Springs by Otto Brick & Tile Works, Inc., and by Harbison-Walker Refractories Co. at its Garrett open-pit. Flint fire clay for firebrick manufacture was produced near Shanksville by Svonavec, Inc. and by General Refractories Co. near Fort Hill and Rockwood.

Limestone was produced by Keystone Lime Co. near Springs and by Somerset Limestone Co., Inc., near Bakersville for

concrete aggregate, roadstone, agricultural purposes, and riprap. Sandstone was produced by Clarence Rodamer near Springs for stone sand and by Detwilers Industries, Inc., near Central City for concrete aggregate and roadstone. Sand for construction uses was recovered and processed at a stationary plant near Boswell by Boswell Sand Co.

Susquehanna.—Crushed sandstone for concrete aggregate and roadstone was produced by State Aggregates, Inc., near Montrose, who purchased the quarry from Susquehanna Quarry Co. early in the year; and by Keelor Supply Co., Inc., Bennett's quarry near Clifford. Sandstone for flagging was quarried by Powers Brothers Quarries near Birchardville; Lee A. Wilbur Flagstone Co. near Kingsley; Herbert Harvey & Sons near Springville; and Wade H. Swingle, Jr., near Harford. Mitchell Stone Co. near Springville and Susquehanna Bluestone Co. near Fairdale quarried irregular-shaped bluestone for construction work and flagging.

Tioga.—Strip mines producing bituminous coal reported 11 power shovels, 7 draglines, 14 bulldozers, 4 power drills, and 13 trucks. One preparation plant cleaned coal with pneumatic equipment and 2 tipples crushed 485,000 tons. Sand for foundry uses and gravel for road work was recovered and processed at a portable plant near Middlebury Center by Fredric M. Gee Gravel Co.

Venango.—Strip mines producing bituminous coal reported 13 power shovels, 8 draglines, 11 bulldozers, 3 power drills, and 52 trucks. Gravel for building, paving, fill, and other uses was recovered at a stationary plant near Titusville by White City Sand and Gravel Co. and near Oil City by Oil City Sand & Gravel Co. Pennsylvania Glass Sand Corp. produced industrial sand for molding and furnace uses at its Venango Works.

Washington.—Twelve of the 15 underground mines loaded 13.5 million tons of bituminous coal mechanically with 67 continuous miners and 40 mobile loaders, of which 9 were used with continuous miners. Thirty-one cutting machines cut 4.1 million tons. Strip mines reported 21 power shovels, 5 draglines, 22 bulldozers, 7 power drills, and 37 trucks. Seven preparation plants prepared 12.4 million tons of clean coal, 12.2 million tons of which was underground coal. Seven mine tipples crushed 6.9 million tons, and 3 plants treated 1.0 million tons with oil. Limestone was produced by Washington Stone Co., Inc., near Washington for concrete aggregate and roadstone.

Wayne.—Sandstone flagging, irregular-shaped construction stone, and cut architectural stone were quarried by Sterling Quarries, Inc., W. R. Strong & Son, and Paul Tompkins Estate. Crushed sandstone was produced near Lake Ariel by Wayne Crushed Stone, Inc., for concrete aggregate and roadstone. Sand for building purposes was recovered at the Willis Black Sand & Gravel pit near Lake Ariel. Sand and gravel for paving purposes was recovered and processed by Keystone Pavement & Construction Co., Inc., at its stationary plant near Lake Ariel.

Westmoreland.—Eight of the 24 underground mines loaded 3.5 million tons of bituminous coal mechanically with 20 continuous miners, 16 mobile loaders (8 of which were used with continuous miners), and 2 hand-loaded face conveyors. Twenty-four cutting machines cut 709,000 tons. Strip mines reported 24 power shovels, 7 draglines, 27 bulldozers, 9 power drills, and 35 trucks. Five preparation plants prepared 3.2 million tons of clean coal, all of which was mined underground. Seven mine tipples crushed 2.2 million tons and two plants treated 1.7 million tons with oil and other materials. Sand and gravel was recovered by dredging the Allegheny River near New Kensington by Davison Sand & Gravel Co. and processed for construction purposes.

Crushed sandstone for concrete aggregate was produced by J. M. Hall, Inc., near Baggaley; Eidemiller Enterprises, Inc., near Whitney; Penn Aggregates near Jeannette; Murrysville Bluestone Co., Inc., near Murrysville; and Latrobe Construction Co. near Ligonier. Crushed shale was produced by Clayton H. Remaley near Sardis for driveways and filter beds and by Reifschneider Brothers near Lower Burrell for concrete aggregate and roadstone. Dimension sandstone was quarried by Clifford B. Wareham near Irwin for irregular-shaped stone for construction work and by Lynn's Quarry near Belle Vernon for flagging. Limestone was produced by Agricultural Lime &

Stone Co. in Derry Township and by Paul W. Kendi & Sons., Inc., near Mt. Pleasant for concrete aggregate, roadstone, agricultural purposes, and lime manufacture. Shale was produced near Trafford by Charles Kunkle for use by Pitt & Suburban Brick Co. A small amount of high-magnesium lime for agricultural purposes was produced by Agricultural Lime & Stone Co. near Derry.

Wyoming.—Sand and gravel was recovered and processed at the Wyoanna plant near Falls by Wyoming Sand & Stone Co. for building, paving, and antiskid purposes. Sandstone was quarried by J. G. Robinson, Inc., near Ft. Washington for flagging.

York.—Portland and masonry cement was produced by Medusa Portland Cement Co. near York. Most of the portland cement was the general use and moderate heat type, but substantial quantities of white and high-early-strength were also produced. Shipments were mainly in bulk and shipped by railroad. Most of the cement was sold to ready-mixed concrete companies with a large amount also sold to concrete product manufacturers. Limestone was produced by Klines Quarry, Inc., near Wrightsville; Standard Concrete Products Co. near York; York Building Products Co., Inc., near Thomasville; Codorus Stone & Supply Co., Inc., near Mt. Wolf; Thomasville Stone & Lime Co. near Thomasville; White Pigment Corp. near York; York Stone & Supply Co., National Gypsum Co., The J. E. Baker Co., and by Medusa Portland Cement Co. all near York.

The Ruberoid Co. processed crushed slate near Delta for granules and flour. Shale was produced near York by Glen Gery Shale Brick Corp. for the manufacture of building brick at its York Colonial Division. Miscellaneous clay was produced by Medusa Portland Cement Co. near York for use in the manufacture of portland and other hydraulic cements. Sand for building purposes was recovered and processed at a stationary plant near York by Neuman Sand & Supply Co. and by Pennsy Supply, Inc., near York Haven. General Mining Associates recovered crude flake mica near York and air-separated it for sales to paint, roofing, rubber (mold lubricant), grease, welding rods, insulation (electric), and textile coating manufacturers. Pennsylvania Perlite Corp. expanded perlite near York chiefly for use in building plaster.

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 Harry F. Robertson,[1] José F. Cadilla,[2] and Roy Y. Ashizawa[3]

PUERTO RICO[4]

Mineral production in Puerto Rico was valued at $50.8 million, a gain of about 11 percent. Cement, sand and gravel, and stone comprised about 48, 29, and 21 percent, respectively, of the total value.

The Puerto Rico Water Resources Authority planned to build two nuclear reactors on the south coast to supply adequate power for expected heavy industry in the area. Proposed location of the plant was near Jobos Bay, 6 miles west of the Phillips Puerto Rico Core, Inc., refinery. Electrical power available to the Island would increase to 2 million kilowatts.

A Senate bill granted Puerto Rico $4.2 million to conduct nuclear projects and research. Approximately $1.8 million was to be used for developing a second nuclear core for the reactor located in Rincón. The remainder of the money will go to nuclear center facilities in Rio Piedras and Mayaguez operated by the University of Puerto Rico in conjunction with the Atomic Energy Commission.

Ponce Mining Co. and Cobre Caribe Corp., subsidiaries of American Metal Climax, Inc., and Kennecott Copper Corp., respectively, continued negotiations with the Puerto Rico Economic Development Administration (PREDA), concerning development of copper deposits in the Utuado-Lares-Adjuntas area.

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Table 1.—Mineral production in Puerto Rico[1]

Mineral		1965		1966	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Cement	thousand 376-pound barrels	7,284	$23,415	7,603	$24,277
Clays	thousand short tons	357	288	350	271
Lime	do.	27	867	30	960
Salt	do.	8	138	11	183
Sand and gravel	do.	8,147	12,405	9,879	14,554
Stone	do.	5,344	9,111	5,732	10,541
Total		XX	46,224	XX	50,786

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]
1957	$17,431
1958	21,957
1959	20,857
1960	30,133
1961	33,994
1962	37,604
1963	40,522
1964	40,083
1965	45,945
1966	49,932

[1] Data for 1952-65 revised.

The U.S. Geological Survey, working under a cooperative agreement with PREDA, mapped quadrangles at various locations on the Island as part of the program of preparing geologic maps and investigating the mineral resources of Puerto Rico. Reports were published on the geology of the Florida quadrangle [5] and the stratigraphy of the Corozal quadrangle.[6]

The Water Resources Division of the U.S. Geological Survey, in cooperation with the Commonwealth of Puerto Rico, worked on water resource reports of the Guánica, Guayanilla-Yauco, Ponce, Juana Diaz, and Jobos areas. Maps delineating boundaries of record floods were being prepared for Ponce, Humacao, Arecibo, and Manati.

The Soils and Geology Division of the Puerto Rican Department of Public Works in cooperation with the Federal Bureau of Public Roads continued a survey of construction material resources of Puerto Rico. Reports were published for San Juan, Juncos, and Manati quadrangles. Work continued on reports for Rio Grande, Barceloneta, and Arecibo quadrangles. responsibility for continuing the series of construction material resources reports was delegated to the Highway Authority.

The Materials Research Division of the Department of Public Works investigated methods of roadbed stabilization. A report was published describing results obtained by injecting lime into the clayey soils under the pavement.[7]

REVIEW BY MINERAL COMMODITIES

Nonmetals. — *Cement.* — Increased construction activity on the Island accounted for a corresponding increase in the usage of portland cement. The quantity of imported cement gained about 2 percent, totaling 568,500 barrels. About 82 percent of the cement was imported from Colombia; Belgium and Japan accounted for most of the remainder.

Puerto Rican Cement Co., Inc. completed the expansion and modernization program at its Ponce and San Juan plants. Two new grinding mills, a new 3.5-million-barrel kiln, and improved raw material reclaiming facilities began operating. At yearend, total annual capacity of the two plants was increased to 11.5 million barrels.

Construction of a new cement plant by Toa Cement Co. continued in the north-central part of the Island. Initial operation of the plant was scheduled for late 1967.

Clay.—Most of the clay produced was used in making cement. Diazlite, Inc., Puerto Rico's only lightweight aggregate

[5] Nelson, Arthur E., and W. H. Monroe. Geology of the Florida Quadrangle, Puerto Rico, U.S. Geol. Survey Bull. 1221–C, 1966, 22 pp.

[6] Nelson, Arthur E. Cretaceous and Tertiary Rocks in the Corozal Quadrangle, Northern Puerto Rico. U.S. Geol. Survey Bull. 1244–C, 1966, 20 pp.

[7] Pérez, Rafael Cruz. Drill-Lime Stabilization. Commonwealth of Puerto Rico Dept. of Public Works Res. Study No. 5, 1966, 33 pp.

Table 3.—Portland cement production and shipments

Year	Production (376-pound barrels)	Shipments		
		376-pound barrels	Value	
			Thousands	Average per barrel
1957–61 (average)	5,434,366	5,413,112	$16,176	$2.99
1962	6,364,736	6,346,662	20,018	3.15
1963	7,171,302	7,217,417	22,090	3.06
1964	7,910,624	7,925,781	23,879	3.01
1965	7,268,773	7,284,219	23,415	3.21
1966	8,071,343	7,602,641	24,277	3.19

plant, expanded clay at its plant near Trujillo Alto. A substantial amount of sandy clay used for fill on various construction projects was not included as mineral production. The high value of land in Puerto Rico permits usage of pit-run fill costing as much as 85 cents per cubic meter.

Lime.—Puerto Rican Cement Co., Inc., produced hydrated lime and quicklime at Ponce. Output gained about 10 percent as compared with last year. Most of the hydrated lime was used as mason's lime by the Island's construction industry. Other uses for the quicklime and hydrated lime were for steel (electric furnaces), soil conditioning, sugar refining, leather tanning, and water purification and softening.

Salt.—Evaporated salt was recovered from ponds operated by Ponce Salt Industries, Carlos Ramirez, and other producers in the Mayaguez District. Users of the salt included nearby chemical plants and seafood processors and canners. Crude salt, imported from Gran Inagua, was refined for domestic use.

Sand and Gravel.—Construction activity accounted for a 20 percent increase in sand and gravel production. Most of the material was used as concrete aggregate. Silica sand from inland beds west of San Juan was used in the nearby cement and glass plants, in foundries, in sandblasting, and in marble polishing. Puerto Rico Glass Corp. used the white, high-grade silica sand in making bottles and jars. The company imported feldspar and other raw materials.

Stone.—Limestone, locally classified as marble, was produced in all districts. Andesite, tuffaceous siltstone, and miscellaneous volcanic stone were produced in all districts except Arecibo. Granite was produced in Humacao and Guayama Districts. Crushed limestone comprised about 77 percent of total stone output. Crushed marble was used in making terrazzo. Production of dimension marble from a quarry near Arecibo was planned. Puerto Rican Cement Co., Inc. reported using about 2 million tons of crushed limestone in cement production.

Table 4.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	2,074	$3,970	2,409	$4,495
Paving	1,572	1,964	1,884	2,130
Fill	592	524	634	547
Other	38	53	-----	-----
Total	4,276	6,511	4,927	7,172
Gravel:				
Building	1,442	2,772	2,245	4,074
Paving	971	1,792	1,214	1,934
Fill	576	479	458	381
Total	2,989	5,043	3,917	6,389
Total sand and gravel	7,265	11,554	8,844	13,561
Government-and-contractor operations:				
Sand:				
Paving	234	263	279	303
Fill	502	450	586	539
Total	736	713	865	842
Gravel:				
Paving	21	30	27	36
Fill	125	108	143	115
Total	146	138	170	151
Total sand and gravel	882	851	1,035	993
Grand total	8,147	12,405	9,879	14,554

Table 5.—Stone sold or used by producers

(Thousand short tons and thousand dollars)

Year	Dimension limestone		Crushed limestone [1]	
	Quantity	Value	Quantity	Value
1957–61 (average)	87	$177	2,635	$3,722
1962	61	130	4,270	5,829
1963	65	152	3,918	5,306
1964	75	191	4,347	6,009
1965	74	180	4,236	6,607
1966	88	231	4,416	7,555

Year	Miscellaneous stone [2]		Total	
	Quantity	Value	Quantity	Value
1957–61 (average)	432	$920	3,154	$4,819
1962	1,258	2,592	5,589	8,551
1963	1,351	2,779	5,334	8,237
1964	1,082	2,386	5,504	8,586
1965	1,034	2,324	5,344	9,111
1966	1,228	2,755	5,732	10,541

[1] Includes limestone for cement and lime.
[2] Includes granite, marble, and miscellaneous stone.

Mineral Fuels.—Crude and unfinished oil imported from Venezuela and the Netherlands Antilles averaged 150,000 barrels per day, a 19 percent increase over the 1965 total. The oils were refined at the Cataño plant of Caribbean Gulf Refining Corp. and the Guayanilla plant of Commonwealth Oil Refining Co.

The Phillips Petroleum Co. and the Commonwealth of Puerto Rico, in a joint venture, began construction of a petrochemical complex near Guayama. The complex will be owned and operated by Phillips Puerto Rico Core, Inc. A 500-foot barge dock was built on Jobos Bay to facilitate delivery of construction materials and hardware for the petrochemical plant. A permanent, deepwater harbor, adjoining the plant site, was being dredged. A nylon fibers plant was being constructed adjacent to the petrochemical core plant. The nylon plant, a joint venture involving Phillips Petroleum Co. and Rhone Polenc Co. of France, will be owned and operated by Fibers International Corp. Completion of this plant was scheduled for late 1967, as was completion of the core plant, channel dredging, and inland harbor facilities.

The Hercor Chemical Corp. paraxylene plant, built in a joint venture by Commonwealth Oil Refining Co. (Corco) and Hercules, Inc., in the Peñuelas area, began production. Raw material for the plant, consisting of mixed xylenes and hydrogen, will be obtained from the adjoining aromatics plant of Commonwealth Petrochemicals. Construction began on two more satellite plants in the Corco oil refining-petrochemical complex at Peñuelas. One of the new plants, being built by Shell and Commonwealth Chemicals, Inc., will make cyclohexane, a principal ingredient in nylon. Cyclohexane will be made from benzene and hydrogen supplied by Corco's aromatics petrochemical plant. The plant will have a capacity of 30 million gallons per year. The second new plant, operated by a wholly owned affiliate of Corco named Styrochem Corp., will make ethylbenzene.

Puerto Rico Chemical Co. announced plans to double capacity of its 50-million-pound-per-year phthalic anhydride plant at Arecibo. Corco supplies orthoxylene feedstock for the phthalic plant through its subsidiary, Commonwealth Petrochemicals at Peñuelas.

Texaco Inc. announced plans to build a 40,000-barrel-per-day crude oil refinery on Puerto Rico's southwest coast. Start of construction depends on U.S. Department of the Interior's permission to bring the crude input from Venezuela. The gasoline recovered from the foreign crude oil would not be sold in the U.S. market.

Metals.—Steel reinforcing bars for concrete construction were produced by Industrial Siderurgica, Inc., at its steel mill near Cotaño. Installation of the second 20-ton electric furnace was completed, and both furnaces were utilized for melting iron and steel scrap. Further equipment replacement was planned by the company.

Ponce Mining Co., Cobre Caribe, and

Table 6.—Value of mineral production in Puerto Rico, by districts

Senatorial district	1965	1966	Minerals produced in 1966, in order of value
Aguadilla	$1,308,300	$1,481,400	Stone, sand and gravel.
Arecibo	1,261,850	1,303,750	Do.
Guayama	1,295,650	2,725,250	Sand and gravel, stone.
Humacao	859,500	999,300	Stone, sand and gravel.
Mayaguez	2,825,090	3,059,522	Sand and gravel, stone, salt.
Ponce	16,827,822	17,345,659	Cement, sand and gravel, stone, lime, clay.
San Juan	21,845,788	23,871,119	Cement, sand and gravel, stone, clay.
Total	46,224,000	50,786,000	

PREDA continued a study of various proposals to mine, concentrate, smelt, and refine Puerto Rican copper ores. The copper deposits, located in the mountains near Utuado, would be mined by open-pit methods. Reports on the subject of the potential copper industry of Puerto Rico were completed.[8]

PANAMA CANAL ZONE [9]

The overall value of mineral production in the Panama Canal Zone decreased about 21 percent. Sand and gravel, produced by Panama Sand Co., Inc., gained slightly in value but was overshadowed by a loss in value of stone production reported by Panama Canal Co.

VIRGIN ISLANDS [10]

The quantity of basalt produced in the Virgin Islands gained substantially, but total value remained about the same. Caribbean Material Supply Co. was the major stone producer. Crushed stone was used for concrete aggregate, roadstone, and riprap. The aggregate industry of the Virgin Islands is adversely affected by the lack of fresh water to wash the crushed stone. At yearend, the Virgin Islands Water and Power Authority studied bids for constructing a combination electric power and water desalting plant in St. Thomas. Specifications call for a 2.5-million-gallon-per-day sea water desalting plant and a 15,000-kilowatt electric generator.

[8] Cadilla, José F. Considerations on Establishment of a Mineral Industry in Puerto Rico. Mining Commission, Office of the Governor and Economic Development Administration, 1966, 210 pp.
———. Copper in Puerto Rico; Geological and Chemical Considerations. Economic Development Administration, 1966, 36 pp.
———. Technical Report on the VIIth International Mineral Congress, A.I.M.E., New York, 1966, 57 pp.
[9] Prepared by Harry F. Robertson.
[10] Prepared by Harry F. Robertson.

Table 7.—Mineral production in the Panama Canal Zone and Virgin Islands [1]

Mineral	1965		1966	
	Short tons	Value	Short tons	Value
Canal Zone:				
Sand and gravel	83,000	$85,000	72,000	$91,000
Stone [2]	153,418	366,098	113,520	266,685
Total	XX	451,098	XX	357,685
Virgin Islands:				
Stone (basalt)	67,948	301,975	87,541	303,358

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Includes basalt.

The alumina plant of Harvey Aluminum, Inc., on St. Croix began operation. The annual capacity of the plant is 220,000 tons of alumina produced from 500,000 tons of imported bauxite.

Hess Oil Virgin Islands Corp., a wholly owned subsidiary of Hess Oil & Chemical Corp., completed a 60,000-barrel-per-day oil refinery on the Island of St. Croix. In addition to the crude unit, downstream processing includes a 6,000-barrel-per-day Platformer, a 12,600-barrel-per-day Unifiner for naphtha and kerosine, and a 11,000-barrel-per-day middle-distillate hydrodesulfurizer.

Puerto Rican Cement Co., Inc. constructed a distribution facility at Christiansted, St. Croix.

PACIFIC ISLAND POSSESSIONS [11]

REVIEW BY ISLANDS

American Samoa.—Coral limestone, sand, and volcanic cinders were produced by crews and contractors of the Government of American Samoa. The materials were used for reconstruction of roads and structures damaged by a hurricane which struck Samoa in January.

Canton.—Maintenance forces stationed at several of the Government facilities on Canton used a small quantity of coral aggregate from a stockpile for patching roads and runway approaches.

Guam.—Government crews and contractors and commercial producers quarried an increased quantity of coral limestone for military and civilian construction projects. Established quarries and stationary crushing and screening plants were operated by Hawaiian Rock Products, Inc., Perez Bros., Inc., and Pacific Rock Corp. They produced crushed coral limestone and crusher-run stone sand for asphalt and portland cement concrete aggregate.

Wake.—Coral limestone was quarried and dredged by Federal Aviation Agency crews and contractors for use in constructing concrete structures and for resurfacing a runway.

Other Pacific Island Possessions.—No mineral production was reported on the Islands of Enderbury, Jarvis, Johnston, Midway, and Palmyra. Materials used for construction projects on Midway and Johnston were supplied by contractors from Hawaii and the U.S. mainland.

Table 8.—Mineral production in the Pacific Island Possessions

Area and mineral	1965		1966	
	Short tons	Value	Short tons	Value
American Samoa:				
Pumice	-----	-----	16,580	$21,816
Sand	60,000	$55,000	20,000	18,000
Stone (crushed)	60,000	60,000	11,860	11,860
Total	XX	115,000	XX	51,676
Guam: Stone (crushed)	482,839	925,030	899,849	1,396,203
Wake: Stone (crushed)	1,253	3,807	11,638	66,500

TRUST TERRITORY OF THE PACIFIC ISLANDS [12]

The Trust Territory of the Pacific Islands is made up of some 2,100 islands distributed over an ocean area of 3 million square miles. Mineral resources in the Territory are limited primarily to phosphate rock on Angaur Island, bauxite on Babelthuap Island, and materials for use in concrete and as roadstone. Phosphate rock and bauxite were not mined during 1966. Volcanic rock and coral were quarried by public works crews for use in building construction and for improving roads, airfields, and harbor facilities.

[11] Prepared by Roy Y. Ashizawa.
[12] Prepared by Roy Y. Ashizawa.

The Mineral Industry of Rhode Island

By Meherwan C. Irani [1]

Mineral production in Rhode Island increased 33 percent in 1966, exceeding the previous alltime high attained in 1960. The value of production was $3.9 million, 35 percent greater than in 1965; 56 percent of the total value was contributed by sand and gravel production. Miscellaneous stone, dimension granite, and crushed limestone also contributed significantly to the total.

Providence County, accounting for about half of the State total, was again the leading producer, followed by Kent, Washington, and Newport Counties.

[1] Metallurgist, Bureau of Mines, Pittsburgh, Pa.

Table 1.—Value of mineral production in Rhode Island, by counties [1]

(Thousands)

County	1965	1966	Minerals produced in 1966, in order of value
Kent	W	W	Sand and gravel.
Newport	$19	$28	Sand and gravel, stone.
Providence	1,617	2,086	Do.
Washington	540	W	Stone, sand and gravel.
Undistributed [2]	755	1,833	
Total	2,931	3,947	

W Withheld to avoid disclosing individual company confidential data.
[1] Bristol County is not listed because no production was reported.
[2] Includes value of gem stones and sand and gravel that cannot be assigned to specific counties and values indicated by symbol W.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value	Year	Value
1957	r $1,383	1962	r $2,924
1958	r 2,263	1963	r 2,766
1959	r 2,297	1964	r 2,504
1960	r 5,555	1965	r 2,913
1961	r 3,013	1966	p 3,881

r Revised.
p Preliminary.

Table 3.—Employment and injury experience in the mineral industries

Year and industry	Average men working daily	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
				Fatal	Nonfatal	Frequency	Severity
1965:							
Sand and gravel	128	25	199	------	3	15.06	497
Stone	46	11	90	------	1	11.05	365
Total	174	36	289	------	4	13.84	457
1966: p							
Sand and gravel	155	29	233	------	2	8.58	948
Stone	55	13	111	------	4	36.04	1,441
Total	210	42	344	------	6	17.44	1,108

p Preliminary.

REVIEW BY MINERAL COMMODITIES

Gem Stones.—Miscellaneous mineral specimens were collected from mine dumps and quarries at various sites, mostly in the northern part of the State. Gem stones recovered included actinolite, agate, fluorescent calcite, and pegmatite minerals.

Sand and Gravel.—Production of sand and gravel increased 35 percent in quantity and 22 percent in value compared with the 1965 figures. Total production was 2.3 million short tons. Nineteen operations were active in four counties. Providence County accounted for over one-half of the sand and gravel output, followed by Kent, Washington, and Newport Counties. Eighty-two percent was produced by washing and screening. About 41 percent of the production was used for building purposes; 36 percent for paving; and the remainder for drainage, ice control, foundry sand, etc. The average value per short ton decreased from $1.08 in 1965 to $0.97 in 1966. Transportation was mainly by truck; a small tonnage was shipped by railroad.

Stone.—The output of stone increased 22 percent in quantity and 55 percent in value compared with 1965 figures. The total value of stone produced was $1.7 million and accounted for 44 percent of the value of the State's mineral production. Miscellaneous stone consisting of granitized schist and crushed conglomerate, accounted for 91 percent of the total quantity of stone produced and 42 percent of the total value. Output in this category increased 27 percent and was used mostly for concrete and roadstone; a small quantity was used for riprap.

The production of crushed limestone, most of which was used for agricultural purposes, declined 4 percent. Other uses of limestone were for roofing gravel, filler for fertilizer, decorative and special aggregate, and flux. A small quantity of dimension limestone was quarried.

Production of dimension granite for monument stone increased about 300 percent, and represented 44 percent of the total stone value.

REVIEW BY COUNTIES

Kent.—Although only sand and gravel was produced in 1966, Kent County continued as the second largest producer of minerals in the State. Output increased 57 percent and the value of production increased 39 percent compared with 1965 figures.

Sand production for paving was greater than in 1965, but building sand output decreased. All markets for gravel increased except that for building which declined 27 percent. Screened and washed sand and gravel constituted 74 percent of the total produced, compared with 62 percent in 1965. Processed sand and gravel was sold for an average unit price of $1.25, compared with $1.62 per ton in 1965. Almost all the sand and gravel was transported by truck. Luigi Vallone, Inc., of Warwick produced sand and gravel for building, paving, fill, ice control, and other construction purposes. The Rhode Island Sand & Gravel Co., Warwick, produced molding sand and sand and gravel for building, paving, and fill purposes. Whitehead Brothers Co., Washington, produced molding sand.

Newport.—Peckham Bros., Inc., Middletown, was the only commercial producer of sand and gravel and stone during 1966. Compared with the 1965 figures, the mineral production of the county rose 16 percent in tonnage and 47 percent in value. Output of paving gravel increased 29 percent in volume and 73 percent in value. The entire production of sand and gravel was washed and screened. The output of crushed miscellaneous stone used for concrete aggregate was virtually the same as in 1965, but the value increased 17 percent.

Providence.—The $2.1 million mineral production in Providence County, an increase of 29 percent over the 1965 value, represented about half of the State's total and was equally divided between stone and sand and gravel. Nine sand and gravel producers and two stone producers operated in 1966. Eighty-seven percent of the sand and gravel production was washed and screened. Most of the sand and gravel was used for building, paving, and fill and was valued at $1.13 million, an increase of 24 percent. The average unit price per ton of processed sand and gravel was $0.92,

compared with $1.04 in 1965. The entire output was transported by truck.

The quantity of sand produced increased 38 percent, and the value rose 24 percent. Production of sand for fill and ice control remained virtually the same as in 1965. Gravel production increased 35 percent, but the value was only 23 percent higher than in 1965. Production of building gravel increased 31 percent but declined in price to $1.01 per ton from $1.22 in 1965.

Producers of sand and gravel in Providence County included Lapham Sand and Gravel Co., at North Smithfield; Forte Bros., Inc., and Mack Sand & Gravel Co., both near Cumberland; J. Santoro Inc., and Tasca Sand & Gravel Co., both at Smithfield; Silvestri Bros., Inc., Johnston; Town Line Sand & Gravel, Slatersville; Del Bonis Sand & Gravel Co., Cranston; and Cardi Construction Co., Inc., at Coventry.

The output of stone in Providence County increased 36 percent in value and 25 percent in volume. Miscellaneous stone used for concrete aggregate and roadstone accounted for 76 percent of the total stone value, with crushed and dimension limestone accounting for the remainder. The M. A. Gammino Construction Co., Cranston, at its Phenix quarry produced miscellaneous stone consisting of granitized schist. It was used for concrete aggregate, riprap, and roadstone. The Conklin Limestone Co., at its Lincoln quarry, produced crushed limestone for agricultural purposes, blast furnace flux, fertilizer filler, roofing gravel, and special aggregate. Rubble was the only dimension stone produced. Most of the production was transported by truck.

Washington.—The county ranked second in stone output and third in sand and gravel in the State.

Sand and gravel output declined 14 percent in tonnage and 28 percent in value; a decline more than compensated for by an 89-percent increase in the value of stone produced.

While the output and value of sand, all for building and paving, remained virtually the same as in 1965, building gravel output declined 65 percent in quantity and 75 percent in value, and that of paving gravel declined 22 and 27 percent respectively, in quantity and value. A small quantity of fill gravel was produced. Eighty-one percent of total sand and gravel was processed by washing and screening. The average unit price of processed sand and gravel was $1.23, compared with $1.52 in 1965. The whole production was transported by truck.

Louis B. Schaeffer at Peace Dale produced gravel for paving, and The South County Sand & Gravel Co., South Kingstown, produced sand and gravel for building and paving.

Dressed granite for monumental purposes was produced by Westerly Granite Corp., Westerly, from its Bradford quarry. Providence Granite Co. produced monumental stone, dressed stone for architectural work, and irregular-shaped stone for construction.

The Mineral Industry of South Carolina

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

By Robert C. Johnson [1] and Henry S. Johnson, Jr.[2]

South Carolina's 1966 mineral production, valued at $45.6 million, an increase of $4.3 million over that of 1965, set a new record. Substantial increases in production of clay, stone, sand and gravel, cement, and vermiculite accounted for most of the gain in total value.

Among the States, South Carolina continued to rank second in the production of kaolin, vermiculite, and kyanite. New high production was recorded for kaolin, miscellaneous clay, sand and gravel, crushed and dimension granite, crushed limestone, vermiculite, masonry and portland cements. Leading mining and mineral processing companies were Giant Portland Cement Co. (cement, miscellaneous clay, and crushed limestone), Campbell Limestone Co. (crushed granite and crushed limestone), Becker County Sand & Gravel Co. (sand and gravel), J. M. Huber Corp. (kaolin), and Palmetto Quarries Co. (crushed granite).

Trends and Developments.—The Division of Geology, State Development Board, continued basic studies of the geology and mineral resources of the State. During the year, 15 projects were carried on and eight reports were published. Specific counties studied were Edgefield, Orangeburg, McCormick, Newberry, Oconee, and Pickens. Quadrangles studied and mapped for publication in the MS Series were the Sumter West (7½ minute), Irmo NE (7½ minute), Wampee (7½ minute), Myrtle Beach (15 minute), James Island (7½ minute), Six Mile (7½ minute), Lake View (7½ minute), and Winnsboro (15

[1] Mining engineer, Bureau of Mines, Knoxville, Tenn.
[2] State geologist, South Carolina Geological Survey, Columbia, S. C.

Table 1.—Mineral production in South Carolina [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	1,837	$8,539	2,139	$8,830
Sand and gravel do	5,248	6,688	6,016	7,668
Stone do	[2] 5,948	[2] 8,447	8,129	12,510
Value of items that cannot be disclosed: Barite, cement, feldspar, kyanite, scrap mica, peat, pyrites, stone (dimension granite and crushed limestone, (1965), vermiculite	XX	17,587	XX	16,585
Total	XX	41,261	XX	45,593

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes certain stone; included with "Value of items that cannot be disclosed."

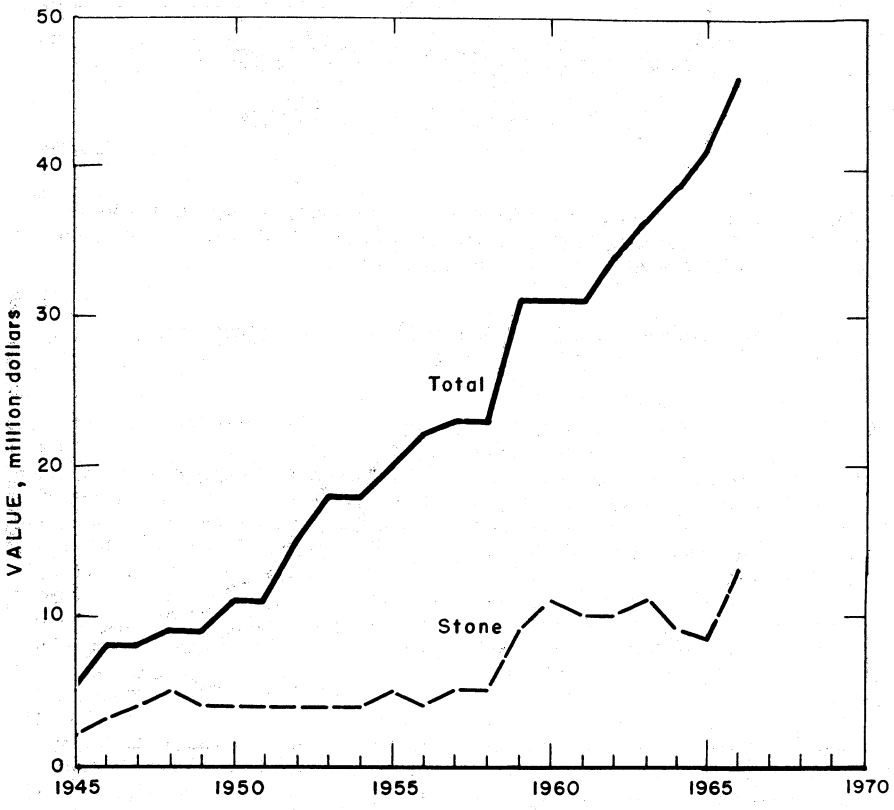

Figure 1.—Value of stone, and total value of mineral production in South Carolina.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value
1957	$22,513
1958	22,360
1959	30,033
1960	30,426
1961	30,336
1962	33,941
1963	35,641
1964	39,024
1965	r 40,685
1966	p 44,575

r Revised. p Preliminary.

minute). Reports published during 1966 were: "Gold Resources of South Carolina," Bulletin 32; "Geology and Mineral Resources of York County, South Carolina," Bulletin 33; "Geology of the Eutawville 15′ Quadrangle," MS–12; "Geology of the Blythewood Quadrangle, South Carolina," MS–13; and "Geologic Notes," Volume 9, Number 4, and Volume 10, Numbers 1, 2, and 3. The Division of Geology also reported the following activities: Company exploration of phosphate deposits in the southern part of the State in and around Beaufort and Jasper Counties; auger drilling to explore for coquina in Georgetown County; exploration for glass sand and discovery of a potentially commercial deposit in Kershaw County; and the presence of gold, copper, zinc, lead, manganese, and barite in a mile-wide belt near McCormick.

At yearend, 358 miles or 53 percent of South Carolina's total Interstate Highway System was open to traffic. Work was in progress on the remaining 323 miles designated for the State.

Table 3.—Employment 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
1965:								
Nonmetal and peat	943	260	246	1,993	---	35	17.57	3,331
Sand and gravel	416	242	101	815	1	27	34.36	12,104
Stone	747	266	198	1,630	---	24	14.73	465
Total	2,106	259	545	4,438	1	86	19.60	3,889
1966: p								
Nonmetal and peat	865	265	229	1,870	---	42	22.46	463
Sand and gravel	395	250	99	802	---	17	21.20	507
Stone	795	262	209	1,754	---	32	18.24	7,603
Total	2,055	261	537	4,426	---	91	20.56	3,300

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Mineral production in the State was almost exclusively nonmetals. Peat was mined on a small scale and marketed for agricultural use.

Barite.—Industrial Minerals, Inc. at Kings Creek in Cherokee County remained the only barite producer in the State. Both production and total value decreased. The barite was ground and used as rubber filler.

Cement.—Record years were established for the production of both masonry and portland cement. Masonry cement shipments and value increased 8 percent and 10 percent respectively, while portland cement shipments increased 10 percent. Unit prices increased slightly for masonry cement and remained constant for portland cement. Carolina Giant Division of Giant Portland Cement Co., near Harleyville, Dorchester County, continued to be the major producer of portland cement in the State. Santee Portland Cement Corp. placed on stream a new $10 million cement plant near Holly Hill.[3] The plant has a capacity of 2 million barrels per year.

Clays.—South Carolina again ranked second nationally in the production of kaolin. Production of all clays in 1966 constituted 19 percent of the State's total mineral output value. Production and value of kaolin increased 4 percent and 2 percent respectively to set a new State record. In Aiken County, six companies operated 11 mines. In Richland County, two companies operated two mines. Kaolin was used in rubber filler, paper, fertilizer, whiteware, saggers, firebrick, plaster, paint, insecticides, and other uses.

Miscellaneous clay production established a new record for the year with 1.6 million tons valued at $1.4 million, increases of 21 percent and 14 percent respectively. Fifteen companies operated 18 mines in 14 counties. Leading counties were Aiken, Dorchester, Greenwood, Marion, and Richland. Leading producers were Georgia-Carolina Brick Co., Giant Portland Cement Co., Pee Dee Ceramics, Inc., and Southern Brick Co. The primary use for miscellaneous clay was in the manufacture of brick, cement, draintile and sewer pipe.

Feldspar.—Production of a feldspar-silica mixture from Campbell Limestone Co.'s Pacolet granite quarry was continued by Spartan Minerals Co. The material was ground and shipped out of State for use in the manufacture of glass and pottery, and as rubber filler.

Kyanite.—Production of kyanite for refractory use was continued by Commercialores, Inc. at their Henry Knob kyanite mine in York County.

Lime.—Four companies produced regenerated or recirculated lime for use in paper manufacture and wood processing. Total production was 307,000 tons valued at $3,175,000. Unit value was below that for 1965.

Mica.—Scrap mica was recovered from mica schist mined in Kershaw, Lancaster

[3] Minerals Processing. V. 8, No. 1, January 1967, p. 10.

Table 4.—Kaolin sold or used by producers, by uses

Use	1965			1966		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Rubber	261,940	3,027,958	11.56	235,311	2,843,792	12.09
Paper filling	13,659	294,400	21.55	W	W	W
Fire brick and block	7,508	54,100	7.21	51,471	449,500	8.73
Whiteware, etc	26,165	528,050	20.18	W	W	W
Insecticides and fungicides	8,654	108,080	12.49	18,751	233,000	12.43
Fertilizers	32,891	288,200	8.76	W	W	W
Architectural terracotta	W	W	W	3,702	26,700	7.21
Plaster and plaster products	3,350	58,460	17.45	W	W	W
Mortar	2,350	17,000	7.23	W	W	W
Other uses [1]	162,376	2,941,320	18.11	229,191	3,880,800	16.93
Total	518,893	7,317,568	14.10	538,426	7,433,792	13.81

W Withheld to avoid disclosing individual company confidential data; included with "Other Uses".
[1] Includes foundries and steelworks, linoleum and oil cloth, paint, paper cloating, other fillers, kiln furniture, exports, other uses, and uses indicated by symbol W.

County, by Mineral Mining Corp. Production, about the same as in 1965, was dry ground for use in the manufacture of pipeline enamel, paint, plastics, welding rods, and electrical products.

Pyrite. — Commercialores, Inc., York County, recovered pyrite as a byproduct of kyanite ore milling. The pyrite was shipped out of State.

Sand and Gravel.—Sand and gravel production and value increased 15 percent to establish an alltime high for the State. The total output of 6 million tons valued at $7.7 million was produced by 26 companies from 31 mines in 18 counties. Twenty-two stationary plants, 3 portable plants, and 7 dredges were operated. Sand represented 69 percent of the total production and was used for construction, paving, fill, glass, blast, and other applications. Seventy-five percent of the sand and gravel was processed before shipment. Forty-one percent was shipped by rail and 59 percent by truck. Leading producing counties were Marlboro, Sumter, Lexington, Lancaster, Dorchester, Greenwood, and Aiken, which accounted for 82 percent of the total State production. The leading producers were Becker County Sand & Gravel Co., with mines located in Chesterfield, Dorchester, Marlboro, and Sumter Counties; Brewer Sand Co., in Lancaster County; and Columbia Silica Sand Co. in Lexington and Richland Counties.

Stone.—Crushed granite, dimension granite. and crushed limestone increased both in production and value to establish new records. Total stone production for the year was 8.1 million tons valued at $12.5 million.

Crushed granite was produced by 4 companies from 10 quarries in 7 counties. Leading counties were Lexington, Pickens, Richland, and Spartanburg. Leading producing companies were Campbell Limestone Co., with quarries in Greenville, Pickens, and Spartanburg Counties; Palmetto Quarries Co., with quarries in Fairfield, Greenwood, and Richland Counties, and Weston & Brooker Co., with a quarry in Lexington County. Seventy-two percent of the State's crushed granite production was shipped by truck; the remainder by rail. The stone was used primarily for concrete and roads, construction, and as railroad ballast.

Dimension granite for monumental stone was quarried by three companies operating four quarries in two counties. Producing companies were Winnsboro Granite Co., which operated a quarry in Fairfield Co., Kershaw Granite Co., Inc., with a quarry in Kershaw County, and Comolli Granite Co., with two quarries in Kershaw County.

Crushed limestone primarily for use in cement, agriculture, and construction, was produced in three counties by four companies from four mines. Total production and value increased. Producing companies were Giant Portland Cement Co., with a quarry in Dorchester County, Campbell Limestone Co., with a quarry in Cherokee County, Santee Portland Cement Co., with a quarry in Orangeburg County, and Ideal Cement Co., with a quarry in Dorchester County. Eighty-six percent of the crushed

Table 5.—Sand and gravel sold or used by producers, by uses
(Thousand short tons and thousand dollars)

Use	1965			1966		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	2,628	$1,713	$0.65	2,978	$1,848	$0.62
Paving	418	199	.48	383	230	.60
Fill	27	17	.63	277	171	.62
Glass	W	W	W	240	968	4.03
Blast	10	45	4.50	11	45	4.09
Other sands	W	W	W	249	W	W
Gravel	W	W	W	1,878	W	W
Total sand and gravel [1]	5,248	6,688	1.27	6,016	7,668	1.27

W Withheld to avoid disclosing individual company confidential data; included with "Total sand and gravel."
[1] Includes molding, fire for furnace, engine, filtration, chemical filler, pottery, and other sands; and structural, paving, and railroad ballast gravel.

Table 6.—Sand and gravel sold or used by producers, by counties
(Thousand short tons and thousand dollars)

County	1965		1966	
	Quantity	Value	Quantity	Value
Aiken	284	$252	W	W
Cherokee	W	W	12	W
Chesterfield	W	W	169	$129
Dorchester	W	W	302	W
Greenville	58	32	118	72
Horry	W	W	86	W
Lancaster	400	200	736	368
Lexington	936	1,467	964	1,588
Marion	W	W	7	7
Marlboro	W	W	1,507	W
Richland	77	28	W	W
Spartanburg	W	W	113	W
Sumter	W	W	1,067	W
Other counties [1]	3,493	4,709	935	5,504
Total	5,248	6,688	6,016	7,668

W Withheld to avoid disclosing individual company confidential data; included with "Other counties."
[1] Includes Florence, Greenwood, Jasper, Kershaw, and Pickens Counties, and counties indicated by symbol W.

limestone produced was transported by truck, the remainder was shipped by rail.

Vermiculite.—Production of vermiculite in South Carolina increased slightly. Three companies operated one mine each in Laurens County. They were W. R. Grace & Co., who shipped the crude vermiculite to its exfoliating plant at Traveler's Rest and out of State, Patterson Vermiculite Co., and American Vermiculite Co., both of which operated exfoliating plants in Laurens County. Uses of vermiculite were as loose fill insulation, in plaster, and in concrete.

METALS

Ferroalloys. — Ferrophosphorus was produced as a byproduct of elemental phosphorus furnace operations by Mobil Oil, Corp., Charleston. Ferrosilicon, ferrochromium, and ferrochromium-silicon were produced by Pittsburgh Metallurgical Co., also located in Charleston.

Zicronium.—Production of dry-milled and granular zircon for foundry, refractory, ceramic, and glass industry applications was continued by M & T Chemicals, Inc., located near Andrews, Georgetown County.

MINERAL FUELS

Peat.—Peat production declined slightly for the second consecutive year. Ti-Ti Peat Humus Co., Colleton County, was the only producer. The reed-sedge peat was used as a soil conditioner.

REVIEW BY COUNTIES

Mineral production was reported from 24 of the 46 counties in South Carolina, one county more than in 1965. Sixty percent of the State's total mineral production value was derived from Dorchester, Aiken, Lexington, and Marlboro Counties, listed in order of decreasing value. Other leading counties in production value were Greenville, Greenwood, Laurens, Orangeburg, Pickens, Richland, Spartanburg, Sumter, and York.

Aiken.—Kaolin producers, in order of de-

Table 7.—Value of mineral production in South Carolina, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Aiken	7,350,208	W	Kaolin, miscellaneous clay, sand and gravel.
Cherokee	1,150,000	1,216,150	Limestone, sand and gravel, miscellaneous clay, barite.
Chesterfield	W	129,000	Sand and gravel.
Colleton	W	W	Peat.
Dorchester	W	W	Cement, limestone, miscellaneous clay, sand and gravel.
Edgefield	W	W	Miscellaneous clay.
Fairfield	W	W	Granite, miscellaneous clay.
Florence	W	W	Sand and gravel.
Greenville	W	W	Granite, sand and gravel.
Greenwood	W	W	Granite, miscellaneous clay, sand and gravel.
Horry	W	W	Sand and gravel.
Jasper	W	W	Do.
Kershaw	W	929,624	Sand and gravel, kaolin, granite, miscellaneous clay.
Lancaster	W	W	Sand and gravel, mica, miscellaneous clay.
Laurens	W	W	Vermiculite.
Lexington	3,203,757	W	Granite, sand and gravel, miscellaneous clay.
Marion	W	170,000	Miscellaneous clay, sand and gravel.
Marlboro	W	W	Sand and gravel, miscellaneous clay.
Orangeburg	--	W	Cement, limestone, miscellaneous clay.
Pickens	W	W	Granite, sand and gravel.
Richland	W	W	Granite, miscellaneous clay, kaolin, sand and gravel.
Spartanburg	W	W	Granite, feldspar, sand and gravel.
Sumter	W	W	Sand and gravel, miscellaneous clay.
York	W	W	Kyanite, pyrites.
Undistributed	29,557,035	43,148,226	
Total	41,261,000	45,593,000	

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

[1] The following counties are not listed because no production was reported: Abbeville, Allendale, Anderson, Bamberg, Barnwell, Beaufort, Berkley, Calhoun, Charleston, Chester, Clarendon, Darlington, Dillon, Georgetown, Hampton, Lee, McCormick, Newberry, Oconee, Saluda, Union, and Williamsburg.

creasing output, were J. M. Huber Corp. (Barden, Ideal, and Paragon mines), Dixie Clay Co. (McNamee mine), National Kaolin Products Co. (Aiken County mine), Cyprus Mines Corp. (No. 7 mine), Southeastern Clay Co. (Seigler, Johnson, Rodgers, and Toole mines), and Bell Kaolin Co. (Batesburg mine).

Sand and gravel was mined by Augusta Sand & Gravel Co. (Clearwater mine) and Perry Minerals Co., Inc. (Clearwater mine). Georgia-Carolina Brick & Tile Co. mined miscellaneous clay at their North Augusta mine for use in brick manufacture.

Charleston.—Recirculated industrial lime was produced by West Virginia Pulp & Paper Co. at Charleston for use in pulp and paper processing. Production and value decreased. Crude iodine consumption was reported by the company. Mobil Oil Corp. and Pittsburgh Metallurgical Co., Inc. continued production of ferroalloys.

Cherokee.—Campbell Limestone Co. (Blacksburg quarry) increased production and remained the leading mineral producer in the county. The crushed limestone produced was used as agricultural lime, flux, and fertilizer filler. Broad River Brick Co. produced miscellaneous clay for use in building brick. Jobe Sand Co. (Blacksburg mine) continued production of industrial sand. Industrial Minerals, Inc. (Kings Creek mine) remained the only barite producer in the State.

Chesterfield.—F. T. Williams Co. (Pageland mine) increased production of building sand to become the leading producer in the county. Becker County Sand & Gravel Co. continued to mine sand and gravel at the Cash mine. Both output and value decreased. Huneycut Bros. Sand & Gravel Co. reported production of sand and gravel.

Colleton.—Ti-Ti Peat Humus Co., Inc. produced reed-sedge peat for use as a soil conditioner and remained the only peat producer in the State. Output and value of peat decreased slightly.

Dorchester.—Dorchester County again led the State in mineral production value. The leading mineral producer in the county, Giant Portland Cement Co., crushed limestone and mined miscellaneous clay for use in the manufacture of masonry and portland cement. Production and value of all these commodities increased except for portland cement, which remained about the same. Ideal Cement Co. crushed limestone from its Carolina quarry for use as agricultural lime and asphalt filler. Becker

County Sand & Gravel Co. (Summerville mine) continued production of building and paving sand. Murry Mines mined sand for use in construction.

Edgefield.—Merry Bros. Brick & Tile Co., the county's only mineral producer, mined miscellaneous clay for brick manufacture.

Fairfield.—Crushed granite for use in concrete and as roadstone was produced by Palmetto Quarries Co. (Blair quarry) and Rion Crushed Stone Co. (Rion quarry). During the year Rion was purchased by Superior Stone Co. Winnsboro Granite Co. (Winnsboro quarry) made considerable gains both in production and value of dimension granite. Miscellaneous clay was mined by Richland Shale Products Co. (Richtex mine) for use in building brick manufacture.

Florence.—Lanford Sand Co. (Florence mine) and Coastal Sand Co. (Johnsonville mine) mined building sand. South Carolina Industries, Inc. recovered lime for paper use.

Georgetown.—International Paper Co. (Georgetown limekiln) recovered lime for use in pulp and paper manufacture. Output and value of lime increased considerably.

Greenville.—Campbell Limestone Co. (Lakeside quarry) crushed granite, with increases in output and value. The granite was used primarily in concrete. Cooper Sand Co. (Piedmont mine), Zupan Sand Co. (Greenville mine), and W. M. Barber Sand Co. (Greenville mine) mined sand for building, fill and paving purposes. Increases in production and value were reported. W. R. Grace & Co. continued operation of their vermiculite exfoliating plant at Traveler's rest. Crude vermiculite was obtained from the Company's Enoree mine in Laurens County. The expanded vermiculite was used in concrete, plaster, agriculture, and as loose fill insulation.

Greenwood.—Palmetto Quarries Co. crushed granite at two quarries, Stoney Point, and Coronaca, and was the largest mineral producer in the county. Total output and value increased considerably. The crushed granite was used in concrete. Sand was produced by Wilson Bros. Sand Co. (Hodges mine) for use in paving. Perry Minerals Co., Inc. (Ware Shoals mine) produced sand and gravel for use in construction. Output and value increased for both companies. Southern Brick Co. (Ninety-Six mine) mined miscellaneous clay for use in brick manufacture. Clay output and value increased.

Horry.—E. P. Pitts Sand Co. continued production of glass sand from its Pitts mine. Production and value increases were reported.

Jasper.—Deerfield Sand & Mining Co. mined building sand and reported increases in output and value.

Kershaw.—Comolli Granite Co. (Carolina Mahogany and Carolina Diamond Gray quarries) and Kershaw Granite Co., Inc. (Kershaw quarry) produced dimension granite for rough monumental use. Output and value increased for both companies. Miscellaneous clay production was reported by two companies, Carolina Ceramics, Inc. (Kershaw mine) and Eastern Brick & Tile Co. Output and value remained about the same for Carolina, with increases reported for Eastern. The clay was used in building brick manufacture. Carolina Ceramics, Inc. also produced kaolin in Kershaw County for use in fire brick manufacture. Whitehead Bros. Co. (Lugoff mine) produced molding sand and reported increases in output and value. Another producer of sand, Kershaw County Sand Co. (Camden mine), continued operation with its product being used in building and as fill. Production and value increased for the year. Mineral Mining Corp. (Kershaw grinding plant) produced scrap mica from schist obtained from a deposit in Lancaster County; output and value remained about the same.

Lancaster.—Scrap mica was mined by Mineral Mining Corp. from a schist deposit, and was milled in its Kershaw grinding plant in Kershaw County; output and value were almost unchanged. The scrap mica was used in paint, electrical insulation, welding rod coatings, plastics, and pipeline enamel. Ashe Brick Co. (Van Wyck mine) mined miscellaneous clay for brick manufacture; output and value increased. Brewer Sand Co. mined building sand and reported increases in output and value.

Laurens.—Three companies mined vermiculite and two of them operated exfoliating plants in Laurens County. Zonolite Division of W. R. Grace & Co. (Enoree mine) shipped crude vermiculite to its exfoliating plant near Traveler's Rest, and

out of State. Patterson Vermiculite Co. (Laurens County mine) exfoliated crude vermiculite at its Enoree plant. American Vermiculite Co. (Donnon mine) exfoliated its production at its Enoree plant. Zonolite and Patterson reported increases in output and value. Production and value of American Vermiculite was reported to be comparable with the preceding year's record. Vermiculite uses were primarily in building plaster, concrete, and agriculture.

Lexington.—Foster Bros. Dixiana Sand Co. (Dixiana mine), Southern Silica Mining & Manufacturing Co. (Dixiana mine), Columbia Silica Sand Co. (Edmund mine), and Pennsylvania Glass Sand Corp. (Columbia mine) mined sand in Lexington County. Foster and Pennsylvania reported increases in output and value; Southern dropped slightly in production and value, and Columbia reported decreased production with increased value. Primary uses for sand produced in the county were as glass, blast, engine, molding, chemical filler, pottery, and building sand. Weston & Brooker Co. (Cayce quarry) crushed granite with reported output and value at a new record high. The crushed granite was used in concrete, as railroad ballast and stone sand. Guignard Brick Co. mined miscellaneous clay from its Columbia mine; output and value decreased slightly. The clay was used in the manufacture of building brick.

Marion.—Pee Dee Ceramics, Inc. mined miscellaneous clay for use in building brick manufacture; production and value increased. Building sand was mined by Sandy Bluff Sand Co. at its Snipes mine; both output and value increased.

Marlboro.—Miscellaneous clay for brick manufacture was produced in Marlboro County by two companies, Cheraw Brick Works, Inc. and Palmetto Brick Co. (Irby mine). Both companies reported decreases in output and value. Becker County Sand & Gravel Co. (Marlboro mine) increased production of both sand and gravel. The value of sand dropped slightly, but gravel value increased a small amount. The sand and gravel was used in building, and railroad ballast, and in chemical and metallurgical applications.

Orangeburg.—Santee Portland Cement Corp. produced masonry and portland cement from its new Holly Hill plant. Miscellaneous clay production from the company's Holly Hill mine, and limestone output were also reported.

Pickens.—Campbell Limestone Co. (Beverly quarry) crushed granite for roadstone, riprap, and stone sand; production and value decreased. Holliday Sand Co. (Pickens mine) produced building sand; output and value decreased.

Richland.—Palmetto Quarries Co. (Columbia quarry) crushed granite for roadstone, riprap, and railroad ballast. Miscellaneous clay was produced by Columbia Brick & Tile Co., Eastern Brick & Tile Co. (601 mine), and Carolina Ceramics Co. (Richland mine) for use in the manufacture of building brick. Columbia and Carolina reported decreases in output and value, and Eastern reported increases. D. T. Duncan and Columbia Pipe Co. (Ridgewood mine) mined kaolin for use in fire brick, terra-cotta, and saggers. Sand for use in building and as filler was mined by Ready Sand Co., and Columbia Silica Sand Co. (Harrison mine), formerly Harrison Sand Corp. Columbia production and value dropped from the previous year and Ready Sand Co. reported production for the first time. Columbia Organic Chemical Co., Inc. consumed crude iodine in the production of various iodides, an increase of 68 percent.

Spartanburg.—L. G. Chapman Sand Pit, Inc. produced sand for building and fill and gravel for paving. Sand output and value increased, while gravel production remained constant. Spartan Minerals Co. recovered feldspar from granite screenings at Campbell Limestone Co.'s Pacolet quarry. The product was processed at Spartan's Pacolet grinding plant and used in glass and pottery manufacture and as a rubber filler. Campbell Limestone Co. crushed granite from two quarries, Pacolet and Pelham. Output increased and value decreased slightly. The stone was used in concrete, and as riprap and railroad ballast.

Sumter.—Becker County Sand & Gravel Co. continued production of sand and gravel at its Camden mine. Sand and gravel output and value increased; both were used in construction and paving; gravel was used also as railroad ballast. Eastern Brick & Tile Co. (Wedgefield mine) produced miscellaneous clay for building brick manufacture; both output and value increased.

York.—Commercialores, Inc. (Henry Knob kyanite mine) reported slight decreases in production and value of kyanite and pyrite. The pyrite was recovered from mill tailings. Kyanite was used in the manufacture of refractories. Bowater Carolina Corp. (Catawba limekiln) produced regenerated lime for use in pulp and paper manufacture; production and value decreased slightly.

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 Franklin H. Persse [1] and William C. Henkes [2]

The value of mineral production for 1966 was $52.7 million, a 5-percent increase over that of 1965, but short of the record high of $54.1 million reported in 1963.

Increased production of stone and cement, 48 and 24 percent in value, respectively, was the main source of the $3.2 million gain in nonmetals. The rise in the value of fuels produced ($37,000) resulted from the increased oil output at the Buffalo oilfield. Metals declined another 3 percent because gold and silver production declined at the Homestake mine at Lead; for the 18th consecutive year, however, this mine, and South Dakota remained the leading gold producers in the Nation.

During the year, the Federal Bureau of Mines released three publications on mineral deposits within the State: Reports describing nonpegmatitic beryllium occurrences in eight States including South Dakota;[3] and on berryllium-bearing pegma-

[1] Mining engineer, Bureau of Mines, Denver, Colo.

[2] Petroleum engineer, Bureau of Mines, Denver, Colo.

[3] Meeves, Henry C. Nonpegmatitic Beryllium Occurrences in Arizona, Colorado, New Mexico, Utah, and Four Adjacent States. BuMines Rept. of Inv. 6828, 1966, 68 pp.

Table 1.—Mineral production in South Dakota [1]

Mineral		1965		1966	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrate	short tons, gross weight	W	W	124	$40
Cement:					
Masonry	thousand 280-pound barrels	55	$180	51	170
Portland	thousand 376-pound barrels	1,575	5,127	1,974	6,367
Clays	thousand short tons	223	1,220	231	870
Coal (lignite)	do	10	49	10	45
Feldspar	long tons	51,560	346	83,950	542
Gem stones		NA	20	NA	20
Gold (recoverable content of ores, etc.)	troy ounces	628,259	21,989	606,467	21,226
Gypsum	thousand short tons	7	27	17	68
Lithium minerals	short tons	150	5	W	W
Petroleum (crude)	thousand 42-gallon barrels	219	438	29	479
Sand and gravel	thousand short tons	13,998	14,155	13,630	13,585
Silver (recoverable content of ores, etc.)	thousand troy ounces	129	167	110	142
Stone	thousand short tons	1,554	5,387	2,186	7,995
Uranium ore	short tons	44,738	303	W	W
Value of items that cannot be disclosed: Lime, mica (scrap), molybdenum, tin (1966), vanadium, and values indicated by symbol W		XX	762	XX	1,158
Total		XX	50,175	XX	52,707

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

XX Not applicable.

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

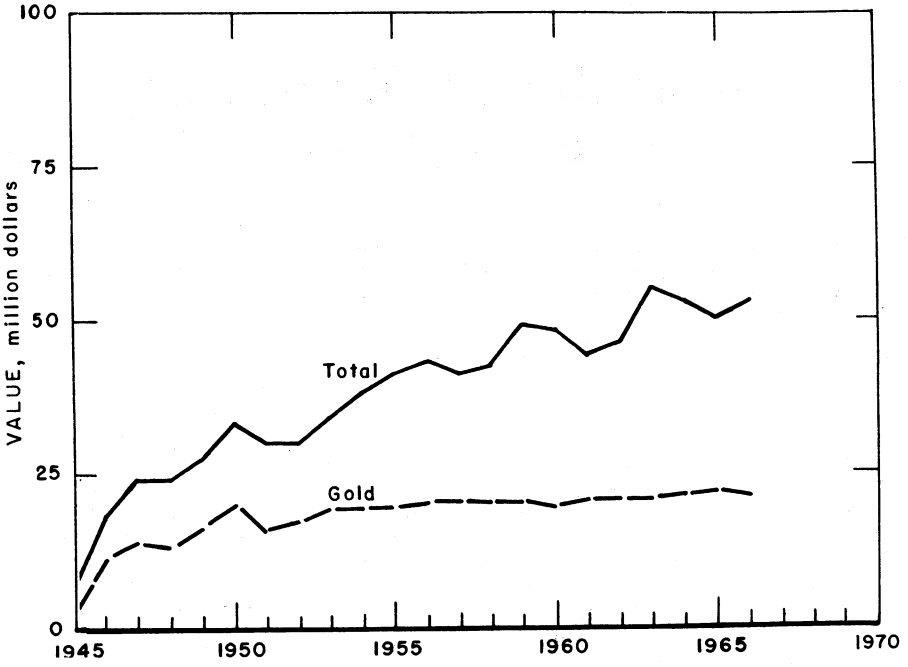

Figure 1.—Value of gold and total value of mineral production in South Dakota.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]
1957	$40,129
1958	41,648
1959	48,222
1960	46,117
1961	43,459
1962	43,809
1963	50,889
1964	49,152
1965	46,851
1966	49,154

[1] Data for 1957–65 revised.

tite deposits in six western States including South Dakota;[4] and on the iron resources in South Dakota.[5]

Employment and Injuries.—Exclusive of the petroleum industry, final statistics for 1965 and preliminary statistics for 1966 of employment and injuries in the mineral industry are given in table 3.

Government Programs.—The South Dakota School of Mines and Technology at Rapid City received two grants from the Federal Bureau of Mines. One grant for $18,046 was to finance research on recovery of beryllium and other valuable metals from mine dumps and mill tailings in the Black Hills. The other, for $11,528, was to be used to develop methods for recovering silver, copper, and other valuable metals from ash generated at power stations in the northern Great Plains that burn lignite. The School also received a grant of $15,965 from the U.S. Geological Survey to gather information on ore deposits in the Black Hills.

Contracts awarded for highway construction in South Dakota amounted to $46.3 million, a 12-percent increase over that of 1965. Contracts awarded for Interstate highway construction had the greatest in-

[4] Meeves, Henry C., Clarence M. Harrer, Melford H. Salsbury, Albert S. Konselman, and Spencer S. Shannon, Jr. Reconnaissance of Beryllium-Bearing Pegmatite Deposits in Six Western States: Arizona, Colorado, New Mexico, South Dakota, Utah, and Wyoming. BuMines Inf. Circ. 8298, 1966, 34 pp.

[5] Harrer, C. M. Iron Resources of South Dakota. BuMines Inf. Circ. 8278, 1966, 160 pp.

Table 3.—Employment 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
1965:								
Coal	4	125	1	4				
Metal	1,877	299	561	4,487	3	83	19.17	6,612
Nonmetal	265	227	60	488		10	20.48	479
Sand and gravel	1,056	158	166	1,370		26	18.98	424
Stone	413	235	97	779	1	18	24.40	8,592
Total	3,615	245	885	7,128	4	137	19.78	5,215
1966: p								
Coal	5	121	(1)	4				
Metal	1,830	299	547	4,359	1	85	19.73	2,234
Nonmetal	270	219	59	481		8	16.63	81
Sand and gravel	1,085	157	171	1,412	1	25	18.41	4,933
Stone	405	244	98	821		19	23.14	1,291
Total	3,595	243	875	7,077	2	137	19.64	2,516

p Preliminary.
1 Less than 500.

crease, $4.1 million or 21 percent.[6] As of December 31, 376.7 miles of Interstate highway was open for traffic—42.4 miles more than as of this date 1 year ago. Highway-maintenance expenditures were $7.3 million, a 25.8-percent increase.[7]

The Secretary of the Interior, Stewart L. Udall, approved the recommendation made by the Office of Coal Research (OCR) that a pilot plant for the gasification of lignite be located at Rapid City. A contract with Consolidation Coal Co. for constructing and operating the plant was to be awarded early in 1967. The operation of the plant would require lignites and limestone, both found in the area. The product would be a synthetic gas competitive with natural gas.

Two applications were submitted to the Office of Minerals Exploration (OME) for loans to explore silver properties; however, none were approved in 1966.

Under the Mining Claim Occupancy Act of 1962, 27 patents were issued to residents of the Lead area at a ceremony held at Lead on December 18.

[6] Engineering News-Record. State Highway Department's Construction Plans for 1967 . . . and Budgets for Maintenance: Highway Construction Spending Will Reach For a Record This Year. V. 78, No. 12, Mar. 23, 1967, pp. 24-25.

[7] Bureau of Public Roads. Quarterly Report on The Federal-Aid Highway Program, Dec. 31, 1966. Press Release BPR 67-5, Feb. 1, 1967.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—The only State-owned cement plant in the United States was the South Dakota Cement Commission plant at Rapid City. This plant, the only cement producer in the State, was the only consumer of gypsum and iron ore, and the largest consumer of limestone and shale in the State; in addition about 11,000 tons of sand, was consumed. These minerals yielded 2,004,330 barrels of portland cement and 64,714 barrels of masonry cement, 30 percent more than in 1965. The gain was attributed to the increased use of concrete in highway construction: Highway contractors received 41.5 percent and ready-mix concrete companies received 33.2 percent of the cement produced. Of the remainder, 15.6 percent went to building material dealers, 6.5 percent to concrete-products manufacturers, 2 percent to other contractors, and 1.2 percent to miscellaneous users. Sixty-five percent of the cement shipments were by railroad.

Clays.—Bentonite, shale, and common clays were produced and processed in the State. American Colloid Co. and International Minerals & Chemical Corp. (IMC) each operated a bentonite processing plant near Belle Fourche where ores mined in Wyoming and South Dakota were processed. IMC resumed mining bentonite in South Dakota after many years. Shale

mined at two locations in Pennington County was the source of more than one-half of the State's total clay production. South Dakota Cement Commission mined the shale used in manufacturing cement. Light Aggregates, Inc. of Rapid City, mined shale and expanded it to lightweight aggregate. Black Hills Clay Products Co. mined common clays in Butte County for brick manufacture at its Belle Fourche plant.

Feldspar.—Twenty-two mines in Custer County and five in Pennington County were the sources of feldspar, all potash type. Although these 27 operations were 8 fewer than in 1965, production increased 63 percent.

Small amounts of hand-sorted ore were shipped to manufacturers of glass, porcelain, and pottery. The remainder was treated at either the grinding plant near Custer or the Northwest Beryllium Corp. flotation mill at Keystone.

Northwest Beryllium Corp. obtained most of its ore from its own Peerless mine. Both the ground feldspar and the floated feldspar were shipped to users in other States, Canada, and Mexico.

Gypsum.—The only producer and consumer of gypsum within the State was the South Dakota Cement Commission. Production from its open pit mine in Pennington County was 17,103 tons, 2.4 times as much as was mined in 1965. Of this amount, 16,714 tons was used at the Rapid City plant for manufacturing cement. The remainder was stockpiled.

Lime.—Lime was produced by Black Hills Lime Co. at Pringle and Pete Lien & Sons near Rapid City. The former com-

Table 4.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	420	$503	404	$493
Paving	200	249	165	206
Fill	39	30	73	65
Other	--	--	[1] 3	[1] 12
Industrial: Glass	--	--	(1)	(1)
Total	659	782	645	776
Gravel:				
Construction:				
Building	305	364	214	317
Paving	1,547	1,796	1,459	1,700
Railroad ballast	32	38	12	9
Fill	57	38	44	35
Other	8	8	30	20
Miscellaneous	2	1	18	18
Total	1,951	2,245	1,777	2,099
Total sand and gravel	2,610	3,027	2,422	2,875
Government-and-contractor operations:				
Sand:				
Building	(2)	1	--	--
Paving	2,772	2,773	2,246	2,258
Other	7	6	9	9
Total	2,779	2,780	2,255	2,267
Gravel:				
Building	66	55	135	100
Paving	8,543	8,293	8,818	8,343
Total	8,609	8,348	8,953	8,443
Total sand and gravel	11,388	11,128	11,208	10,710
All operations:				
Sand	3,438	3,562	2,900	3,043
Gravel	10,560	10,593	10,730	10,542
Total	13,998	14,155	13,630	13,585

[1] Includes glass sand.
[2] Less than ½ unit.

partly manufactured quicklime for metallurgical use, and the latter manufactured quicklime and hydrated lime for use in plaster and water treatment. Substantial quantities of hydrated lime also were used for soil stabilization.

Table 5.—Sand and gravel production in 1966, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value
Aurora	360	$366
Beadle	105	107
Bennett	3	3
Bon Homme	205	198
Brookings	269	309
Brown	560	602
Brule	78	86
Buffalo	78	79
Butte	1,021	1,076
Campbell	123	124
Charles Mix	443	374
Clark	246	187
Clay	70	69
Codington	299	367
Corson	271	233
Custer	102	64
Davison	845	817
Day	344	298
Deuel	110	127
Dewey	49	49
Douglas	99	110
Edmunds	18	18
Fall River	95	95
Faulk	153	158
Grant	409	482
Gregory	114	122
Haakon	56	56
Hamlin	23	30
Hand	818	272
Hanson	289	295
Harding	26	26
Hughes	100	96
Hutchinson	161	167
Hyde	57	46
Jackson	76	76
Jerauld	229	229
Jones	39	39
Kingsbury	95	95
Lake	104	95
Lawrence	121	139
Lincoln	93	95
Lyman	206	199
McCook	166	181
McPherson	244	244
Marshall	138	131
Meade	155	155
Mellette	28	28
Miner	71	71
Minnehaha	585	532
Moody	319	338
Pennington	822	879
Perkins	499	555
Potter	140	140
Roberts	129	143
Sanborn	54	57
Shannon	73	73
Spink	93	94
Sully	87	87
Todd	80	80
Tripp	387	325
Turner	300	303
Union	149	149
Walworth	282	295
Washabaugh	55	55
Yankton	177	184
Ziebach	75	75
Total	13,630	13,585

Lithium.—South Dakota, one of the three States that produced lithium minerals, shipped a small amount of hand-sorted amblygonite ore.

Mica.—Scrap mica was produced from the Hugo mine operated by L. W. Judson, the Ingersoll operated by Keystone Chemical Co., and the Peerless operated by Northwest Beryllium Corp., all in Pennington County near Keystone. The product was shipped to consumers outside of the State, mainly in the Chicago area for paint and roofing material.

Black Hills Rose Quartz Co. trimmed some sheet mica; however, no shipments were made.

Sand and Gravel.—Sand and gravel was produced in 66 of the 67 counties; Stanley County reported no production. The State total production declined 368,000 tons because of a slowdown in building and highway construction during the last half of the year. Butte County led the State with a production of 1 million tons, approximately three times the amount produced in the county in 1965. The South Dakota Department of Highways construction program in Butte County stimulated this increase.

Output was reported by 148 respondents from 410 operations. One hundred and thirty-four commercial operations utilized 27 stationary and 60 portable plants. Government-and-contractor operations numbered 276; using 20 stationary and 49 portable plants. The Government-and-contractor sand and gravel was produced for the Federal Bureau of Indian Affairs, Federal Bureau of Reclamation, U.S. Army Corps of Engineers, South Dakota Aeronautic Commission, South Dakota Cement Commission, South Dakota Department of Highways, and county and municipal highway departments.

Stone.—Seven classifications of stone were produced; crushed and dimension granite, crushed and dimension limestone, crushed and dimension sandstone, and crushed miscellaneous stone. The quantity of total stone produced increased 41 percent and value increased 48 percent; dimension limestone, an exception, decreased slightly. Output came from 41 operations in 11 counties. The leading counties were Grant, with a production value of $4.1 million from six dimension granite quarries and one crushed miscellaneous stone quarry;

Table 6.—Stone sold or used by producers, by kinds

Year	Granite		Limestone		Sandstone [1]	
	Short tons	Value	Short tons	Value	Short tons	Value
1962	25,923	$2,442,181	1,572,300	$2,184,374	1,119,655	$1,779,639
1963	24,630	2,761,546	1,652,571	2,427,016	1,033,749	2,070,837
1964	17,803	2,807,851	1,179,551	1,734,812	920,361	1,702,349
1965	20,129	2,944,586	868,726	1,411,917	650,847	1,006,609
1966	23,806	4,066,853	1,100,575	1,793,263	983,897	1,997,291

Year	Other stone		Total	
	Short tons	Value	Short tons	Value
1962	[2] 134,056	[2] $126,373	2,851,934	$6,532,567
1963	82,618	79,310	2,793,568	7,338,709
1964	----------	----------	2,117,715	6,245,012
1965	14,068	24,117	1,553,770	5,387,229
1966	77,800	137,349	2,186,078	7,994,756

[1] Includes quartz and quartzite.
[2] Includes slate.

Table 7.—Stone sold or used by producers, by uses

Use	1965		1966	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction and rubble---------short tons	4,000	$6,000	W	W
Rough architectural---------cubic feet	[1] 116,635	[1] 869,679	[1] 136,764	[1] $1,741,591
Dressed architectural---------do				
Rough monumental---------do				
Dressed monumental---------do	131,903	2,074,907	157,177	2,330,462
Flagging---------do	25,000	3,000	W	W
Total (approximate, in short tons)----------	26,129	2,953,586	28,796	4,079,553
Crushed and broken stone:				
Riprap---------short tons	33,858	45,915	75,335	127,753
Railroad ballast---------do	285,167	392,220	279,494	378,945
Concrete and roadstone---------do	821,577	1,294,181	1,235,485	2,294,570
Cement---------do	312,564	562,615	451,115	812,007
Other---------do	[2] 74,475	[2] 138,712	[3] 115,853	[3] 301,928
Total---------do	1,527,641	2,433,643	2,157,282	3,915,203
Total stone (approximate, in short tons)-------	1,553,800	5,387,229	2,186,100	7,994,756

W Withheld to avoid disclosing individual company confidential data; included in "Totals."
[1] Rough architectural, dressed architectural, and rough monumental combined to avoid disclosing individual company confidential data.
[2] Includes stone used in other filler, lime, and refractory.
[3] Includes stone used for decorative use, other filler, landscaping, lime, precasting, refractory, and roofing granules.

and Pennington with an output value of $1.8 million from eight limestone and three sandstone operations.

Dimension granite was used for architectural and monumental stone and the crushed granite was used for riprap by the city of Lead. Dimension limestone uses were crushed rubble, curbing, and flagging and the limestone was used for riprap, concrete aggregate, road metal, railroad ballast, filler, and manufacturing lime and cement.

All of the dimension sandstone produced was used as building stone. Crushed sandstone was produced in five counties by eight firms and included uses as ganister, riprap, concrete aggregate, road metal, railroad ballast, filler, and decoration. The leading producers of crushed sandstone were Spencer Quarries, Inc., Hanson County; Concrete Materials Co., Minnehaha County; and John A. Carlson, Inc., Tripp County.

Crushed miscellaneous stone was produced in six counties for riprap, concrete aggregate, and road metal. The product was used on construction projects of the U.S. Army Corps of Engineers, Federal Bureau of Public Roads, South Dakota Department of Highways, and Grant County Highway Department.

METALS

Beryllium.—Production of beryl concentrate increased substantially. Output was reported from the Tin Mountain mine operated by Walter S. Clifford in Custer County, and from various mines in Pennington County. The major Pennington County producers were the Hugo mine operated by L. W. Judson and the Peerless mine operated by Northwest Beryllium Corp. Purchasers included Beryl Ores Co. of Arvada, Colo.

Gold and Silver.—All gold and silver mined within the State came from the Homestake mine at Lead. According to the Homestake Mining Co. annual report, 2,002,239 tons of ore was produced, yielding 606,467 ounces of gold and 109,885 ounces of silver with a combined value of $21,309,115. This amount was $784,757 less than the value of the gold and silver recovered in 1965. Part of this decrease was attributed to the lower grade of ore recovered during the year; in addition, the labor shortage was also a factor, with mine production falling below mill capacity. The metallurgical recovery was 95.7 percent, the same as in 1965.

Ending more than 50 years of operation without union representation, the hourly employees of Homestake Mining Co., in June, voted to be represented by the United Steelworkers of America. A 3-year labor contract was negotiated and signed on December 5. Since 1947, six previous attempts to organize a union at the mine had failed.

Iron Ore.—Iron ore had been mined near Nemo and stockpiled in sufficient quantity to last the only consumer, the State-owned cement plant, many years. Production was to resume when the stockpile was depleted.

Molybdenum.—Molybdenum output was from uraniferous lignite ore mined in Harding County. Most of the ore was shipped for processing to the Kerr-McGee Corp. burning plant at Bowman, N. Dak. The ash was then shipped to its New Mexico mill for recovery of uranium and molybdenum. A small quantity of molybdenum also was recovered as a byproduct by Mines Development, Inc., a subsidiary of The Susquehanna Corp. at its Edgemont plant.

Tin.—Northwest Beryllium Corp. recovered a small amount of tin concentrate (cassiterite) from the pegmatite ore processed at its Keystone mill, the first production reported in the State after a lapse of 17 years.

Uranium.—Output of uranium ore increased slightly over that of 1965. Uraniferous lignite ore was produced at 5 mines in Harding County and sandstone ore was produced at 27 mines in Fall River County; a total of 5 more operations than in 1965. The uraniferous lignite ore was shipped to the Mines Development, Inc., mill at Edgemont and to the Kerr-McGee Corp. plant at Bowman, N. Dak. After burning the ore, Kerr-McGee sent the ash to its mill at Grants, N. Mex., for recovery of uranium and molybdenum. The sandstone ore was shipped to the Mines Development, Inc., mill at Edgemont for recovery of uranium.

In addition to processing indigenous uranium ore, Mines Development, Inc., processed uraniferous lignite ore from North Dakota and sandstone ore from Washington and Wyoming.

The authority for Mines Development, Inc., to sell uranium ore to the U.S. Atomic Energy Commission (AEC), due to expire December 31, 1966, was extended to

Table 8.—Mine production of gold and silver in terms of recoverable metals

Year	Mines producing		Material sold or treated [1] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1957–61 (average)	2	------	1,786	565,863	$19,805	129	$118
1962	2	------	1,869	577,232	20,203	113	123
1963	3	1	1,909	576,726	20,185	117	150
1964	1	1	2,033	616,913	21,592	133	172
1965	1	------	2,032	628,259	21,989	129	167
1966	1	------	2,002	606,467	21,226	110	142
1876–1966	NA	NA	NA	31,814,359	895,099	12,247	9,429

NA Not available.
[1] Excludes placer gravel.

permit limited production for sale to the AEC through December 31, 1968.

Vanadium.—Susquehanna-Western, Inc., a subsidiary of The Susquehanna Corp., recovered vanadium pentoxide at its Edgemont plant. The product was recovered from uranium-sandstone ore tailings from the adjoining uranium mill of Mines Development, Inc., and from California slag. The uranium-vanadium sandstone ores were mined in Fall River County and Washington and Wyoming.

MINERAL FUELS

Coal.—Lignite was strip mined from the 54-inch thick Hellcreek seam near Firesteel. Although the mine, operated by Dewey County Coal Co., was idle from mid-February until late fall, output was approximately the same as that of 1965.

Petroleum.—Crude oil production from the Buffalo field in Harding County increased 16 percent to 219,888 barrels. This increase resulted from three new wells (two in late 1965) and from more efficient operation of the field.

The increase at the Buffalo field more than offset the drop in production at the small Barker Dome field. The net increase for the State was 9 percent. Natural gas produced at Buffalo field, 14 million cubic feet, was used for field fuel or flared.

Drilling declined sharply from the 1965 peak; total drilling amounted to 14 wells, compared with 33 wells in 1965. Two development oil wells were drilled: One each in the Buffalo and Barker Dome fields. Exploratory drilling was scattered through the southcentral part of the State. In its continuing exploration program—with five wells during the year—Gulf Oil Corp. found shows of oil in the Winnipeg formation (Ordovician) in a well drilled in 1965 in sec 14, T43N, R29E, Mellette County. Additional tests in 1966 failed to establish commercial production.

At yearend, 475,453 acres of Federal and 50,422 acres of Indian lands were under lease for oil and gas. Sales of Indian leases were held on June 21 and July 13. The first sale covered lands on the Rosebud Reservation and totaled 39,202 acres for which the average bid was 52 cents an acre. The second, in the Cheyenne River Reservation, covered 7,542 acres which received an average bid of $3.34 an acre.

The State Department of School and Public Lands held two oil- and gas-lease sales. Total acreage leased was 244,556 which brought a bonus of $15,224. Largest offerings were in the southcentral counties: Bennett, Jones, Mellette, Stanley, Sully, and Tripp. Most active leases were Gulf Oil Corp. and Tenneco Oil Co.

Table 9.—Drilling for petroleum in 1966, by counties

County	Oil	Dry	Total	Footage
Exploratory completions:				
Bennett	--	1	1	4,556
Custer	--	1	1	1,333
Fall River	--	1	1	1,526
Haakon	--	2	2	8,947
Harding	--	1	1	7,800
Jones	--	1	1	2,653
Lyman	--	1	1	2,458
Mellette	--	1	1	3,276
Stanley	--	2	2	5,537
Sully	--	1	1	2,251
Total	--	12	12	40,337
Development completions:				
Custer	1	--	1	1,426
Harding	1	--	1	8,420
Total	2	--	2	9,846
Total all drilling	2	12	14	50,183

Source: Committee on Statistics of Drilling, American Association of Petroleum Geologists.

REVIEW BY COUNTIES

Mineral output was reported by 66 of the 67 counties; Stanley County was the exception. However, only those counties with significant production or activity in the mineral industry are discussed.

Butte.—Value of mineral production increased 20 percent, as a result of substantial increases in the output and value of sand and gravel and in the output of common clay. Sand and gravel output was stimulated principally by increased highway construction.

Black Hills Clay Products Co. manufactured brick at its Belle Fourche plant from the miscellaneous clay mined within the county.

The plants at Belle Fourche, owned by American Colloid Co. and IMC, processed bentonite ore mined in the county and in Wyoming; however, total production was below that of 1965. Nearly one-half of the South Dakota bentonite was used by foundries. Other principal uses were in rotary drilling, insulation, animal feed, and reservoir lining. A substantial tonnage was exported.

Custer.—Increased production of sand and gravel and feldspar more than offset the decline in lime, stone, beryl concentrate, and petroleum.

Twenty-two mines, five fewer than in 1965, yielded the increased amount of feldspar ore—mostly processed at the IMC plant at Custer. The one major producer was IMC at the Shamrock and Tip Top mines. Sand and gravel production increased many fold because of use for road construction and maintenance by the Custer County Highway Department and the State Department of Highways.

Although a new development well was drilled in the Barker Dome Oilfield, production declined 34 percent; the decline reflected the steady depletion of the reservoir.

Walter Clifford, operating the Tin Mountain mine, reported a small amount of tantalum produced and stockpiled.

Fall River.—The value of the three minerals produced—sand and gravel, uranium, and vanadium—increased.

Sand and gravel, all used for State and county highway construction, more than doubled. The number of uranium ore mines and the value of the uranium ore both increased. The ore, a sandstone containing uranium and vanadium, was processed at the Edgemont mills. Mines Development, Inc., recovered uranium from sandstone ore mined in Fall River County and from ore mined in Washington and Wyoming. The company also recovered uranium from uraniferous lignite mined in Harding County, S. Dak., and Billings and Slope Counties, N. Dak. Tailings from the sandstone ores were processed in the adjoining Susquehanna-Western, Inc., mill where vanadium pentoxide was recovered. The Susquehanna-Western, Inc., mill also processed vanadium bearing slags from California. Vanadium pentoxide recovery from ores mined in Fall River County declined. Additional equipment installed in the vanadium mill at yearend was expected to increase the vanadium pentoxide output.[8]

At its Edgemont mill, Mines Development, Inc., recovered a small amount of molybdenum from uraniferous lignite ores mined in Harding County.

Only 1 exploratory oil well was completed, compared with 11 for each of the 2 previous years.

Grant.—The value of mineral production increased 48 percent. Sand and gravel and stone were the only two mineral commodities produced. The sand and gravel producers were the South Dakota Department of Highways and the Grant County Highway Department, which also produced crushed stone. The value of dimension stone from six granite quarries near Milbank and Big Stone City was over $4 million. Quarry operators were Cold Spring Granite Co., Dakota Granite Co. (operating two quarries), Delano Granite Works, Inc., Robert Hunter Granite Co., Inc., and Steiner-Rausch Granite Co.

Harding.—The 6-percent increase in the value of minerals produced could be attributed to only two minerals, petroleum and uranium. Full production from three new wells and more efficient operations increased output at the Buffalo oilfield by 30,350 barrels. Uranium content of the uraniferous lignite ash—shipped by Kerr-McGee Corp. to its plant in Grants, N. Mex., and by Susquehanna-Western, Inc, to

[8] The Susquehanna Corp. annual report 1966 to stockholders.

Table 10.—Value of mineral production in South Dakota, by counties

County	1965	1966	Minerals produced in 1966 in order of value
Aurora	$382,000	$366,000	Sand and gravel.
Beadle	99,000	107,000	Do.
Bennett	77,000	3,000	Do.
Bon Homme	289,000	198,000	Do.
Brookings	543,000	303,000	Do.
Brown	W	602,000	Do.
Brule	752,970	86,000	Do.
Buffalo	4,000	82,300	Sand and gravel, stone.
Butte	W	W	Sand and gravel, clays.
Compbell	83,000	124,000	Sand and gravel.
Charles Mix	474,480	374,000	Do.
Clark	197,000	187,000	Do.
Clay	62,000	69,000	Do.
Codington	631,000	367,000	Do.
Corson	644,000	233,000	Do.
Custer	464,628	471,538	Feldspar, sand and gravel, petroleum, lime, stone, beryllium concentrate.
Davison	176,000	817,000	Sand and gravel.
Day	371,000	298,000	Do.
Deuel	141,000	127,000	Do.
Dewey	67,700	94,125	Sand and gravel, coal.
Douglas	266,000	110,000	Sand and gravel.
Edmunds	70,000	18,000	Do.
Fall River	250,187	W	Uranium ore, sand and gravel, vanadium.
Faulk	166,000	153,000	Sand and gravel.
Grant	3,079,586	4,549,927	Stone, sand and gravel.
Gregory	256,000	122,000	Sand and gravel.
Haakon	30,000	56,000	Do.
Hamlin	17,000	30,000	Do.
Hand	50,000	272,000	Do.
Hanson	969,781	1,089,239	Stone, sand and gravel.
Harding	838,689	892,773	Petroleum, uranium ore, molybdenum, sand and gravel.
Hughes	70,608	110,350	Sand and gravel, stone.
Hutchinson	295,000	167,000	Sand and gravel.
Hyde	25,000	46,000	Do.
Jackson	15,000	76,000	Do.
Jerauld	42,000	229,000	Do.
Jones	----------	39,000	Do.
Kingsbury	268,000	95,000	Do.
Lake	99,000	95,000	Do.
Lawrence	22,381,179	21,696,095	Gold, stone, silver, sand and gravel.
Lincoln	561,000	95,000	Sand and gravel.
Lyman	200,000	199,000	Do.
Marshall	127,000	131,000	Do.
McCook	659,000	131,000	Do.
McPherson	161,000	244,000	Do.
Meade	186,000	155,015	Sand and gravel, stone.
Mellette	65,000	28,000	Sand and gravel.
Miner	30,000	71,000	Do.
Minnehaha	1,239,430	1,191,069	Stone, sand and gravel.
Moody	229,000	338,000	Sand and gravel.
Pennington	7,557,035	10,178,931	Cement, stone, sand and gravel, lime, feldspar, clays, gypsum, beryllium concentrate, mica (scrap), tin.
Perkins	335,000	555,000	Sand and gravel.
Potter	----------	140,000	Do.
Roberts	438,000	143,000	Do.
Sandborn	87,000	57,000	Do.
Shannon	37,000	73,000	Do.
Spink	284,000	94,000	Do.
Stanley	27,000	----------	
Sully	108,000	87,000	Sand and gravel.
Todd	26,000	80,000	Do.
Tripp	W	W	Stone, sand and gravel.
Turner	259,000	303,000	Sand and gravel.
Union	209,000	149,000	Do.
Walworth	496,000	295,000	Do.
Washabaugh	47,000	55,000	Do.
Yankton	W	W	Sand and gravel, stone.
Ziebach	----------	75,000	Sand and gravel.
Undistributed [1]	2,160,044	3,083,617	
Total	50,175,000	52,707,000	

W Withheld to avoid disclosing individual company confidential data, included with "Undistributed."
[1] Includes production of gem stones that cannot be assigned to specific counties and values indicated by symbol W.

Mines Development, Inc., plant at Edgemont—was slightly higher. Molybdenum production decreased. Sand and gravel production declined 46 percent; the only consumer was the South Dakota Department of Highways.

Lawrence.—With mineral production valued at $21.7 million, 3 percent below that of 1965, the county led the State in output value. Decreased production of gold and silver at the Homestake mine at Lead accounted for part of the decline.

Homestake Mining Co. annual report stated:

> Development of Nineteen ledge continued from the 5,000 level to the 6,800 level. Numerous good ore intersections were found. Between the 4,700 and 5,900 levels, there were 1,332,000 tons of measured and indicated ore with an average grade of about $12.65 per ton in gold. * * * * Bottomdump skips having a 10-percent increase in capacity were installed at the Ross and Yates shafts * * * *

Sand and gravel and stone were the other minerals produced. Sand and gravel, used mainly by the State and county highway departments, decreased 58,000 tons. Production of stone from five quarries increased more than threefold as crushed stone was used for road surfacing and riprap by the Federal Bureau of Public Roads, Federal Forest Service, State Department of Highways, and the city of Lead.

Mellette.—The only mineral production was 28,000 tons of sand and gravel for use by the State Department of Highways. Petroleum activity, however, was increasing. A total of 36,800 acres of oil and gas leases in the county was sold at a State sale in April; most of the acreage was acquired by Gulf Oil Corp. The northcentral part of the county was the site of a significant show of oil in one of Gulf's exploratory wells.

Pennington.—The value of mineral production was $10.2 million, a 35-percent increase. Of the 12 minerals produced, only lithium and mica declined in quantity and value.

Cement shipped by the State-owned cement plant at Rapid City had the largest increase ($1.2 million), 25 percent more than in 1965. This gain, in turn, contributed to the increased production of clay (shale), gypsum, limestone, and sand.

Clay (shale), in addition to that used for manufacturing cement, was mined and expanded to a lightweight aggregate by Light Aggregates, Inc., of Rapid City.

The only consumer of gypsum and the largest consumer of crushed limestone was the State-owned cement plant at Rapid City. Other uses of crushed limestone were concrete aggregate, road metal, railroad ballast, lime manufacture, filler, and riprap. Crushed limestone was produced by L. G. Everist, Inc.; Hills Materials Co., a subsidiary of Northwestern Engineering Co.; Pete Lien & Sons; Northwestern Engineering Co.; and Summit, Inc. Pete Lien & Sons also produced dimension limestone for curbing and flagging. Small quantities of crushed quartz for decorative use were produced at the Hugo mine by L. W. Judson and at the Peerless mine by Northwest Beryllium Corp. Dimension sandstone produced by Black Hills Rose Quartz Co. was used for architectural purposes.

Sand and gravel production increased almost twofold because of increased use in highway construction.

Various operators, in the vicinity of Key-

Table 11.—Homestake mine ore milled, receipts, and dividends [1]

Year	Ore milled (thousand short tons)	Receipts for bullion product		Dividends (thousands)
		Total (thousands)	Per ton	
1962	1,869	$20,271	$10.85	$3,242
1963	1,909	20,278	10.62	3,265
1964	2,033	21,703	10.68	3,288
1965	2,032	22,094	10.88	3,445
1966	2,002	21,309	10.64	3,937

[1] From 1876 to 1966, inclusive, this mine yielded bullion and concentrates that brought a net return of $323.3 million and paid $232.0 million in dividends.
Source: Homestake Mining Co. annual report.

stone; mined pegmatites from which seven mineral products were recovered; beryllium concentrate, feldspar, glass sand, lithium mica, columbium-tantalum concentrate, and tin concentrate (cassiterite). Northwest Beryllium Corp., operating the Peerless mine, recovered beryllium concentrate, feldspar, glass sand, scrap mica, tin concentrate (cassiterite), and columbium-tantalum concentrate by processing the ore in its flotation mill at Keystone. Beryllium concentrate, feldspar, lithium (amblygonite), and scrap mica were recovered from the Ingersoll mine operated by Keystone Chemical Co. Beryllium concentrate, feldspar, and scrap mica were recovered from ore from the Hugo mine operated by L. W. Judson.

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 except fuels.

By James R. Boyle [1] and William D. Hardeman [2]

Record production of phosphate rock, pyrite, sand and gravel, crushed limestone, crushed sandstone, and copper highlighted the mineral industry of Tennessee in 1966. Tennessee led the Nation in production of ball clay, pyrite, and zinc; ranked third in production of phosphate rock and dimension marble; and fourth in production of fuller's earth; and sixth in dimension sandstone. Zinc output decreased owing to a strike in the last quarter of 1966 at the American Zinc Co. operations, but increased production of bituminous coal, phosphate rock, and stone made up for the loss in zinc production. The total value of mineral production was slightly less than the previous record production in 1965.

Leading mineral industries, which together furnished 81 percent of the total value of production, were as follows: Stone, zinc, cement, phosphate rock, and coal.

[1] Mining engineer, Bureau of Mines, Knoxville, Tenn.

[2] State geologist, Division of Geology, Department of Conservation, Nashville, Tenn.

Table 1.—Mineral production in Tennessee [1]

Mineral		1965		1966	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Barite	short tons	30,532	$442	29,206	$412
Cement:					
Portland	thousand 376-pound barrels	8,724	27,535	8,177	25,718
Masonry	thousand 280-pound barrels	1,185	3,140	1,095	2,822
Clays	thousand short tons	1,495	6,103	[2] 1,359	[2] 4,909
Coal (bituminous)	do	5,865	20,930	6,309	23,763
Copper (recoverable content of ores, etc.)	short tons	14,823	10,495	15,410	11,148
Gold (recoverable content of ores, etc.)	troy ounces	122	4	141	5
Lead (recoverable content of ores, etc.)	short tons	-----	-----	181	55
Natural gas	million cubic feet	85	16	-----	-----
Petroleum (crude)	thousand 42-gallon barrels	11	W	7	W
Phosphate rock	thousand short tons	2,954	22,296	3,125	23,886
Sand and gravel	do	8,193	10,690	8,628	11,142
Silver (recoverable content of ores, etc.)	thousand troy ounces	94	122	101	130
Stone [3]	thousand short tons	28,888	38,859	31,260	41,432
Zinc (recoverable content of ores, etc.)	short tons	122,387	35,737	103,117	29,904
Value of items that cannot be disclosed: Clay (fuller's earth 1966), lime, pyrite, stone (crushed sandstone), and values indicated by symbol W		XX	6,572	XX	7,258
Total		XX	182,941	XX	182,584

W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed."
XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes fullers earth; included with "Value of items that cannot be disclosed."
[3] Excludes crushed sandstone; included with "Value of items that cannot be disclosed."

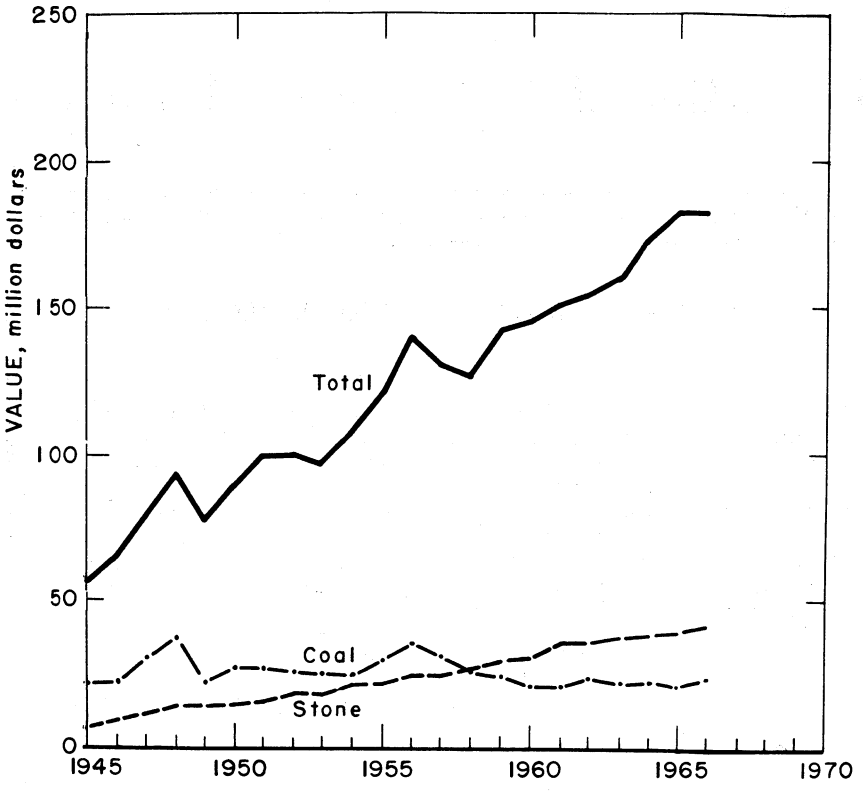

Figure 1.—Value of stone, coal, and total value of mineral production in Tennessee.

Leading companies were Tennessee Copper Co. (copper, gold, lead, pyrite, silver, and zinc), Monsanto Co. (phosphate rock), Vulcan Materials Co. (limestone and sand and gravel), American Zinc Co. (limestone and zinc), Penn-Dixie Cement Corp. (cement, clays, and limestone), Marquette Cement Manufacturing Co. (cement, clays, and limestone), Ideal Cement Co. (cement, clays, and limestone), and General Portland Cement Co. (cement and limestone).

Government Programs.—The Tennessee Division of Geology, Department of Conservation, published a new State Geologic Map in four sheets. Each sheet, with a scale of 1:250,000, has geology overprinted on a U.S. Army Map Service topographic base. The Division published 26 geologic and mineral resource maps, bringing the total published to 122. The maps, on 7—½-minute quadrangle sheets, provide detailed information on Tennessee's mineral resources.

Tennessee Valley Authority (TVA) was conducting final tests on the 950,000-kilowatt Bull Run Steam Plant. Coal-handling facilities were completed early in the year,

Table 2.—Value of mineral production in constant 1957–59 dollars
(Thousands)

Year	Value
1957	$130,190
1958	129,526
1959	141,534
1960	142,823
1961	151,067
1962	154,268
1963	163,360
1964	172,641
1965	r 174,863
1966	p 174,256

p Preliminary. r Revised.

Table 3.—Employment 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
1965:								
Coal	2,503	181	454	3,672	11	108	32.40	19,020
Metal	1,712	268	458	3,665	3	114	31.92	8,352
Nonmetal	855	268	229	1,877	---	46	24.51	2,038
Sand and gravel	668	248	166	1,413	1	21	15.57	6,887
Stone	2,971	264	783	6,543	---	124	18.95	2,937
Total	8,709	240	2,090	17,170	15	413	24.93	7,760
1966: p								
Coal	2,490	158	395	3,215	6	90	29.86	12,205
Metal	1,685	243	410	3,301	2	98	30.29	6,622
Nonmetal	855	269	230	1,891	---	36	19.04	1,757
Sand and gravel	730	258	188	1,599	---	33	20.64	438
Stone	2,845	273	776	6,343	2	161	25.70	2,887
Total	8,605	232	1,999	16,349	10	418	26.18	5,103

p Preliminary.

and coal consumption is expected to be 2.2 million tons per year. It will be shipped in 72-car unit trains from east Kentucky on a 48-hour, round-trip schedule.

TVA continued work on the Nickajack Dam on the Tennessee River below Chattanooga. The dam, 83 feet high and 3,700 feet long, will have a power installation of 97,200 kilowatts. Initial operation is scheduled in 1967.

TVA started construction of the Tims Ford Dam on the Elk River in south-central Tennessee. The dam will be 165 feet high and 1,350 feet long and have a power installation of 45,000 kilowatts. Completion is expected late in 1969.

At yearend, 527 miles of Tennesse's total Interstate Highway System mileage was open to traffic; 50 percent of the system is now complete. Work was in progress on the remaining mileage of interstate highway designated for the State.

The Federal Bureau of Mines, with a Mineral Resource Office at Knoxville and a Mineral Resource Field Office at Tuscaloosa, Ala., conducted mineral resource studies of bituminous coal in Alabama, Kentucky, and Tennessee and of metal and nonmetal resources of the area.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Production of nonmetals accounted for 64 percent of the total value of mineral production, compared with 63 percent in 1965. The five principal commodities in order of value were stone, cement, phosphate rock, sand and gravel, and clays.

Barite.—Three operators mined crude barite from five mines in three counties for oil-well-drilling muds, chemicals, and other uses. The leading producer was National Lead Co. (Ballard mine). Production decreased by 5 percent and was 72 percent below the record total of 1941.

Cement.—Tennessee ranked fifth in the Nation in production of masonry cement accounting for 5 percent of the National total. Four companies produced masonry cement at five plants in five counties; the leading producer was Marquette Cement Manufacturing Co. Shipments decreased 8 percent and were 10 percent below the 1964 record. Of total shipments 64 percent, were to Tennessee consumers. Shipments were also made to Georgia (13 percent), North Carolina (9 percent), Kentucky (4 percent), Alabama, South Carolina, and Virginia (3 percent each), and other States (1 percent).

Four companies produced portland cement at six plants in six counties. The leading producer was Penn-Dixie Cement Co. Shipments decreased 6 percent below the 1965 record. Fifty five percent of the shipments were within the State, 20 per-

cent to North Carolina, 15 percent to Georgia, 3 percent each to Virginia and Alabama, and the remainder to Kentucky, South Carolina and other States. Raw materials used in cement included limestone (62 percent), cement rock (24 percent), clays and shale (9 percent), gypsum (3 percent), and other materials (2 percent). All limestone and cement rock were produced from captive operations.

Portland cement was used as follows: Ready-mixed concrete (62 percent), concrete products (20 percent), building materials dealers (7 percent), highway contractors (7 percent), and miscellaneous (4 percent).

Clays.—Tennessee led the Nation in the production of ball clay, accounting for 67 percent of the National total. Five companies operated six mines in Henry and Weakley Counties; leading producers were H. C. Spinks Clay Co. Inc. and Ky-Tennessee Clay Co. Production was 1 percent less than that of 1965, the record year. During the year H. C. Spinks Clay Co. Inc. installed a new 4-cubic yard dragline with a 90-foot boom at its Paris operation.

Production of fuller's earth increased 13 percent, but was 37 percent below the 1956 record. The State ranked fourth in the country, with 4 percent of the National total. Southern Clay Co. Inc. and Tennessee Absorbent Clay Co. mined fuller's earth in Henry County for absorbent uses.

Miscellaneous clay was mined by nine companies at 14 mines in nine counties for building brick, heavy clay products, lightweight aggregate, and cement. Leading counties were Knox, Sullivan, and Davidson; leading producers were General Shale Products Corp., Shalite Corp., and Old Hickory Brick Co. Inc. Production was 10 percent below the 1965 record.

General Shale Products Corp. announced plans for construction of a single-layer brick kiln that can produce 33 million brick per year. The kiln, part of a fully automated plant expected to be in operation by mid-1967, will be built at Knoxville.

As a result of plant and machinery modifications, Shalite Corp. increased output of sintered lightweight aggregate at its Knoxville plant. The raw material used is the Pumkin Valley Shale and underlying Rome Formation, on Sharp's Ridge. Plant production from September 1950 to June 1965 was well in excess of 1 million tons.

Tennlite, Inc., started production of lightweight aggregate at its new plant at Greenbrier, north of Nashville. The 500 ton per day plant is equipped with two 150 by 8-foot kilns and uses New Providence Shale, mined near Ridgetop, as the raw material.

Lime.—Williams Lime Manufacturing Co. and Foote Mineral Co. produced quicklime and hydrated lime at Knoxville for building and chemical uses. Production increased 26 percent. Tennessee received 41 percent of the shipments, North Carolina 44 percent, South Carolina 6 percent, Kentucky and Virginia 3 percent each, and other States (3 percent).

Perlite.—Chemrock Corp. expanded crude perlite at the Nashville plant for filter aids, concrete aggregate, loose fill insulation, building plaster, and filler. Production increased substantially.

Phosphate Rock.—Six companies mined and processed phosphate rock in Maury, Giles, Hickman, Davidson, Sumner, and Williamson Counties. Leading producers were Monsanto Co., Hooker Chemical Co., and Stauffer Chemical Co. Marketable production increased 6 percent over that of

Table 4.—Ball clay sold or used by producers, by uses

Use	1965			1966		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Whiteware, etc.	228,484	$3,377,147	$14.78	223,421	$3,008,173	$13.46
Floor and wall tile	64,700	874,828	13.52	66,600	664,092	9.97
Other uses [1]	95,460	940,766	9.86	95,220	873,205	9.17
Total	388,644	5,192,741	13.36	385,241	4,545,470	11.80

[1] Includes heavy clay products, firebrick and block, enameling, kiln furniture, art pottery, and other uses.

1965, the previous record year. Tennessee ranked third in the Nation in the production of phosphate rock and produced 8 percent of the National total.

Pyrite.—Tennessee Copper Co. recovered pyrite concentrate from sulfide ore mined in Polk County. Production increased 2 percent over that of 1965, the previous record year. Tennessee continued to lead the Nation in output of pyrite.

Sand and Gravel.—Sand and gravel was mined by 37 commercial operators at 42 locations in 32 counties. Government-and-contractor production amounted to 9 percent of the total mined. There were seven Government-and-contractor operators at seven locations in seven counties. Leading counties were Shelby, Benton, Davidson, and Gibson. Leading commercial producers were Ingram Materials, Inc., Hardy Sand Co., W. S. Jordan & Sons Sand & Gravel Co., Mid-South Aggregates, Inc., and Hadley Contracting Co. Inc., which together produced 40 percent of the commercial production of sand and gravel. Seventeen operators mined from 100,000 to 500,000 tons and accounted for 59 percent of the commercial production. Total production increased 5 percent over that of 1965, the previous record year. Of the total production, 84 percent was washed. Thirty-three of the commercial producers and four of the Government-and-contractor operators had stationary plants. Transportation was 79 percent by truck, 19 percent by rail, and 2 percent by water.

Stone.—Record production of crushed limestone was by 55 commercial operators at 89 locations in 53 counties. Government-and-contractor production, from 31 quarries in 24 counties amounted to 9 percent of the total. Leading commercial producers were Vulcan Materials Co. (Blount, Claiborne, Davidson, Decatur, Hamilton, Hardin, Hawkins, Humphreys, Knox, Marion, Muary, Sevier, Smith, Sullivan, Union, Wayne, and Williamson Counties), Ralph Rogers & Co. Inc. (Anderson, Coffee, and Sumner Counties), and Lambert & Lambert Stone Co. Inc. (Bedford, Hamilton, Rutherford, and Warren Counties). Production increased 8 percent over that of 1965. Crushed limestone production has increased in 8 of the last 9 years. Crushed limestone was used for concrete and roads (83 percent), cement (7 percent), agricultural stone (agstone) (6 percent), and other uses (4 percent).

Table 5.—Sand and gravel sold or used by producers, by counties
(Thousand short tons and thousand dollars)

County	1965		1966	
	Quantity	Value	Quantity	Value
Benton	858	$1,457	931	$1,707
Carroll	W	W	284	W
Cumberland	60	75	110	181
Davidson	W	W	748	1,320
Fayette	65	67	65	74
Franklin	W	W	86	W
Gibson	W	W	585	W
Giles	306	270	291	141
Grundy	152	23	193	338
Hamilton	W	W	406	626
Hardeman	75	90	76	W
Hardin	25	25	W	W
Haywood	60	51	56	48
Henderson	W	W	54	W
Humphreys	W	W	499	564
Lauderdale	112	95	106	92
Loudon	4	8	17	20
McMinn	W	W	67	152
Monroe	45	53	30	45
Obion	294	289	225	273
Perry	-----	-----	182	249
Polk	31	55	18	33
Putnam	W	W	84	141
Shelby	1,540	1,449	1,875	1,685
Other counties [1]	4,566	6,683	1,640	3,453
Total	8,193	10,690	8,628	11,142

W Withheld to avoid disclosing individual company confidential data.

[1] Includes Decatur, Greene, Knox, McNairy, Sevier, Stewart (1965), Tipton, Unicoi, and Wayne Counties, and counties indicated by symbol W.

Table 6.—Sand and gravel sold or used by producers, by uses
(Thousand short tons and thousand dollars)

Use	1965			1966		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Sand:						
Structural	2,344	$3,372	$1.44	2,195	$2,752	$1.25
Paving	1,062	1,581	1.49	1,135	1,815	1.60
Molding	301	906	3.01	340	1,039	3.06
Fill	29	19	.66	59	42	.71
Railroad ballast	---	---	---	24	41	1.71
Fire or furnace	26	51	1.96	10	22	2.20
Engine	1	2	2.00	1	2	2.00
Other sands [1]	423	864	2.04	534	1,015	1.90
Total	4,186	6,795	1.62	4,298	6,728	1.57
Gravel:						
Paving	2,557	2,197	.86	2,740	2,424	.88
Structural	1,140	1,367	1.20	965	1,203	1.25
Fill	229	242	1.06	115	80	.70
Railroad ballast	60	60	1.00	W	W	W
Other gravel [2]	21	29	1.38	510	707	1.39
Total	4,007	3,895	.97	4,330	4,414	1.02
Total sand and gravel	8,193	10,690	1.30	8,628	11,142	1.29

W Withheld to avoid disclosing individual company confidential data.
[1] Includes glass, grinding and polishing, and other sands.
[2] Includes miscellaneous and other gravel as indicated by symbol W.

John J. Craig Co., Appalachian Marble Co., and Knoxville Crushed Stone Co. crushed marble for terrazzo and other uses. Production decreased 12 percent and was 24 percent below the 1948 record. Appalachian Marble Co. (Bond and Appalachian quarries), Tennessee Marble Co. (Endsley, Eagle, and Luttrell quarries), John J. Craig Co. (Hamil, Marmor, and Lee quarries), and Imperial Black Marble Corp. quarried dimension marble in Blount, Grainger, Knox, and Union Counties. Production decreased 40 percent, and was 77 percent below the 1957 record. Tennessee ranked third in the Nation in production of dimension marble and produced 15 percent of the National total.

Sewanee Silica Co., White Silica Sand Co., and Turner Bros. Stone Co. Inc. crushed sandstone for glass, concrete and roads, abrasives, cement, and other uses. Record production increased 22 percent over that of 1965. Dimension sandstone was quarried by eight companies at eight quarries, in Cumberland and Fentress Counties, for rough architectural stone, sawed and dressed building stone, and flagging. Leading producers were Turner Bros. Stone Co. Inc., Crab Orchard Stone Co. Inc., and Ross L. Brown Cut Stone Co. Inc. Production decreased 46 percent from the 1965 total. Tennessee ranked sixth in the Nation in production of dimension sandstone and produced 5 percent of the National total.

METALS

Production of metals accounted for 23 percent of the total value of mineral production compared with 25 percent in 1965. Zinc production accounted for nearly 73 percent of this value and copper production for 27 percent.

Aluminum. — Consolidated Aluminum Corp. (Conalco), at New Johnsonville, completed its third potline in 1966 and started construction on a fourth potline. Aluminum production is 106,000 tons per year, but with completion of the fourth potline early in 1968, output is expected to be 140,000 tons per year. Conalco's plans call for an eventual capacity of 300,000 tons per year. Alumina used at the plant is shipped from Surinam.

Copper.—Tennessee Copper Co. recovered copper concentrate from sulfide ore mined in Polk County; mines operated were Boyd, Calloway, Cherokee, Eureka, and Mary. Record production of recover-

Table 7.—Crushed limestone sold or used by producers, by counties

County	1965		1966	
	Short tons	Value	Short tons	Value
Anderson	W	W	405,407	W
Bedford	W	W	351,500	W
Blount	W	W	652,510	W
Bradley	W	W	503,559	W
Campbell	W	W	420,000	W
Cocke	75,000	$97,500	108,000	$96,000
Coffee	W	W	899,656	W
Cumberland	442,200	737,800	W	W
Davidson	4,112,030	4,789,482	4,060,089	4,611,056
Decatur	1,074,140	1,168,548	W	W
Fentress	213,005	299,947	183,983	255,082
Franklin	791,416	1,078,020	830,379	1,197,786
Giles	W	W	248,000	W
Grainger	40,657	60,232	32,000	40,000
Greene	W	W	421,589	W
Hamilton	W	W	1,991,590	W
Jefferson	W	W	1,698,108	1,722,684
Knox	2,108,024	2,983,404	2,096,145	3,084,533
Macon	W	W	121,000	182,000
Marion	1,829,989	2,049,557	2,243,295	2,696,199
McMinn	W	W	387,182	512,283
Monroe	568,609	708,128	W	W
Pickett	28,288	35,360	19,640	29,460
Putnam	W	W	452,000	462,000
Rhea	141,050	191,600	W	W
Roane	W	W	195,810	268,326
Scott	-----	-----	29,994	40,491
Sevier	W	W	343,016	W
Smith	W	W	196,765	W
Sullivan	W	W	892,988	W
Sumner	682,666	829,034	W	W
Unicoi	125,000	162,000	125,000	158,000
Union	W	W	227,200	W
Warren	W	W	260,500	W
Washington	123,826	160,850	186,942	233,676
White	W	W	273,000	W
Other counties [1]	16,445,291	21,212,784	10,343,311	23,645,585
Total	28,801,191	36,564,246	31,200,158	39,235,161

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

[1] Includes Cannon, Carter, Claiborne, Clay, Grundy, Hamblen, Hancock, Hardin, Hawkins, Humphreys, Johnson, Lincoln, Marshall, Maury, Meigs, Montgomery (1966), Overton, Robertson, Rutherford, Sequatchie, Wayne, Williamson, and Wilson Counties, and counties indicated by symbol W.

Table 8.—Crushed limestone sold or used by producers, by uses

Use	1965			1966		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Concrete and roads	23,101,188	$29,086,521	$1.26	25,901,618	$32,162,897	$1.24
Cement	2,231,729	2,591,657	1.16	2,235,045	2,775,502	1.24
Agstone	2,208,537	2,810,964	1.27	1,906,539	2,300,860	1.21
Stone sand	282,181	401,438	1.42	189,500	275,759	1.46
Lime	168,382	248,400	1.48	W	W	W
Railroad ballast	304,275	369,828	1.22	W	W	W
Paper	22,000	31,900	1.45	W	W	W
Rock dust for coal mines	8,500	42,500	5.00	W	W	W
Whiting	3,500	26,150	7.47	W	W	W
Alkali	3,000	4,500	1.50	-----	-----	-----
Mineral food	116,000	232,000	2.00	-----	-----	-----
Other uses [1]	351,899	718,388	2.04	967,456	1,720,143	1.78
Total	28,801,191	36,564,246	1.27	31,200,158	39,235,161	1.26

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

[1] Includes riprap, fluxing stone, glass, asphalt filler, fertilizer filler, filter beds (1966), and other uses, and uses indicated by symbol W.

able copper was 4 percent greater than 1965, the previous record year. The Tennessee Copper Co.'s Calloway mine was awarded the "Sentinels of Safety" trophy for having attained the best safety record in the Underground Metal Mine Group of the 1966 National Safety Competition. The mine operated 247,424 man-hours during the year without a disabling work injury.

The Tennessee Division of Geology published a report on the copper-sulfuric acid industry of the State.[3]

Ferroalloys.—Shipments of ferromanganese, silicomanganese, ferrosilicon, ferrochromium, and ferrochrome silicon totaled 325,835 tons, valued at $44,167,000, a 38 percent increase in tonnage and a 65 percent in value from the 1965 figures.

Gold.—Tennessee Copper Co. recovered gold as a byproduct from smelting copper concentrate. Production increased 16 percent.

Lead.—Tennessee Copper Co. recovered lead as a byproduct from smelting copper concentrate. It was the first recorded production since 1962.

Manganese.—Foote Mineral Co. began construction of a $10 million electrolytic manganese plant at New Johnsonville. The plant, reported to be the largest of its kind in the world, is scheduled to be onstream early in 1968. Manganese ores from Africa and South America will be used as raw material.

Silver.—Silver was recovered as a byproduct from smelting copper concentrate by Tennessee Copper Co. Production increased 7 percent over that of 1965, but was 10 percent below the 1962 record.

Zinc.—Zinc production was 16 percent below the record production of 1965. This was due primarily to a strike at American Zinc Co. operations during the last quarter of the year. Tennessee continued to be the leading zinc-producing State with 18 percent of the National production.

Total crude ore milled in the State was 4,988,770 tons, a decrease of 10 percent from 1965; total waste material handled was 352,754 tons. Zinc concentrates were shipped to Illinois, Ohio, Oklahoma, Pennsylvania, and Texas.

American Zinc Co. operated the Young, Graselli, Coy, and North Friends Station mines in Jefferson County and the Mascot No. 2 mine in Knox County. The firm continued development of the Immel mine in Knox County, which is scheduled for production in early 1968. Major underground development included driving 12,500 feet of drifts. Completion of the mine has been delayed by problems encountered during shaft sinking and by a 5-month strike. American Zinc Co. completed expansion of the Mascot mill to 6,800 tons per day. New Jersey Zinc Co. operated the Jefferson City mine in Jefferson County and the Flat Gap mine in Hancock County. Cowin & Co. Inc., Birmingham, Ala. started sinking a 1,350-foot shaft to develop New Jersey Zinc Co.'s Idol mine in the Copper Ridge District, approximately 7 miles southeast of the Flat Gap mine. Plans include a connecting incline and a 2,000-ton-per-day mill. United States Steel Corp. operated the Zinc Mine Works in Jefferson County. Tennessee Copper Co. recovered zinc concentrate from copper-zinc ores mined in Polk County. New Market Zinc Co. operated the New Market mine in Jefferson County. Production has not reached its ultimate tonnage as yet. The New Market concentrator treated ores from the American Zinc Co. Young mine through May.

[3] Maher, Stuart W. The Copper-Sulfuric Acid Industry in Tennessee. Tennessee Dept. Conservation, Div. Geol., Inf. Circ. 14, 1966, 28 pp.

Table 9.—Mine production of recoverable gold, silver, copper, lead, and zinc

Commodity	1965		1966		Earliest record to date	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gold, troy ounces	122	$4	141	$5	24,715	$608
Silver, do	94,142	122	100,716	130	4,368,993	3,484
Copper, short tons	14,823	10,495	15,410	11,148	591,217	233,623
Lead, do	-----	-----	181	55	27,824	3,240
Zinc, do	122,387	35,737	103,117	29,904	2,034,308	441,603
Total	XX	46,358	XX	41,242	XX	682,558

XX Not applicable.

Reported exploration and development at zinc and copper mines included the following: Diamond drilling, 124,212 feet; percussion drilling, 142,522 feet; long-hole drilling, 17,441 feet; churn drilling, 328 feet; drifting and crosscutting, 47,775 feet; and raising, 6,782 feet.

MINERAL FUELS

Production of mineral fuels accounted for 13 percent of the total value of mineral production, compared with 12 percent in 1965.

Coal (Bituminous).—Bituminous coal was mined at 203 mines in 16 counties, compared with 230 in 17 counties in 1965. Forty-six new mines started operations during the year. Leading producing counties were Anderson, Campbell, and Marion. Leading producers were Consolidation Coal Co. (Morco mine), Tennessee Auger Co. Inc. (Walnut Mountain No. 2 mine), and Tenneo, Inc. (No. 1 strip mine). Production increased 8 percent, the first increase since 1962. Average production per mine increased from 25,500 to 31,000 tons.

Tennessee Valley Authority (TVA) purchased 53 percent of the coal mined in Tennessee, compared with 55 percent in 1965. This amounted to 14 percent of TVA coal purchases, the same percentage as in 1965.

In the northern part of the State (District 8), 135 mines in nine counties produced 4,744,000 tons of coal, compared with 156 mines in 10 counties that produced 4,585,000 tons in 1965. Average production per mine increased from 29,400 to 35,100 tons. Underground mines produced 62 percent of the total tonnage; strip mines, 32 percent; and auger mines, 6 percent. Shipments were 62 percent by rail or water and 38 percent by truck.

The equipment used at 90 underground mines included 93 cutting machines that cut 75 percent of the total tonnage; 119 power drills that drilled 70 percent; 41 mobile loading machines that loaded 59 percent; eight continuous mining machines that loaded 21 percent; 30 face conveyors that loaded 7 percent; and 73 locomotives; 44 shuttle cars; and 39 shuttle buggies. The equipment used at 35 strip mines included 63 power shovels, two draglines, 53 bulldozers, 26 power drills, and 91 trucks. The equipment used at 10 auger mines included 10 coal recovery augers, one power shovel, and seven bulldozers. Thirty-five percent of the coal was crushed, and 11 percent was cleaned.

In the southern part of the State (District 13), 68 mines in seven counties produced 1,565,000 tons, compared with 74 mines in seven counties that produced 1,280,000 tons in 1965. Average production per mine increased from 17,300 to 23,000 tons. Output was equally distributed between underground and strip mines. Shipments were 81 percent by rail or water and 19 percent by truck. The coal was sold in the open market, mainly to TVA.

The equipment used at 54 underground mines included 35 cutting machines that cut 67 percent of the total tonnage; 103 power drills that drilled 95 percent; 10 mobile loading machines that loaded 32 percent; 12 locomotives; four shuttle cars; and one shuttle buggy. The equipment used at 14 strip mines included 22 power shovels, four draglines, 18 bulldozers, 13 power drills, and 58 trucks. Of the total tonnage, 26 percent was crushed.

Consolidation Coal Co. continued development of a $15 million mine in Claiborne County. Surface facilities are expected to be completed by mid-1967 and underground development will then begin. Initial production from the mine, designed to produce 1.5 million tons annually, is expected early in 1968.

Coke.—Woodward Iron Co. was the only coke producer in Tennessee. Coke and breeze were produced by 44 coke ovens; coke was used in foundries and blast furnaces, and breeze was used and sold. Coal chemicals produced included coke oven gas, ammonium sulfate, tar, and crude light oil that was converted to industrial-grade benzene, toluene, and crude naphtha.

Petroleum.—Cumulative production of crude petroleum since 1916 was 692,000 barrels. Leading producing counties were Morgan and Scott. Exploratory drilling continued in Tennessee with 62 completions in 11 counties. The total footage drilled was 58,717, crude oil was hit in four holes in Macon and Scott Counties and gas was hit in one hole in Macon County. Exploration drilling in 1965 resulted in 20 completions with a total footage of 23,061; four holes hit crude oil and three hit gas.

Table 10.—Coal (bituminous) production, by counties

County	1965		1966	
	Short tons	Value	Short tons	Value
Anderson	2,032,067	$7,343,480	2,364,359	$9,018,483
Bledsoe	11,569	50,046	2,500	10,000
Campbell	1,075,219	3,205,684	771,403	2,647,966
Claiborne	261,931	967,285	613,996	2,192,034
Cumberland	4,000	14,000	12,158	36,109
Fentress	58,560	238,924	49,319	190,276
Grundy	203,958	828,462	220,661	911,980
Hamilton	42,258	174,557	42,376	141,531
Marion	634,565	2,960,977	692,213	3,202,895
Morgan	383,690	1,224,574	434,982	1,450,334
Overton	25,759	99,944	21,423	77,122
Pickett	3,024	11,733	-----	-----
Putnam	219,612	803,779	45,000	162,000
Rhea	24,000	106,560	12,200	56,120
Scott	521,298	1,593,549	431,342	1,392,208
Sequatchie	113,891	431,340	405,450	1,507,854
Van Buren	249,772	874,850	189,142	765,647
Total	5,865,173	20,929,744	6,308,524	23,762,559
Earliest record to date	424,465,000	NA	430,774,000	NA

NA Not available.

REVIEW BY COUNTIES

Mineral production was reported from 80 counties; leading counties were Jefferson, Polk, Maury, Knox, Davidson, Marion, Hamilton, and Anderson, which supplied 59 percent of the total mineral production value. In addition to the commodities listed in table 11, small quantities of oil and gas were produced; the county origin of these was undetermined. The number of wells and footage drilled by counties in this section were furnished by the American Association of Petroleum Geologists.

Anderson.—Anderson County ranked eighth in the State in total value of mineral production. Consolidation Coal Co. (Morco Colliery), Tennessee Auger Co. Inc. (Walnut Mountain Deep No. 2 mine) and Tennco, Inc. (No. 1 strip mine) were the leading producers of the 33 active coal mines. Of these coal mines, 22 were underground, 10 were strip, and one was auger; nine new mines started operations during the year. Ralph Rogers & Co. Inc. (Oak Ridge quarry) and Anderson County Highway Department (Taylor's quarry No. 1) crushed limestone for concrete and roads. Lalite Corp. (Briceville mine) mined miscellaneous clay for lightweight aggregates.

Table 11.—Value of mineral production in Tennessee, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Anderson	W	W	Coal, limestone, miscellaneous clay.
Bedford	W	W	Limestone.
Benton	$1,457,000	$1,707,000	Sand and gravel.
Bledsoe	50,046	10,000	Coal.
Blount	W	W	Limestone, marble.
Bradley	W	W	Limestone.
Campbell	W	W	Coal, limestone, sandstone.
Cannon	W	W	Limestone.
Carroll	W	W	Sand and gravel.
Carter	W	W	Limestone.
Claiborne	W	W	Coal, limestone.
Clay	W	W	Limestone.
Cocke	97,500	96,000	Do.
Coffee	W	W	Do.
Cumberland	1,625,182	W	Limestone, sandstone, sand and gravel, coal,
Davidson	12,593,797	11,251,112	Limestone, cement, sand and gravel, phosphate rock, miscellaneous clay.
Decatur	W	W	Limestone, sand and gravel.
Fayette	67,000	74,000	Sand and gravel.
Fentress	542,371	447,358	Limestone, coal, sandstone.

See footnotes at end of table.

Table 11.—Value of mineral production in Tennessee, by counties [1]—Continued

County	1965	1966	Minerals produced in 1966 in order of value
Franklin	W	$5,412,757	Cement, limestone, sandstone, sand and gravel, miscellaneous clay.
Gibson	W	W	Sand and gravel.
Giles	W	W	Phosphate rock, limestone, sand and gravel.
Grainger	$96,232	W	Limestone, marble.
Greene	W	W	Limestone, sand and gravel.
Grundy	W	W	Coal, sand and gravel, limestone.
Hamblen	W	W	Limestone.
Hamilton	9,676,019	9,699,483	Cement, limestone, sand and gravel, coal, miscellaneous clay.
Hancock	W	W	Zinc, limestone.
Hardeman	90,000	W	Sand and gravel.
Hardin	W	W	Limestone, sand and gravel.
Hawkins	W	W	Limestone.
Haywood	51,000	48,000	Sand and gravel.
Henderson	W	W	Do.
Henry	3,002,511	W	Ball clay, fuller's earth.
Hickman	W	W	Phosphate rock.
Humphreys	W	W	Limestone, sand and gravel.
Jefferson	W	22,809,454	Zinc, limestone.
Johnson	W	W	Limestone.
Knox	16,700,923	15,077,976	Cement, limestone, zinc, lime, marble, sand and gravel, miscellaneous clay.
Lauderdale	95,000	92,000	Sand and gravel.
Lincoln	W	W	Limestone.
Loudon	W	W	Miscellaneous clay, barite, sand and gravel.
Macon	W	182,000	Limestone.
Marion	W	W	Cement, coal, limestone.
Marshall	W	W	Limestone.
Maury	W	W	Phosphate rock, limestone.
McMinn	W	W	Limestone, barite, sand and gravel.
McNairy	W	W	Sand and gravel.
Meigs	W	W	Limestone.
Monroe	761,128	W	Limestone, sand and gravel, barite.
Montgomery	-----	W	Limestone.
Morgan	1,224,574	1,450,334	Coal.
Obion	289,000	273,000	Sand and gravel.
Overton	W	W	Limestone, coal.
Perry	-----	249,000	Sand and gravel.
Pickett	47,093	29,460	Limestone.
Polk	W	W	Copper, pyrites, zinc, silver, lead, sand and gravel, gold.
Putnam	W	765,000	Limestone, coal, sand and gravel.
Rhea	298,160	W	Limestone, coal.
Roane	W	268,326	Limestone.
Robertson	W	W	Do.
Rutherford	W	W	Do.
Scott	1,593,549	1,432,699	Coal, limestone.
Sequatchie	W	W	Do.
Sevier	W	W	Limestone, sand and gravel.
Shelby	W	W	Sand and gravel, miscellaneous clay.
Smith	-----	W	Limestone.
Stewart	W	-----	
Sullivan	W	W	Cement, limestone, miscellaneous clay.
Sumner	W	W	Phosphate rock, limestone.
Tipton	W	W	Sand and gravel.
Unicoi	W	W	Sand and gravel, limestone.
Union	W	W	Marble, limestone.
Van Buren	874,850	765,647	Coal.
Warren	W	W	Limestone.
Washington	W	W	Limestone, miscellaneous clay.
Wayne	W	W	Limestone, sand and gravel.
Weakley	2,579,750	2,097,117	Ball clay.
White	W	W	Limestone.
Williamson	W	W	Phosphate rock, limestone.
Wilson	W	W	Limestone.
Undistributed [2]	129,128,315	108,346,277	
Total	182,941,000	182,584,000	

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

[1] The following counties are not listed because no production was reported: Cheatham, Chester, Crockett, DeKalb, Dickson, Dyer, Houston, Jackson, Lake, Lawrence, Lewis, Madison, Moore, and Trousdale.

[2] Includes value of petroleum, natural gas (1965), and values indicated by symbol W.

Bedford.—Lambert & Lambert Stone Co. (Shelbyville quarry) crushed limestone for concrete, roads, agstone, and riprap.

Benton.—Four mines produced glass and molding sand; the leading producer was Hardy Sand Co. (Silica and Camden mines). Camden Gravel Co. and Memphis Stone & Gravel Co. mined gravel for paving.

Bledsoe.—State Vocational Training School (No. 4 mine) was the only active coal producer.

Blount.—Vulcan Materials Co. (Maryville quarry) crushed limestone for concrete, roads, and agstone. John J. Craig Co. (Hamil, Marmor, and Lee quarries) and Tennessee Marble Co. (Endsley quarry) quarried dimension marble for rough and dressed building stone and dressed monumental stone, and the former crushed marble for terrazzo and other uses.

Bradley.—Bradley Limestone Co. Inc. (Welch quarry) and Bradley County Highway Department crushed limestone for concrete, roads, agstone, and riprap.

Campbell.—Coal was produced at 34 mines, including 18 underground, 11 strip, and five auger. Leading producers were Dixie Pine Coal Co. Inc. (No. 1 strip mine), Hurricane Mountain Coal Co. (No. 4 mine), and Cox-Jellico Coal Corp. (No. 1-A strip mine). Eleven new mines started operations during the year. Jellico Stone Co. Inc. (Jellico quarry) and Claiborne Construction & Supply Co. (LaFollette quarry) crushed limestone for concrete, roads, and agstone. White Silica Sand Co. crushed sandstone for abrasives, glass, cement, and other uses.

Cannon.—Woodbury Stone Co. crushed limestone from its Norvell quarry near McMinnville for concrete, roads, and agstone.

Carroll.—Hardy Sand Co. (Bruceton mine) mined sand for grinding and polishing and for fertilizer filler.

Carter.—Watauga Stone Co. (Watauga quarry) crushed limestone for concrete, roads, railroad ballast, and stone sand.

Claiborne.—Coal was produced at 12 mines, including seven underground, three strip, and two auger. Leading producers were Rich Mountain Mining Co. Inc. (No. 2 mine), Four Leaf Coal Co. Inc. (No. 2 strip mine), and Tacket Coal Corp. (No. 4 strip mine). One new mine started operations during the year. Vulcan Materials Co. (Tazewell quarry) crushed limestone for concrete and roads.

Clay.—Dixie Limestone Co. (Celina quarry) crushed limestone for concrete, roads, and agstone. Twenty oil wells, totaling 12,003 feet, were drilled.

Cocke.—Cocke County Highway Department crushed limestone from the Smith quarry near Newport for concrete and roads.

Coffee.—Ralph Rogers & Co. Inc. and Coffee County Highway Department (Winton quarry) crushed limestone for concrete and roads.

Cumberland.—Southern States Lime Corp. (Crab Orchard mine) and Cumberland County Highway Department crushed limestone for fluxing stone, concrete, roads, asphalt filler, agstone, glass, rock dust for coal mines, mineral food, and other uses. Eight companies quarried dimension sandstone for rough architectural, sawed and dressed building stone, and flagging. Leading producers were Turner Bros. Stone Co., Inc., Crab Orchard Stone Co., Inc. (Peck quarry), and Ross L. Brown Cut Stone Co., Inc. Potter Sand & Gravel Co. (Crossville mine) mined sand and gravel for structural and paving uses. George Kilby Coal Co. mined coal from the No. 1 strip mine, a new operation. Turner Bros. Stone Co., Inc., crushed sandstone for refractory use.

Davidson.—Davidson County ranked fifth in the State in total value of mineral production. Vulcan Materials Co. (Danley, Hermitage, and River Road quarries), Menefee Crushed Stone Co. (Nashville quarry), Hoover, Inc., (Nashville quarry), and Eller & Olson Crushed Stone Co., Inc. crushed limestone for concrete, roads, agstone, railroad ballast, asphalt filler, and fertilizer filler. Marquette Cement Manufacturing Co. produced masonry and portland cement at its Nashville plant throughout the year. Ingram Materials, Inc. (Nashville mine) mined sand and gravel for structural and paving uses. Monsanto Co. mined phosphate rock from the Davidson County mine. Chemrock Corp. expanded crude perlite at its Nashville processing plant. W. G. Bush & Co. Inc. (Nashville mine) and Tennlite, Inc. (Baker Station mine) mined miscellaneous clay for heavy

clay products, cement, and lightweight aggregate.

Decatur.—Western Materials, Inc., (Parsons quarry) crushed limestone for concrete, roads, and agstone. Teague Bros. Sand & Gravel Co. (Decaturville mine) and Tinker Sand & Gravel Co. (Perryville mine) mined sand and gravel for structural uses.

Fentress.—Frogge & Williams, Inc. (Wright quarry) crushed limestone for concrete, roads, and agstone. Fentress County Coal Co. (Fentress mine), Layton P. Hood Coal Co. (No. 2 mine), and Crass Coal Co. (No. 1 strip mine) were the leading producers of the 10 active coal mines (nine underground and one strip). Two new mines started operations during the year. Crossville Stone Co. (Jamestown quarry) quarried dimension sandstone for rough architectural stone.

Franklin.—Marquette Cement Manufacturing Co. produced masonry and portland cements at the Cowan mill throughout the year. Cowan Stone Co. (Anderson mine and Cowan quarry), Marquette Cement Manufacturing Co. (Cowan quarry), and Franklin County Highway Department (Bostick quarry) crushed limestone for concrete, roads, fluxing stone, agstone, glass, and cement. Sewanee Silica Co. (Monteagle quarry) crushed sandstone for concrete, roads, abrasives, foundry, glass, pottery, and other uses. Estill Springs Sand-Gravel Co. (Estill Springs mine) mined sand for structural and paving uses and gravel for paving and other uses. Marquette Cement Manufacturing Co. (Cowan mine) mined miscellaneous clay for use in cement manufacture.

Gibson.—Hadley Contracting Co. Inc. (Humboldt mine) mined sand and gravel for paving.

Giles.—Monsanto Co. (Giles County mine), M. C. West, and Stauffer Chemical Co. (Wales mine) mined phosphate rock. Cedar Grove Lime Co. (Cedar Grove quarry) crushed limestone for concrete, roads, and agstone. Giles County Highway Department mined paving sand and gravel.

Grainger.—Grainger County Highway Department (Mitchell's quarry) crushed limestone for concrete and roads. Imperial Black Marble Corp. (Thornhill quarry) quarried dimension marble for rough building stone.

Greene.—Malone Bros. Quarry, Inc. (Malone Bros. quarry), Greene County Highway Department (Midway, Dog Walk, and Cove Creek quarries), and Agricultural Lime Co. Inc. (Greeneville quarry) crushed limestone for concrete, roads, and agstone. Busler Sand Co. (Greeneville mine) mined sand for structural uses.

Grundy.—Phipps & Sons Coal Co. (Commando strip mine) and Ramsey Coal Co. (No. 1 strip mine) were the leading producers of the four active coal mines (three strip and one underground). Cumberland Mountain Sand Co. (McMinnville mine) mined structural and paving sand. Grundy Limestone Co. Inc. (Old State quarry) crushed limestone for concrete, roads, and agstone.

Hamblen.—White Pine Stone Co. crushed limestone from the Hamblen quarry near White Pine for concrete and roads.

Hamilton.—Hamilton County ranked seventh in the State in total value of mineral production. General Portland Cement Co. produced masonry and portland cements at the Chattanooga mill throughout the year. Vulcan Materials Co. (Chattanooga quarry) and Lambert & Lambert Stone Co. crushed limestone for concrete, roads, riprap, and agstone. Dixie Sand & Gravel Corp. mined sand and gravel for structural, paving, fill, and other uses. Four mines, three underground and one strip, produced coal. Leading producers were Russell Mining Co. (No. 7 strip mine), Conner, Conner & Chaffin Coal Co. (No. A–1 mine), and Tentex Coal Corp. (Oak Hill mine). General Shale Products Co. (Chattanooga mine) and Federal Ceramic Corp. (Daisy mine) mined miscellaneous clay for heavy clay products. Woodward Iron Co. produced coke and coal chemicals at its Chattanooga plant.

Hancock.—New Jersey Zinc Co. (Flat Gap mine) mined and milled zinc ore and recovered limestone as a byproduct. The limestone was used for concrete, roads, and agstone.

Hardeman.—Bolivar Sand Co. (Bolivar mine) and Tri-State Sand Co. (Saulsbury mine) mined structural sand and gravel.

Hardin.—Vulcan Materials Co. crushed limestone for concrete, roads, and agstone. Davis Contracting Co. (Savannah mine) mined structural sand and gravel. Tennessee River Pulp & Paper Co. reclaimed lime for industrial uses.

Hawkins.—Vulcan Materials Co. (McCloud quarry) crushed limestone for concrete and roads.

Henderson.—Ayers Mineral Co. mined molding sand from the Zane mine.

Henry.—Kentucky-Tennessee Clay Co. (Tennessee mine), H. C. Spinks Clay Co. Inc. (Henry County mine), and Laird Brick Co. (Puryear mine) mined ball clay for whiteware, floor and wall tile, refractories, heavy clay products, and exports. Southern Clay Co. Inc. and Tennessee Absorbent Co. mined fuller's earth for absorbent uses.

Hickman.—M. C. West (Highland mine) and M. C. Boyle Phosphate Co. (Bratton and Worley mines) mines phosphate rock for agricultural uses.

Humphreys.—Vulcan Materials Co. (Rock Hill quarry) crushed limestone for concrete, roads, railroad ballast, and agstone. Sangravel Co. Inc. (Johnsonville mine) mined sand and gravel for structural and paving uses.

Jackson.—Two oil wells totaling 1,971 feet were drilled.

Jefferson.—Jefferson County ranked first in the State in total value of mineral production. American Zinc Co. (Young, Grasselli, Coy, and North Friends Station mines), United States Steel Corp. (Zinc Mine Works), New Market Zinc Co. (New Market mine), and New Jersey Zinc Co. (Jefferson City mine) mined zinc ore. Limestone was crushed by the Jefferson County Highway Department and also recovered as a byproduct from zinc milling; this material was used for concrete, roads, railroad ballast, agstone, and stone sand.

Johnson.—Maynard Lime Co., Inc. crushed limestone from the Dowell quarry near Shouns for concrete, roads, and agstone.

Knox.—Knox County ranked fourth in the State in total value of mineral production. Ideal Cement Co. produced masonry and portland cements at the Knoxville mill throughout the year. American Zinc Co. (Mascot No. 2 mine) mined and milled zinc ore and recovered limestone as a byproduct. Six quarries and one mine crushed limestone for concrete, roads, cement, lime, railroad ballast, agstone, stone sand, and other uses. The leading producers were Vulcan Materials Co. (City and Dixie Lee quarries), Ideal Cement Co. (Knoxville quarry), and Williams Lime Manufacturing Co. (Knoxville quarry). Foote Mineral Co. and Williams Lime Manufacturing Co. produced lime for construction and chemical uses.

Knoxville Sand & Gravel Co. and Oliver King Sand & Lime Co. Inc. dredged sand and gravel at Knoxville for structural, paving, grinding and polishing, and engine uses. Shalite Corp., General Shale Products Corp. and Ideal Cement Co. mined miscellaneous clay at Knoxville for lightweight aggregate, heavy clay products, and cement. Appalachian Marble Co. (Appalachian and Bond quarries) and Tennessee Marble Co. (Eagle quarry) quarried dimension marble for dressed building stone and dressed monumental stone. Knoxville Crushed Stone Co. (Stone Road quarry) and Appalachian Marble Co. crushed marble for terrazzo and other uses.

Lake.—One oil well, totaling 6,021 feet, was drilled.

Lincoln.—Clark & Stephenson (Fayetteville quarry) and Lincoln County Highway Department crushed limestone for concrete, roads, and agstone.

Loudon.—Old Hickory Brick Co. Inc. (Greenback mine) mined miscellaneous clay for heavy clay products. B. C. Wood mined barite at the Cedar Fork mine. Tennessee River Sand Co. (Loudon mine) mined sand for grinding, polishing, and structural uses.

Macon. — Dixon-Stubblefield Limestone Co. crushed limestone from the Hillsdale quarry for concrete, roads, and agstone. Twenty-one oil wells, totaling 12,058 feet, were drilled; three hit oil and one hit gas.

Marion.—Marion County ranked sixth in the State in total value of mineral production. Penn-Dixie Cement Corp. produced portland cement at the Richard City mill throughout the year. Coal was produced by 35 mines (34 underground and one strip). Leading producers were Virginia Mining Co. (Pine No. 16 mine), Walnut Coal Co. Inc. (Walnut No. 12 mine), and Grundy Mining Co. Inc. (No. 21 mine). Four new mines began operations during the year. Vulcan Materials Co. (Nickajack Dam and Marion quarries), General Portland Cement Co. (Bennetts Lake quarry), and Penn-Dixie Cement Corp. (Richard City quarry) crushed limestone for concrete, roads, agstone, and cement.

Marshall.—Lewisburg Limestone Co. crushed limestone from the Lewisburg quarry for concrete, roads, and agstone.

Maury.—Maury County ranked third in the State in total value of mineral production. Five operators mined phosphate rock; leading producers were Monsanto Co. (Monsanto mine), Hooker Chemical Corp. (Columbia mine), and Stauffer Chemical Co. (Southport, Mount Pleasant, and Columbia mines), Vulcan Materials Co. (Lewisburg quarry) and Columbia Rock Products Corp. (Theta Pike mine) crushed limestone for concrete, roads, agstone, stone sand, and asphalt filler. Union Carbide Corp. manufactured carbon and graphite products at the Columbia plant.

McMinn.—National Lead Co. (Ballard mine) and Godsey Mines, Inc., (Athens and Niota mines) mined barite. Hiwassee Sand Co. Inc. (Athens mine) mined sand and gravel for structural uses. McMinn County Highway Department (Athens quarry) crushed limestone for concrete and roads. Bowaters Southern Paper Corp. reclaimed lime for industrial uses.

McNairy.—Worsham Bros. mined sand and gravel for structural, paving, and other uses.

Meigs.—Ten Mile Stone Co. Inc. (Ten Mile quarry) and Meigs Stone Co. (Posey quarry) crushed limestone for concrete, roads, riprap, and agstone.

Monroe.—Creighhead Limestone Co. (Creighead quarry) and Monroe County Highways Department (Madisonville quarry) crushed limestone for concrete, roads, riprap, and agstone. Vonore Sand Co. (Vonore mine) mined structural sand. Godsey Mines, Inc., mined barite at the Forkner mine.

Montgomery.—Simpson Stone Co. (Simpson quarry) crushed limestone for concrete, roads, and agstone.

Morgan.—Coal was produced at 23 mines (15 underground, seven strip, and one auger). Leading producers were Camp Austin Coal Co. (No. 1 strip mine), G & F Coal Co. Inc. (G & F strip mine), and Lueking Coal Co. (No. 1–A strip mine). Eight new mines began operations during the year. One oil well, totaling 1,500 feet, was drilled.

Obion.—Reelfoot Materials, Inc., (Troy mine) and Obion County Highway Department mined paving sand and gravel.

Overton.—Livingston Limestone Co. (East and South quarries) crushed limestone for concrete, roads, and agstone. Five mines, all underground operations, produced coal; leading producers were Wilder Coal Co. Inc. (No. 1 mine), Holly John Coal Co. Inc. (No. 1 mine), and Murphy & Sells Coal Co. (Bills Branch mine). Two new mines started operations during the year. Four oil, wells totaling 557 feet, were drilled.

Perry.—T. L. Herbert & Sons, Inc. mined structural sand and gravel from the Dover mine.

Pickett.—Pickett County Highway Department crushed limestone for concrete and roads. One oil well, totaling 5,827 feet, was drilled.

Polk.—Polk County ranked second in the State in total value of mineral production. Tennessee Copper Co. mined sulfide ore at the Boyd, Calloway, Eureka, Mary, and Cherokee mines. The ore was concentrated at the London flotation mill and yielded copper, iron (pyrite), and zinc concentrates. Gold and silver were recovered as byproducts from smelting copper concentrate. The iron concentrate or pyrite concentrate was roasted, yielding sulfur dioxide, which was used mainly in manufacturing sulfuric acid, and iron oxide, which was sintered for use by iron and steel mills. Campbell Sand & Gravel Co. (Isabella mine) mined sand for structural and fire or furnace use, and gravel for paving.

Putnam.—R. E. Poteet and Putnam County Highway Department crushed limestone for concrete, roads, and agstone. Clear Creek Coal Co. (Clear Creek No. 2 mine), an underground operation, was the only active coal producer. Mid-State Materials Co. Inc. (Monterey mine) mined structural and paving sand. Two oil wells, totaling 187 feet, were drilled.

Rhea.—Rhea County Limestone Co. (Dayton quarry) crushed limestone for concrete, roads, and agstone. Rocky Creek Coal Co. (R C No. 1 and R C No. 6 mines) was the only active coal producer.

Roane.—A. B. Long Quarries, Inc. (Swan Pond quarry) crushed limestone for concrete, roads, agstone, and stone sand.

Robertson.—Porter Brown Limestone Co. (Springfield No. 1 quarry) crushed limestone for concrete, roads, and agstone. One oil well, totaling 612 feet, was drilled.

Rutherford.—Lambert & Lambert Stone Co. (Murfreesboro quarry) and Rutherford County Highway Department crushed limestone for concrete, roads, riprap, and agstone.

Scott.—Coal was produced at 16 mines (13 underground, two strip, and one auger). Leading producers were Royal Dean Coal Co. (No. 1 mine), Pee Wee Mining Co. Inc. (Pee Wee mine) and C. R. Lewis Coal Co. (Shack Creek auger mine). One new mine started operations during the year. Campbell County Highway Department crushed limestone for concrete and roads. Seven oil wells, totaling 16,613 feet, were drilled; one hit oil.

Sequatchie.—Fifteen mines, 12 underground and three strip, produced coal; leading producers were Allen Bros. Coal Co. (Allen No. 2 strip mine) and Walden Ridge Coal Co. (Walden Ridge No. 1 and No. 2 strip mines). Four new mines started operations during the year. Dunlap Stone Co. crushed limestone for concrete, roads, and agstone.

Sevier.—Vulcan Materials Co. (Sevierville quarry and Sevier County Highway Department crushed limestone for concrete and roads. Hodges Sand & Soil Co. (Sevierville mine) and French Broad Materials, Inc., (Boyds Creek mine) mined structural and paving sand.

Shelby.—Seven mines produced sand and gravel for structural, paving, fill, and other uses; leading producers were W. S. Jordan Gravel Co., Mid-South Aggregates, Inc. (Holmes and Ellis mines), and Cordova Sand & Gravel Co. John A. Denies Sons Co. mined miscellaneous clay for lightweight aggregate.

Smith.—Smith County Highway Department and Vulcan Materials Co. (Cordell Hull Dam quarry) crushed limestone for concrete and roads.

Sullivan.—Penn-Dixie Cement Corp. produced masonry and portland cements at the Kingsport mill throughout the year. Vulcan Materials Co. (New Kingsport quarry) crushed limestone for concrete, roads, and agstone. General Shale Products Corp. (Kingsport mine) and Penn-Dixie Cement Corp. (Kingsport Shale mine) mined miscellaneous clay for use in heavy clay products and cement. The Mead Corp. reclaimed lime for industrial use.

Sumner.—Monsanto Co. mined phosphate rock. Ralph Rogers & Co., Inc. (Pilot Knob mine) and Sumner County Highway Department crushed limestone for concrete, roads, and agstone.

Tipton.—Clyde W. Owens Sand & Gravel Co. (Covington mine) and Tipton County Highway Department mined sand and gravel for structural, paving, fill, and other uses.

Unicoi.—Vulcan Materials Co. (Erwin mine) mined paving sand and paving and railroad ballast gravel. Unicoi County Highway Department (Rex Lewis quarry) crushed limestone for concrete and roads.

Union.—Vulcan Materials Co. and Union County Highway Department (Welch and Luttrell quarries) crushed limestone for concrete and roads. Tennessee Marble Co. (Luttrell No. 3 quarry) quarried dimension marble for dressed building stone.

Van Buren.—Coal was mined at one underground mine and six strip mines; the leading producers were C R & B Coal Co. (No. 2 strip mine), Waters Coal & Construction Corp. (No. 6 strip mine), and Walden Ridge Coal Co. (Walden Ridge No. 1 and No. 2 strip mines).

Warren.—Lambert & Lambert Stone Co., Inc. crushed limestone for concrete, roads, riprap, and agstone.

Washington.—Washington County Highway Department (Taylor Bridge, Dillow, Boones Creek, Gray, and Corby quarries) crushed limestone for concrete and roads. General Shale Products Corp. (Johnson City mine) mined miscellaneous clay for use in heavy clay products.

Wayne.—Vulcan Materials Co. (Waynesboro quarry) crushed limestone for concrete, roads, riprap, and agstone. Hassell & Dowdy, Inc. (Baker mine) mined structural sand and gravel.

Weakley.—Cyprus Mines Corp. (No. 6 mine), Bell Clay Co. (Collins mine), and H. C. Spinks Clay Co. Inc. mined ball clay for whiteware, enameling, floor and wall tile, firebrick and block, and heavy clay products.

White.—Sparta Limestone Co. (Sparta quarry) and White County Highway Department crushed limestone for concrete, roads, and agstone. Two oil wells, totaling 1,368 feet, were drilled.

Williamson.—Monsanto Co. (Williamson County mine) and TVA (Franklin mine) mined phosphate rock. Vulcan Materials Co. (Franklin quarry) and Williamson

County Highway Department (Globe quarry) crushed limestone for concrete, roads, and agstone.

Wilson.—Wilson County Rock Products, Inc. (Lebanon and No. 2 quarries) and Marquette Cement Manufacturing Co. (Martha quarry) crushed limestone for cement, concrete, roads, and agstone.

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, for collecting information on all minerals except fuels.

By F. F. Netzeband [1] and Roselle Girard [2]

The mineral industry of Texas maintained its important position in the economy of the State, the Southwest region, and the Nation in 1966 with a record output of minerals valued at $5 billion, about one-fourth of the total U.S. mineral value. Texas remained the principal domestic producer of petroleum, natural gas, natural gas liquids, shell, and magnesium metal. Other mineral commidities produced in significant quantities were bromine, cement, clay, gypsum, lime, salt, sand and gravel, stone, and sulfur. Of the 27 mineral commodities produced, five mineral fuels had increased outputs while one declined; 11 nonmetals increased in output, five declined, and one showed no change; three metals advanced in output and one registered no change.

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Table 1.—Mineral production in Texas [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Cement:				
Portland—thousand 376-pound barrels	30,820	$97,598	30,827	$97,188
Masonry—thousand 280-pound barrels	968	3,011	884	2,872
Clays—thousand short tons	4,469	6,865	4,516	7,187
Gem stones	NA	150	NA	150
Gypsum—thousand short tons	1,045	3,794	899	3,258
Helium:				
Refined—thousand cubic feet	r 350,000	r 12,250	364,100	12,744
Crude—do	1,015,708	10,330	1,030,500	10,605
Lime—thousand short tons	1,338	19,663	1,473	18,696
Natural gas—million cubic feet	6,636,555	858,396	6,953,790	903,993
Natural gas liquids:				
Natural gasoline and cycle products thousand gallons	3,772,471	256,959	3,890,267	259,332
LP gases—do	5,847,601	204,666	6,359,870	260,755
Perlite (crude)—short tons	1,000	8	W	W
Petroleum (crude)—thousand 42-gallon barrels	1,000,749	2,962,119	1,057,706	3,141,387
Salt—thousand short tons	6,964	30,771	7,724	33,797
Sand and gravel—do	32,649	36,075	26,222	31,313
Stone—do	39,520	53,659	43,578	56,659
Sulfur (Frasch process)—thousand long tons	3,674	r 83,282	3,703	96,820
Talc—short tons	64,211	204	102,399	367
Value of items that cannot be disclosed: Asphalt (native), barite, bromine, coal (lignite), graphite, iron ore (usable), magnesium chloride (for metal), magnesium compounds (except for metal), mercury, pumice, sodium sulfate, uranium ore, and values indicated by symbol W	XX	r 78,328	XX	72,627
Total	XX	r 4,718,128	XX	5,019,750

r Revised. XX Not applicable. NA Not available.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957–59 dollars

(Millions)

Year	Value [1]
1957	$4,444
1958	4,037
1959	4,284
1960	4,134
1961	4,214
1962	4,262
1963	4,374
1964	4,534
1965	4,687
1966	[p] 4,928

[p] Preliminary.
[1] Data for 1959–65 revised.

Production of mineral fuels was responsible for nearly 92 percent of the total mineral value. About half of the natural gas output and important volumes of petroleum and natural gas liquids were transferred to out-of-State markets. Pipelines and barges carried the materials to domestic markets. Ocean tankers moved significant quantities of crude oil and petroleum products to eastern seaboard markets and to foreign ports.

Mineral resources of the State were produced widely with 233 of the State's 254 counties reporting output. Production of

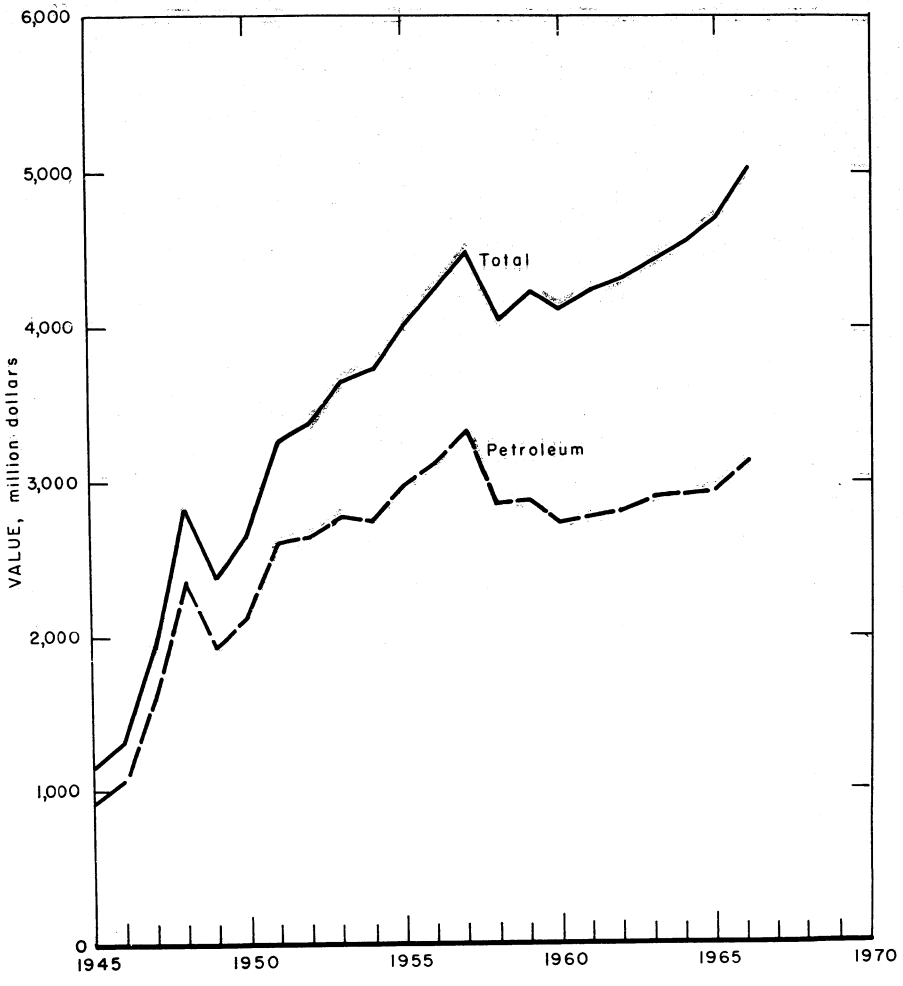

Figure 1.—Value of petroleum and total value of mineral production in Texas.

some form of mineral fuels—petroleum, natural gas, natural gas liquids, asphalt, and lignite—was registered in 206 counties; nonmetallic minerals were produced from 155 counties and metals from eight counties.

The mineral industry recovered secondary products from State-produced minerals such as sulfur recovered in the purification of natural gas, and carbon black from natural gas and refinery residues. Other secondary minerals were recovered in processing ores from other States and foreign countries. Nonmetallic minerals, excluding sulfur, were sold largely in local and intrastate markets. Crude oil refining and petrochemical manufacture were important segments of the State's mineral economy. Oil refining capacity was 2.7 million barrels per day, about 27 percent of the Nation's daily capacity of nearly 10 million barrels.

A monitoring program of important U.S. waterways including the Sabine, Trinity, and Brazos Rivers of Texas was planned by the U.S. Geological Survey in cooperation with State agencies. Electronic monitors will measure oxygen content, temperature, total dissolved solids, and turbidity of water.

The Texas Water Board promulgated its 1966 water plan to serve municipal, industrial, irrigation, and recreational demands. It called for construction of 53 new reservoirs, modifications of six existing reservoirs, and the erection of two salt-water barriers. At yearend there were 135 completed reservoirs in Texas having a total conservation storage capacity of 18.5 million acre-feet and a total flood control storage capacity of 15.6 million acre-feet. Fourteen major reservoirs were under construction, having additional conservation storage capacity of 11.6 million acre-feet and flood control storage capacity of 2.8 million acre-feet.

The Texas Railroad Commission continued its program of regulating pollution of fresh water supplies from oilfield brine. Studies proved that earthern pits, used for disposal of oilfield brines in many areas, caused pollution of fresh water. Orders requiring oil operators to discontinue use of salt water disposal pits for storage and evaporation of oilfield brines were issued by the Commission. More than 500 oilfields in nearly 50 counties were involved.

A Clean Waters Restoration Act of 1966 provided Federal grants to municipalities for wastewater-treatment plant construction, with incentives to States participating in the program.

The State's largest steamflood oil recovery project was begun by Shell Oil Co. in the Wilcox Formation of Slocum field in Anderson County. The project included drilling 65 wells arranged in seven 13-well patterns; 10 steam generators, capable of converting 10,000 barrels of water daily to steam, were installed. Heavy oil reserves of the Wilcox were estimated at 77 million barrels.

Table 3.—Employment 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
1965:								
Coal	102	273	28	226	---	3	13.28	235
Metal	1,409	305	430	3,442	---	22	6.39	172
Nonmetal and native asphalt	2,898	293	850	6,872	---	161	23.43	873
Sand and gravel	2,558	254	649	5,560	4	133	24.64	5,019
Stone	4,313	304	1,312	11,150	2	227	20.54	1,717
Total	11,280	290	3,269	27,250	6	546	20.26	1,971
1966: p								
Coal	90	280	25	195	---	5	25.64	462
Metal	1,465	303	445	3,562	---	21	5.90	182
Nonmetal and native asphalt	3,370	289	974	7,929	2	161	20.56	3,065
Sand and gravel	2,470	260	643	5,675	2	168	29.96	2,743
Stone	4,365	304	1,327	11,020	5	177	16.52	3,554
Total	11,760	290	3,414	28,381	9	532	19.06	2,811

p Preliminary.

The Texas Railroad Commission extended the period for unregulated production in new oilfields from 18 months to 2 years. The number of wells for new fields was raised from five to 10 wells.

Two important decisions which had particular interest to the mineral industry were returned by the Texas Supreme Court in 1966. The high court ruled that the Texas Railroad Commission could order a pipeliner to take ratable gas from separate reservoirs in the same field and defined the word "field" as a geographic area served by a common purchaser. In a second case, the high court ruled that mineral development applications other than oil, natural gas, coal, and lignite were governed by the Mineral Act of July 31, 1919, and not under the Sales and Leasing Act of 1931.

Employment and Injuries.—According to the Texas Employment Commission, mining employment in Texas remained unchanged at 107,500 employees with the oil and gas industry accounting for over 99 percent of this total. Average wages held steady at $132.82 while the workweek declined from 43.5 hours in January to 42.3 hours in December. The workweek of sulfur employees advanced from 40.1 hours in January to 43.4 hours in December.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

A 4.3-percent growth rate in the national economy in 1966 resulted in expanded State and national production of mineral fuels. The industry and commerce sector increased consumption by 9 percent and provided the largest single market for both basic and electric energy. The transportation market advanced about 5 percent despite the prolonged airline strike. Influenced by the moderate winter of 1965–66, energy demand in the residential market made only a modest advance. Natural gas supplied most of the increased fuel demand in industrial, commercial, and residential markets; expanded transportation markets were supplied by crude oil; and the electric utilities sector accounted for increased consumption of coal.

Texas crude oil producers have lost energy markets to natural gas and natural gas liquids since 1940. At that time crude oil represented 71 percent of the State's mineral fuels output, natural gas 27 percent, and liquids 2 percent. In 1966, crude oil output declined to 43 percent of the fuels output with natural gas accounting for 50 percent and natural gas liquids for the remaining 7 percent.

Asphalt, Native. — Highway construction resulted in the growth in both volume and value of asphalt by the two producers in Uvalde County.

Carbon Black.—Of 18 carbon black plants operating, 14 were furnace-type plants located in 10 counties and four were channel-type located in four counties. Natural gas used in producing carbon black declined for the 12th consecutive year to 48,541-million cubic feet.

Production of carbon black from petroleum liquids amounted to 1,150.3 million pounds and from natural gas, 146 million pounds. Average carbon black yield from liquids was 4.7 pounds per thousand gallons. Three pounds were recovered per thousand cubic feet of natural gas. Furnace blacks averaged 6.7 cents per pound and channel blacks 16.9 cents per pound.

Coal (Lignite).—Lignite, used as a fuel for generating electric power and as raw material for activated carbon was mined by open pit methods in Milam and Harrison Counties.

Helium.—Helium production in Texas can be divided into two categories; grade-A helium produced for consumer sale, and crude helium produced for the Government's conservation program.

Grade-A helium, having a purity of 99.995 percent, was produced at two plants owned and operated by the U.S. Bureau of Mines. These plants, located at Amarillo and Exell, produced a combined total of 364.1 million cubic feet during 1966, an increase of 14.1 million cubic feet (4 percent) over the 1965 production. At the Bureau of Mines established sales price of $35 per 1,000 cubic feet (f.o.b. plant), the 1966 production was valued at $12.74 million. The Amarillo helium plant is the only Bureau of Mines plant equipped to handle, fill, and ship helium in standard gas cylin-

ders, as well as highway semitrailers. Shipments from the Exell plant are by special railway tank cars or highway semitrailers. All Bureau of Mines shipments are of gaseous helium.

Crude helium is extracted from natural gas but unpurified or further treated. It varies in purity from 50 to 80 percent helium by volume, and is produced solely as part of the Government's helium conservation program. Under this program, helium-bearing natural gas is processed for helium extraction before such gas reaches its ultimate market. The helium so produced is sold to the Government, transported via pipeline to the Cliffside gasfield near Amarillo, and placed in underground storage in a partially depleted natural gas reservoir. When future helium requirements cannot be met from other sources, the stored helium will be produced, purified, and marketed.

Five plants, privately owned and operated, form the basis of the helium conservation program. Two of these, both owned and operated by Phillips Petroleum Co., are located in Texas, at Dumas and Hansford County. These two plants produced a total of 1,030.5 mullion cubic feet of crude helium in 1966, valued (at the price at which the crude helium was sold to the Government) at $10.6 million. The entire output of both plants was purchased by the Government.

Natural Gas.—Of the 10,736 wells drilled, 1,168 were completed as gas wells. Extensions and revisions added 6,663 billion cubic feet or 18.6 percent to natural gas reserves. Exploratory drilling added 3,317 billion cubic feet to reserves through new discoveries. Recoverable natural gas reserves were estimated at 123,609 billion cubic feet on December 31, 1966, according to the American Gas Association. This amounted to 17.8 cubic feet of gas reserves for each cubic foot of gas produced.

Natural Gas Liquids.—Recovery of natural gas liquids advanced 6.5 percent to 10,250 million gallons as petro-chemical, motor fuel, and industrial markets maintained their growth. Liquefied petroleum (LP) gases supplied 62 percent of the total output and natural gasoline and cycling products, the remainder. Most of the natural gasoline was utilized by the refining industry within Texas; the major portion of the LP gases was shipped to markets outside of the State. Production was reported from 362 gasoline plants, seven of which were new installations and 32 were cycling plants. Installed capacity was 24,981 million cubic feet per day yielding 29.2 million gallons per day of products.

Exploratory and development drilling increased the natural gas liquid reserve to 4.1 billion barrels—49 percent of the Nation's natural gas liquid reserve—according to the American Gas Association.

Petroleum.—Output of crude oil was reported from 200 counties. Production in excess of 1 million barrels was reported by 125 counties. The five leading counties in order of production were Andrews, Ector, Crane, Gaines, and Scurry. All phases of the State's petroleum industry—exploration, production, transportation, refining, and marketing—were influenced by national and international trends. Texas produced 35 percent of the domestic petroleum output, far more than State require-

Table 4.—Production trends of crude oil, natural gas, and natural gas liquids for select years
(Million barrels of oil equivalent)

Year	Production [1]				Percentage of—						
					Annual total			Change of reported year			
	Oil	Gas	Liquids	Total	Oil	Gas	Liquids	Oil	Gas	Liquids	Total
1950	830	558	69	1,457	57.0	38.3	4.7	68.4	193.7	331.3	108.4
1956	1,108	892	116	2,116	52.4	42.1	5.5	33.5	59.9	68.1	54.2
1960	927	1,052	128	2,107	44.0	49.9	6.1	−16.3	17.9	10.3	−.4
1961	939	1,065	137	2,141	43.9	49.7	6.4	1.3	1.2	7.0	1.6
1962	943	1,086	143	2,172	43.4	50.0	6.6	.4	2.0	4.4	1.4
1963	978	1,108	151	2,237	43.7	49.5	6.8	3.7	2.0	5.6	3.0
1964	990	1,159	157	2,306	42.9	50.3	6.8	1.2	4.6	4.0	3.1
1965	1,001	1,185	168	2,354	42.5	50.4	7.1	1.1	2.2	7.0	2.1
1966	1,058	p 1,237	179	2,474	42.8	50.0	7.2	5.7	4.4	6.5	5.1

p Preliminary.
[1] One barrel of crude oil equivalent to 5,600 cubic feet of natural gas or 57.4 gallons of natural gas luiqids a composite of 52.7 gallons of natural gasoline and 60.8 gallons of LP gases.

Table 5.—Comparison of mineral fuels production in Texas and the United States

Fuel	Production [1] as oil equivalent				Percent of fuels				Texas percent of United States		Percent change from 1965	
	Texas		United States		Texas		United States					
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966	Texas	United States
Crude oil	1,001	1,058	2,849	3,028	42.5	42.8	47.2	47.6	35.1	34.9	+5.7	+6.3
Natural gas	1,185	1,287	2,864	p 2,988	50.4	50.0	47.4	47.0	41.4	40.4	+4.8	+7.4
Natural gas liquids	168	179	323	343	7.1	7.2	5.4	5.4	52.0	52.1	+6.5	+6.2
Total equivalent	2,354	2,474	6,036	6,359	100	100	100	100	39.0	38.9	+5.1	+5.4

p Preliminary.
[1] Million barrels of oil equivalent, derived by gas and liquids factors reported in table 4.

Table 6.—Fuels reserves ratio to production in Texas and the United States

Fuel	Reserves [1]				Percent—				Reserve ratio			
	Texas		United States		Texas of United States		Change from 1965		Texas		United States	
	1965	1966	1965	1966	1965	1966	Texas	United States	1965	1966	1965	1966
Crude oil	14,303	14,077	31,352	31,452	45.6	44.8	−1.6	+0.3	14.3	13.3	11.0	10.4
Natural gas	21,539	22,073	51,155	51,667	42.1	42.7	+2.5	+1.0	18.2	17.8	17.9	17.8
Natural gas liquids	2,970	3,001	5,871	6,094	50.6	49.2	+1.0	+3.8	17.7	16.8	18.2	17.8
Total oil equivalent	38,812	39,151	88,378	89,213	43.9	43.9	+.9	+.9	16.5	15.8	14.6	14.0

[1] Million barrels of oil equivalent, derived by gas and liquids factors reported in table 4.

Table 7.—Production and value of mineral fuels

Year	Crude petroleum		Natural gas [1]	
	Thousand barrels	Value (thousands)	Million cubic feet	Value (thousands)
1957–61 (average)	970,536	$2,928,753	5,581,918	$607,002
1962	943,328	2,818,709	6,080,210	747,866
1963	977,835	2,908,380	6,205,034	775,629
1964	989,525	2,928,994	6,490,202	809,180
1965	1,000,749	2,962,119	6,636,555	858,396
1966	1,057,706	3,141,387	6,953,790	903,993

Year	Natural gas liquids					
	Natural gasoline and cycle products		LP gas		Total	
	Thousand gallons	Value (thousands)	Thousand gallons	Value (thousands)	Thousand gallons	Value (thousands)
1957–61 (average)	2,919,692	$207,405	4,243,194	$173,339	7,162,886	$380,744
1962	3,205,517	233,345	5,012,291	189,382	8,217,808	422,727
1963	3,320,416	218,975	5,366,831	169,695	8,687,247	388,670
1964	3,512,460	232,245	5,521,236	167,492	9,033,696	399,737
1965	3,772,471	256,959	5,847,601	204,666	9,620,072	461,625
1966	3,890,267	269,332	6,359,870	260,755	10,250,137	530,087

[1] Marketed production, gas either sold or consumed by producers including losses in transmission, amounts added to storage, and increases in gas pipelines.

ments. Over 27 percent of the U.S. refining capacity was located in Texas. Pipelines carried the major part of the crude oil and refinery products to markets within and outside of the State.

The oil and gas industry drilled 10,736 wells in search of crude oil and natural gas. The success ratio of wildcat drilling was one discovery—oil or gas—for every four wells drilled. Estimated proved recoverable reserves of crude oil declined 1.6 percent to 14,077 million barrels as of December 31, 1966, according to the American Petroleum Institute. Extensions and revisions added 699 million barrels to proved reserves and new discoveries added 71 million barrels.

In 1966, 48 refineries processed 922 million barrels of crude oil. Refinery capacity

Table 8.—Crude petroleum production, indicated demand, and stocks, in 1966, by months

(Thousand 42-gallon barrels)

Month	Production	Indicated demand	Stocks originating in Texas
January	87,457	87,543	89,643
February	80,192	78,845	90,990
March	90,287	86,735	94,542
April	87,067	83,406	98,203
May	91,255	86,572	102,886
June	88,133	86,047	104,972
July	89,143	91,223	102,892
August	88,770	91,295	100,367
September	85,779	90,808	95,338
October	89,710	89,815	95,233
November	87,631	87,452	95,412
December	92,282	88,482	99,212
Total:			
1966	1,057,706	1,048,223	XX
1965	1,000,749	r 1,005,232	XX

r Revised.
XX Not applicable.

Table 9.—Petroleum daily average production and runs to stills

(Thousand 42-gallon barrels)

Month	1965		1966	
	Crude production	Runs to stills	Crude production	Runs to stills
January	2,761	2,760	2,821	2,837
February	2,772	2,816	2,864	2,764
March	2,753	2,746	2,912	2,705
April	2,780	2,622	2,902	2,744
May	2,687	2,636	2,944	2,755
June	2,754	2,756	2,938	2,795
July	2,727	2,818	2,876	2,842
August	2,733	2,693	2,864	2,921
September	2,706	2,800	2,859	2,883
October	2,780	2,752	2,894	2,887
November	2,783	2,822	2,921	2,883
December	2,890	2,901	2,977	2,971

Table 10.—Runs to stills and output of refineries in 1966, by months

(Thousand 42-gallon barrels)

Month	Runs			Output					
						Fuel oil			
	Crude	Products	Rerun	Gasoline [1]	Kerosine	Distillate	Residual	Jet fuel	Miscellaneous
January	77,450	10,217	271	42,535	4,338	20,117	4,091	4,880	11,977
February	69,781	9,177	−1,552	37,110	4,347	17,460	2,734	4,299	11,456
March	75,235	10,110	−1,496	40,923	4,132	18,390	3,122	5,198	12,084
April	72,519	10,309	−496	40,737	3,396	17,463	3,181	4,918	12,637
May	77,813	10,299	−2,716	42,460	3,351	17,635	3,335	5,248	13,367
June	75,863	10,522	−2,527	41,226	3,626	17,164	3,287	4,946	13,609
July	78,388	11,077	−1,348	43,220	3,304	19,258	3,333	4,933	14,069
August	80,374	10,744	−545	43,754	3,896	20,378	3,764	4,992	13,789
September	79,122	10,630	−3,251	42,911	3,845	18,971	3,745	4,879	12,150
October	79,028	11,312	−853	44,588	3,963	18,685	3,390	5,305	13,556
November	75,102	10,943	456	43,082	3,598	18,335	3,067	5,708	12,711
December	80,944	11,637	−463	44,920	4,094	20,068	3,633	6,311	13,092
Total:									
1966	921,619	126,977	−14,520	507,466	45,890	223,924	40,682	61,617	154,497
1965	889,679	115,482	−14,954	481,559	41,194	226,104	39,590	51,728	150,032

[1] Includes special naphthas.

Table 11.—Stocks of crude petroleum at refineries, tank farms, and gathering systems in 1966, by months

(Thousand 42-gallon barrels)

Month	Refineries	Tank farms and pipelines	Lease tanks	Total
January	12,998	59,249	7,157	79,404
February	13,046	59,811	7,068	79,925
March	14,335	62,456	6,816	83,607
April	16,089	64,322	6,978	87,389
May	15,184	67,297	7,596	90,077
June	14,963	68,049	8,252	91,264
July	15,532	65,141	9,464	90,137
August	14,288	63,335	9,785	87,408
September	14,233	60,229	9,672	84,134
October	13,732	59,402	10,050	83,184
November	14,672	58,290	7,739	80,701
December	14,075	59,197	11,719	84,991

Table 12.—Stocks of refined products by refineries with plants and pipelines in 1966, by months

(Thousand 42-gallon barrels)

Month	Gasoline [1]	Kerosine	Fuel oil		Jet fuel	Natural gas liquids	Miscellaneous products
			Distillate	Residual			
January	36,248	2,337	13,388	7,678	3,412	908	30,854
February	37,124	2,461	9,813	6,974	3,379	961	31,739
March	36,482	2,796	8,983	6,883	3,817	984	31,538
April	35,273	3,416	10,553	7,021	3,304	984	30,856
May	32,424	3,057	12,323	7,342	4,051	903	32,326
June	29,650	3,656	13,289	7,722	3,921	987	33,049
July	29,521	3,718	16,769	8,249	4,171	1,073	33,154
August	29,249	4,069	18,322	8,312	4,703	1,138	31,742
September	28,810	4,403	21,356	9,114	4,765	1,032	32,708
October	29,581	4,750	24,115	9,331	4,203	1,141	32,771
November	31,319	3,519	22,528	8,813	3,961	1,426	31,455
December	32,666	3,167	19,363	8,300	4,278	1,049	31,210

[1] Includes naphtha.

in the State at yearend was 2.8 million barrels of crude oil daily, 27 percent of U.S. capacity. About 85 percent of the Texas plant capacity was in the Beaumont-Port Arthur-Houston area. No new refineries were constructed in 1966. Humble Oil & Refining Co. was adding equipment to its Baytown refinery to expand installed capacity to 326,000 barrels. Mobil Oil Co. planned to raise crude throughput by 59,000 barrels per day at its Beaumont refinery for a total daily capacity of 294,000 barrels. American Oil Co. planned to increase its Texas City crude capacity from 181,000 to 248,000 barrels per stream day.

Petrochemicals.—Major advances in new facilities and plants were made in the petrochemical industry, although little change was notable in composition of the industries corporate structure. Expansions were equally divided between oil and gas companies and chemical companies. The most spectacular advances were made in facilities producing ethylene and ammonia.

NONMETALS

Nonmetals advanced 2 percent in value over that of 1965 and accounted for about 7.6 percent of the State's total mineral value. An increase in production was noted for several nonmetals including lime, natural salines, salt, stone, sulfur, and talc and soapstone. Decreases were recorded in production of barite, bromine, gypsum, and sand and gravel.

Barite.—Crude barite was mined by one producer, Continental Minerals, from an open-pit in the Seven Heart Gap area of Culberson County. Output was less than that of 1965. The crude barite was prepared for use as a weighting agent for drilling muds at the company's plant approximately 6 miles east of Van Horn.

Table 13.—Portland cement production, shipments, and consumption
(Thousand 376-pound barrels and thousand dollars)

Year	Production	Shipments		Consumption (quantity)
		Quantity	Value	
1957–61 (average)	24,500	24,358	$76,636	21,372
1962	26,443	26,204	83,162	22,900
1963	29,150	29,104	92,734	24,618
1964	29,792	30,030	94,492	26,156
1965	30,771	30,820	97,598	26,371
1966	31,487	30,827	97,188	26,995

Barite produced outside of Texas was prepared at grinding plants in Brownsville, Houston, and Corpus Christi. Reported output and value increased about 6 percent over that of the previous year.

Bromine.—Texas ranked second in bromine production in the United States. Ethyl-Dow Chemical Co. extracted bromine from sea water at its Freeport plant for the manufacture of ethylene dibromide. Production and value were less than in 1965.

The chief use of ethylene dibromide was in antiknock compounds for gasoline. Other uses for bromine and bromine compounds included the production of flame retardants for paper products, plastics, and textiles; sanitizers for swimming pools; fire extinguisher fluids; dyes; pharmaceuticals; and photographic chemicals.

Cement.—Shipments of portland cement were almost the same as in 1965; total values dropped slightly. Shipments of masonry cement decreased about 9 percent. Thirteen companies manufactured portland cement at 19 plants in 1966; 11 of the companies also produced masonry cement at 17 of the plants.

Texas gained a new cement producer in 1966 when Gifford-Hill & Co., Inc., a large producer of construction materials, opened its plant near Midlothian in Ellis County. The plant has an annual capacity of 1.5 million barrels and uses computerized quality control techniques. Texas Industries, Inc., which also produces cement at Midlothian, announced plans to increase plant capacity to almost 5 million barrels per year.

Ideal Cement Co. began modifying its No. 1 plant at Houston for the manufacture of white cement. Texas Portland Cement Co., Division of Alpha Portland Cement Co., was expanding its facility at Orange by building a new 2.4-million-barrel-per-year plant to replace its 700,000-barrel-per-year plant.

Universal Atlas Cement, Division of United States Steel Corp., announced plans to expand its cement facilities near Waco by the addition of a white portland cement plant adjacent to its gray cement plant. The new plant was scheduled to be completed in 1967.

Clays.—Production included bentonite, fire clay, ball clay, kaolin, fullers earth, and miscellaneous clay. Total clay production increased about 1 percent, and total value increased about 5 percent over that of 1965. A total of 54 companies at 69 locations including 10 portland cement companies, reported production from 48 counties.

Miscellaneous clay accounted for 78 percent of the total production, but for only 55 percent of the total value. Approximately 36 percent of the miscellaneous clay was used in manufacturing cement, 30 percent in heavy clay products, and 33 percent for lightweight aggregate.

Table 14.—Clays sold or used by producers, by kinds
(Thousand short tons and thousand dollars)

Year	Bentonite		Fire clay		Miscellaneous clay		Total [1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	124	$914	614	$1,423	2,796	$3,034	3,534	$5,371
1962	118	873	615	1,558	3,011	3,203	3,744	5,634
1963	120	1,366	808	2,054	3,271	3,429	4,199	6,849
1964	111	1,294	666	1,815	3,379	3,586	4,156	6,695
1965	114	829	735	1,999	3,605	3,832	[2] 4,469	[2] 6,865
1966	107	876	859	2,057	3,523	3,934	[2] 4,516	[2] 7,187

[1] Incomplete total (1957–64), excludes kaolin (1964) and fuller's earth.
[2] Includes ball, kaolin, and fuller's earth.

Among clay consumers several new plants were added, and processing methods and equipment were improved at some existing plants. Yarti Tile Co. was renovating and equipping a 25,000-square-foot building at Woodville for manufacturing glazed and unglazed floor and wall tile. Materials, Inc., planned a 200,000-ton-per-year plant at Beaumont for the manufacture of burned clay aggregate for use as road base material. Two new brick plants—Leesburg Brick Co. and Camp County Clay Products Co.—were placed in operation at Pittsburg in Camp County. Cisco Pottery opened the idle flowerpot plant in Cisco formerly owned by N. D. Gallagher Clay Products Corp.; the new ownership announced plans to expand and modernize the facilities. Acme Brick Co. enlarged the process building at its Denton brick plant. Ceramic Southern, Inc., planned construction of a plant to manufacture porcelain insulators at Marshall. Texas Clay Products, Inc., automated a portion of its Malakoff brick plant. Texas Industries, Inc., planned a $2.25 million lightweight aggregate plant west of Clodine in the Houston area. Kilgore Ceramics Corp., a manufacturer of vitreous china plumbing fixtures and related products, planned a 20,400-square-foot addition to its plant at Kilgore.

Gem Stones.—Agate, jasper, fluorite, topaz, calcite, opal, and petrified wood with an estimated value of $150,000 were recovered in Texas during the year.

Graphite.—The Nation's only production of natural graphite came from the open-pit mine of Southwestern Graphite Co. in western Burnet County. The company processed the crystalline flake graphite at a mill adjacent to the mine. Production was slightly greater than in 1965.

Gypsum.—Production of gypsum was reported by eight companies in six counties. About 90 percent of the output was calcined and was used chiefly in building products such as wallboard, lath, exterior sheathing, and plaster. Some uncalcined gypsum was sold to cement companies for use as a retarder. Production and value of crude gypsum declined 14 percent in 1966 following a similar decline in the State's residential construction.

Lime.—Heavy demand by chemical and other industrial users, combined with large amounts of lime required for soil stabilization in the State's highway program, resulted in a record output of lime in 1966. (The record tonnage does not include regenerated lime.) Production was 10 percent higher than that of the previous year; total value, however, declined slightly.

Table 15.—Crude gypsum mined

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	1,168	$4,005
1962	1,120	3,956
1963	1,099	3,999
1964	1,131	4,049
1965	1,045	3,794
1966	899	3,258

Approximately 27 percent of the lime was used by the construction industry—mostly in soil stabilization. The remainder was used in agriculture and for refractory, chemical, and other industrial purposes. Eleven companies manufactured lime in 14 plants, using shell and crushed limestone as raw material.

A new lime plant began production during the year—the 240-ton-per-day plant of Texas Lime Co., located 12 miles west of Cleburne. This was the second lime plant operated by the company in Johnson County. Chemical Limestone Products, Inc. (also known as Clifstone Chemical Lime Co.) announced plans to construct a lime plant near Clifton. Brazos Lime Co. (Hill County), Round Rock Lime Co. (Williamson County), and Southwestern Superior Products Co. (Williamson County) merged during the year and began operating under the corporate name of Round Rock Lime Companies. United States Gypsum Co. was installing a highly automated new kiln at the New Braunfels plant that was expected to increase production by 50 percent.

Magnesium Compounds.—The Dow Chemical Co. produced magnesium chloride and other magnesium compounds at its Freeport plant in Brazoria County. Sea water from the Gulf of Mexico was used as the raw material.

E. J. Lavino & Co. processed magnesium hydroxide obtained from Dow to produce refractory magnesia (periclase) at its plant at Freeport. Early in the year A. P. Green Refractories Co. announced plans to construct a $3.5 million plant at Freeport for the production of refractory material from magnesium hydroxide to be supplied by Dow.

Table 16.—Lime sold or used by producers

Year	Quicklime (short tons)	Hydrated lime (short tons)	Total	
			Short tons	Value (thousands)
1957–61 (average)	446,649	334,713	781,362	$8,191
1962	585,214	461,042	1,046,256	11,999
1963	571,515	559,690	1,131,205	13,026
1964	764,250	586,115	1,350,365	17,201
1965	716,574	621,377	1,337,951	19,663
1966	802,214	671,015	1,473,229	18,696

Mica.—No mica production was reported in 1966. Shipments from out-of-State were processed at the Fort Worth grinding plant of Western Mica Corp. for use in joint cement.

Natural Salines.—Production increased over that of the previous year. Ozark-Mohoning Co. extracted sodium sulfate (salt cake) from west Texas brines at facilities near Seagraves (Gaines County), Brownfield (Terry County), and Monahans (Ward County), American Cyanamid Co. recovered sodium sulfate as a byproduct at its Fort Worth chemical and fertilizer plant.

Perlite.—Perlite Producers, Inc., mined crude perlite from open pits in the Pinto Canyon area of Presidio County. The company operated a drying, grinding, and expanding plant adjacent to the mine.

Seven companies operated perlite expanding plants in Dallas, Fort Worth, Houston, Irving, Lacoste, LaPorte, and Midland. Expanded perlite was used for building plaster, as loose-fiill insulation, concrete aggregate, soil-conditioning agent, filler, and filter aid, and for other purposes.

Pumicite (Volcanic Ash).—One producer mined volcanic ash from open pits near Rio Grande City in Starr County. Chief use was as concrete admixture.

Salt (Sodium Chloride).—Output of salt in Texas reached a record high of 7.7 million short tons, 11 percent over that of 1965, and represented approximately 21 percent of the Nation's total output in 1966. Most of the output was used as a basic raw material by the chemical industry.

Eleven companies produced salt from Gulf Coastal Plain salt domes and from Permian Basin salt deposits. Most of the year's production was recovered as brine. Rock salt was mined at Hockley dome in Harris County by United Salt Corp. and at Grand Saline dome in Van Zandt County by Morton Salt Co.

The name of Frontier Chemical Co., Division of Vulcan Materials, a salt brine producer in Yoakum County was changed to Vulcan Materials Co., Chemical Division during the year.

Table 17.—Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	4,485	$17,124
1962	5,553	19,485
1963	5,965	22,355
1964	6,410	28,797
1965	6,964	30,771
1966	7,724	33,797

Sand and Gravel.—Production of sand and gravel in Texas dropped sharply from that of 1965. Total tonnage by commercial and Government-and-contractor operations declined about 20 percent; total value, lowest since 1961, decreased 13 percent. Most of the output was used for construction, and the decline in production reflects a drop in those markets.

Two new sand and gravel plants—Parker Brothers and Superior Sand & Gravel, Inc. —were constructed near Eagle Lake in Colorado County. Texas Construction Material Co. added facilities to produce blast sand at its Eagle Lake plant. Wayne W. Wilson, Robstown, announced plans to manufacture vinyl plastic coatings for gravel—the product would be used for decorative ground cover and for roofing material. Wedron Silica Co. of Chicago purchased Capitol Products, Division of Capitol Aggregates, Inc., Cleburne, a producer of silica sand and silica flour. The subsidiary was named Capitol Silica Co.

Table 18.—Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Year	Commercial		Government-and-contractor		Total sand and gravel	
	Quantity	Value	Quantity	Value	Quantity	Value
1957–61 (average)	25,176	$28,122	4,643	$1,959	29,819	$30,081
1962	25,619	29,948	4,457	3,149	30,076	33,097
1963	27,511	32,085	5,745	4,226	33,256	36,311
1964	25,249	30,896	3,906	2,498	29,155	33,394
1965	27,488	33,572	5,161	2,503	32,649	36,075
1966	23,089	28,947	3,133	2,366	26,222	31,313

Table 19.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	9,376	$9,873	7,455	$6,896
Paving	3,096	3,709	2,906	2,900
Fill	523	204	510	260
Other [1]	994	3,072	848	3,310
Total	13,989	16,858	11,719	13,366
Gravel:				
Building	8,792	10,842	6,809	9,566
Paving	4,257	5,403	4,045	5,457
Fill	160	89	244	130
Other [2]	290	380	272	428
Total	13,499	16,714	11,370	15,581
Total sand and gravel	27,488	33,572	23,089	28,947
Government-and-contractor operations:				
Sand:				
Building	2	2	10	17
Paving	475	231	404	247
Fill	40	20	-----	-----
Other [3]	40	7	-----	-----
Total	557	260	414	264
Gravel:				
Building	-----	-----	3	5
Paving	4,487	2,196	2,716	2,097
Other [4]	117	47	-----	-----
Total	4,604	2,243	2,719	2,102
Total sand and gravel	5,161	2,503	3,133	2,366
Grand total	32,649	36,075	26,222	31,313

[1] Includes other construction sand and industrial sand (unground and ground).
[2] Includes railroad ballast, miscellaneous, and other construction gravel.
[3] Includes other construction sand.
[4] Includes other construction gravel.

Several companies were expanding or constructing glassmaking facilities during the year. Pittsburgh Plate Glass Co., Chemical Division, announced plans for a $1 million expansion program at its Corpus Christi plant that included a glassblowing unit. Armstrong Cork Co. planned to build a new plant at Waxahachie to produce about 500,000 glass bottles per day. Chattanooga Glass Co. enlarged its Corsicana plant and installed new equipment at an estimated cost of $2 million—capacity for producing beverage bottles was doubled.

Stone.—Texas ranked fourth in the United States in stone output in 1966. Producers quarried and processed basalt, granite, graphitic schist, marble, marl, limestone, sandstone, shell, and rhyolite. Output, including shell, amounted to almost 43.6 million short tons, an increase of

Table 20.—Stone sold or used by producers, by kinds

(Thousand short tons and thousand dollars)

Year	Limestone		Sandstone		Shell		Total [1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1962	25,717	$27,851	1,266	$2,045	10,073	$14,701	38,067	$48,988
1963	31,375	34,682	1,412	1,756	9,804	14,026	43,142	54,007
1964	28,263	31,950	1,304	1,753	9,990	15,077	40,240	52,070
1965	27,882	31,095	881	1,423	9,689	15,356	39,520	53,659
1966	32,373	39,591	1,257	1,729	9,365	12,839	43,578	56,659

[1] Includes other stone to avoid disclosing individual company confidential data.

10 percent over that of 1965. Crushed limestone accounted for the largest part of total production, and shell accounted for approximately 21 percent.

Chemical Limestone Products, Inc., was constructing a high-purity limestone plant southeast of Clifton. The company planned to market the crushed limestone for use in chemical and steel industries and in agriculture. Trinity Concrete Products purchased the basalt quarry of Southwest Stone Co. in Uvalde County.

Results of studies of limestone and dolomite from approximately 250 localities in 49 Texas counties were published.[3]

Although most of the stone quarried in 1966 was crushed before use, some dimension stone also was produced. Four producers operated dimension limestone quarries in Gillespie and Williamson Counties, three companies produced dimension granite in Burnet and Llano Counties, and two producers quarried dimension sandstone in El Paso and Parker Counties.

Sulfur.—Shipments of Texas Frasch sulfur, which showed an increase of about 1 percent over those of the previous year, were largest since 1955. The shipments averaged $26.15 per long ton and total value was 16 percent greater than that of 1965.

Table 21.—Sulfur produced and shipped from Frasch mines

(Thousand long tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1957–61 (average)	2,786	2,789	$65,284
1962	2,622	2,655	57,297
1963	2,413	2,550	50,109
1964	2,489	3,302	65,780
1965	2,534	3,674	r 83,282
1966	2,916	3,703	96,820

r Revised.

Demand for sulfur in the United States continued to exceed the supply. Domestic production was supplemented by shipments from Canada and Mexico. Most of the sulfur output was consumed in making sulfuric acid, which is used in manufacturing fertilizers and industrial chemicals. Texas sulfuric acid plant capacity was undergoing expansion at yearend. Stauffer Chemical Co., Consolidated Chemicals Division, was building a 700,000-ton-per-year plant in Houston, and Texaco Inc., a 92,400-ton-per-year plant in Port Arthur.

Texas Gulf Sulphur Co. produced Frasch sulfur from caprock of the Fannett and Spindletop salt domes in Jefferson County, Moss Bluff Dome in Liberty County, Gulf Dome in Matagorda County, and Boling Dome in Wharton County. In Fort Bend County, Duval Corp. produced sulfur from a Frasch mine at Orchard Dome, and Jefferson Lake Sulphur Co. produced from Long Point Dome. Hooker Chemical Co. leased Bryan Mound salt dome in Brazoria County and planned an economic evaluation for sulfur mining. Phelan Sulphur Co. started production on a $2.5 million, 150,000-ton-per-year facility near Damon in Brazoria County to produce Frasch sulfur from Nash Dome (formerly mined by Freeport Sulphur Co.).

Exploration for new sources of sulfur continued at an accelerated rate. Much of the activity centered in Pecos, Reeves, and Culberson Counties of west Texas. Interest in State-owned sulfur lands in the area increased after a decision by the Supreme Court of Texas upheld the validity of a State mining law under which annual rental on State-owned land is 50 cents per acre and under which, after 5 years of development, a patent can be obtained for $7.50

[3] The University of Texas. Limestone and Dolomite Resources, Lower Cretaceous Rocks, Texas. Bureau of Economic Geology, Rept. of Inv. 56, 1966.

per acre. Companies exploring for sulfur in the area included Atlantic-Richfield Co., Duval Corp., Humble Oil & Refining Co., Phillips Petroleum Co., Piper Petroleum, Sinclair Oil & Gas Co., Texas American Oil Corp., and others. Duval Corp. began operating a Frasch pilot-scale facility to mine sulfur northeast of Fort Stockton in Pecos County.

A number of companies also explored for sulfur in the Gulf of Mexico. Jefferson Lake Sulphur Co. announced plans to drill 15 exploratory wells in the Stuart Beach salt dome area about 3 miles offshore from Galveston. Texas Gulf Sulphur Co., Freeport Sulphur Co., and several major oil companies were exploring for sulfur on submerged Federal lands more than 45 miles off the Texas coast. No announcement was made of any significant sulfur discoveries resulting from this exploration.

Talc.—Mine production set a record high for Texas as it increased 59 percent over that of 1965. The rise, however, resulted in a buildup of stockpiles as tonnage of talc and soapstone sold or used in 1966 dropped 5 percent. Total value of the sold or used material increased 36 percent over 1965 value.

Six companies mined talc from open pits in Hudspeth County, and one of the companies mined soapstone from an open pit in Gillespie County. Most of the output was used by the ceramics industry.

Pioneer Talc Co., Inc., processed talc at a grinding mill at Allamoore, Hudspeth County.

Vermiculite.—Perlite Producers, Inc., mined vermiculite from an open pit in Llano County and exfoliated it at a plant in Llano. It was used chiefly as a soil conditioner. Crude vermiculite, not mined in Texas, was exfoliated at plants in Dallas, Houston, and San Antonio.

METALS

Metal mining was not a major factor in the Texas mineral economy. Individually, two of the four metals produced in 1966—iron and magnesium—were important in their own industry. The State's metal industry consisted of a large number of metallurgical plants that processed ores or other materials from other States and foreign countries and included numerous plants that fabricated the metals into various shapes and products. Metals produced at the extractive plants included aluminum from imported bauxite ores, antimony, manganese, and tin from foreign ores and concentrates, copper, lead, and zinc from domestic and foreign ores, and cadmium and silver as byproducts of base metal smelting operations. All except iron depended on markets outside of Texas.

Aluminum.—Record demand for aluminum resulted in capacity operation at the three aluminum reduction plants—Point Comfort and Rockdale works of Aluminum Company of America (Alcoa), and San Patricio works of Reynolds Metals Co.

Alcoa began constructing a 48-million-pound-per-year atomized aluminum powder facility at its Rockdale plant. In 1966, the market for the powder was largely military, being used in solid propellant missiles and as an ingredient in explosives. The company also began installing a continuous casting unit to produce electrical conductor redraw rods. Reynolds Metals Co. began constructing a 2-million-pound-per-day alumina unit at its San Patricio plant near Corpus Christi. The unit will have the largest rotary kiln in the industry.

Antimony.—Antimony was recovered from foreign ores and concentrates at the Laredo smelter of National Lead Co. The plant was operated at near capacity as market demand recorded a 14 percent increase over that of 1965. The principal market remained antimonial lead for storage batteries; other important markets included additive for bearing metal, as a pigment in ceramic enamels, paints, and lacquers, and as an ingredient in ceramic frits.

Cadmium.—Cadmium was recovered from flue dusts of zinc smelters at the Corpus Christi electrolytic zinc smelter of American Smelting and Refining Company (Asarco).

Copper.—Copper ores and concentrates from other States and from foreign countries were smelted at the El Paso plant of Asarco. Blister and anode copper from the Arizona operations of Phelps-Dodge Refining Corp. were treated at the company's Nichols refinery in El Paso.

Iron Ore.—Brown iron ores were produced in Cass, Cherokee, Morris, and Nacogdoches Counties. Total output was

about 25 percent greater than in 1965. Major markets for the Texas brown ores were one of the State's steel mills and the cement industry.

Operations of Lone Star Steel Co. were idle for a brief period early in 1966 to permit repairs to the blast furnace. Armco Steel Corp. planned a $25 million structural steel mill to be located adjacent to its Houston plant. U.S. Steel purchased between 7,000 and 8,000 acres on Cedar Point east of Baytown, where it plans to build a steel mill. Facilities will include two electric furnaces, a 160-inch plate mill, and auxiliary equipment. Bethlehem Steel Corp. secured 167 acres with berth facilities on the Houston ship channel, with options for additional acreage.

Lead.—Lead ores and concentrates from other States and from foreign countries were smelted at the El Paso plant of Asarco.

Magnesium.—Magnesium metal and magnesium compounds were produced at the Freeport complex of The Dow Chemical Co. The magnesia was recovered from sea water by chemical process. The company planned to increase its Freeport metal capacity from 100,000 to 120,000 tons per year through improvements to its electrolytic cells and modernization and activation of some idle capacity.

Manganese.—Foreign manganese ores were processed into ferromanganese at the Houston plant of Tenn-Tex Alloy & Chemical Corp.

Mercury.—Five mercury prospects were active in the Terlingua-Study Butte area of Brewster County in 1966. Diamond Alkali Co. reported that its Study Butte prospect had sufficient reserves to warrant development.

Silver.—Silver was recovered from foreign and domestic lead and copper ores and from zinc smelter residues at the El Paso lead smelter of Asarco.

Tin—Tungsten—Rare-Earth Metals.—These metals were recovered from foreign ores and concentrates and secondary scrap materials at the Texas City electrolytic smelter of Wah Chang Corp. during 1966.

Uranium.—Uranium ore produced in Karnes County was processed at the Falls City mill of Susquehanna-Western Inc. The company completed contracts to supply a West German utility company with uranium oxide.

Zinc.—Zinc was recovered from domestic and foreign ores at two retort smelters and one electrolytic smelter in 1966. Concentrate supplied to all smelters was ample during the year with all facilities operating at or near capacity. Markets continued strong throughout the year.

REVIEW BY COUNTIES

This review is limited to those counties having significant mineral production or mineral information.

Andrews.—The county was the State's largest oil producer and led in total mineral value. Natural gas liquids were recovered at seven gasoline plants whose combined output ranked the county fifth among natural gas liquids producers. Sulfur was recovered in purification of natural gas at the Midland Farms gasoline plant of Pan American Petroleum Corp. and at the Andrews plant of Parker-Andrews Co. Of 124 wells drilled, 97 were completed as oil wells, four of which were discoveries. Three wells were completed as gas producers, with one discovery.

Angeline.—The county ranked fifth in value of clay output. Bentonite was mined from open pits near Zavala by Bennett Clark Company, Inc., and Magnet Cove Barium Corp. One exploratory well resulted in a gas discovery.

Texas Foundries expanded malleable casting capacity to 30,000-tons-per-year at two new furnaces, its steel casting capacity to 6,000-tons-per-year, and ductile iron capacity to 3,000-tons-per-year. The company also added heat treating and cleaning facilities and planned a fifth furnace for a new ductile and premium gray-iron foundry. Notional Poly Chemicals Inc. sold its phenolic and urea resins facilities at Lufkin to the Georgia Pacific Corp. of Portland, Oreg.

Aransas.—Mineral fuels were the principal resource produced in the county in 1966. Shell was recovered from shallow bays near Rockport by Heldenfels Bros. Contractors prepared limestone for riprap

Table 22.—Value of mineral production in Texas, by counties [1]

County	1965 r	1966	Minerals produced in 1966 in order of value
Anderson	$20,215,500	$21,432,900	Petroleum, natural gas.
Andrews	262,910,030	278,941,939	Petroleum, natural gas liquids, natural gas.
Angelina	493,430	498,251	Clays, natural gas, petroleum.
Aransas	10,550,731	11,172,431	Natural gas, petroleum, natural gas liquids, shell, stone.
Archer	30,239,470	32,110,024	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Atascosa	18,701,610	19,930,280	Petroleum, natural gas, natural gas liquids, sand and gravel.
Austin	6,156,200	6,509,205	Do.
Bastrop	857,875	932,737	Clays, petroleum, stone, sand and gravel, natural gas.
Baylor	5,719,600	6,103,900	Petroleum, sand and gravel, natural gas.
Bee	22,458,855	23,545,885	Natural gas, petroleum, natural gas liquids, stone.
Bell	W	102,087	Sand and gravel, stone.
Bexar	22,908,377	25,336,821	Cement, stone, sand and gravel, petroleum, natural gas liquids, clays.
Blanco	16,000	W	Stone, sand and gravel.
Borden	22,174,200	23,518,700	Petroleum, natural gas, sand and gravel.
Bosque	5,000	117,000	Sand and gravel.
Bowie	134,100	127,300	Petroleum.
Brazoria	190,880,485	192,563,335	Petroleum, natural gas, bromine, natural gas liquids, magnesium chloride, salt, lime, magnesium compounds, sand and gravel.
Brazos	35,900	23,200	Natural gas, petroleum.
Brewster	W	W	Mercury, clays.
Briscoe	W	----	
Brooks	32,476,810	36,261,053	Natural gas, petroleum, natural gas liquids.
Brown	2,345,306	2,205,932	Stone, petroleum, natural gas, clays.
Burleson	153,900	W	Sand and gravel, petroleum.
Burnet	5,926,879	4,412,650	Stone, graphite, sand and gravel.
Caldwell	13,594,300	14,417,000	Petroleum.
Calhoun	20,364,468	21,225,846	Natural gas, petroleum, natural gas liquids, lime, shell, sand and gravel.
Callahan	6,991,323	7,440,323	Petroleum, natural gas, stone, natural gas liquids.
Cameron	1,336,200	1,414,100	Natural gas, petroleum.
Camp	2,995,400	3,176,600	Petroleum, natural gas.
Carson	21,876,540	23,058,190	Petroleum, natural gas, natural gas liquids.
Cass	13,782,106	14,037,574	Natural gas liquids, petroleum, natural gas, iron ore.
Chambers	73,621,849	77,657,425	Petroleum, natural gas, shell, salt, natural gas liquids.
Cherokee	2,958,699	3,273,807	Petroleum, natural gas, natural gas liquids, iron ore, clays.
Childress	272,600	247,700	Petroleum, natural gas.
Clay	11,694,800	12,446,700	Petroleum, natural gas, sand and gravel, stone.
Cochran	24,648,400	26,101,922	Petroleum, natural gas, natural gas liquids.
Coke	27,768,810	29,593,860	Petroleum, natural gas liquids, natural gas, sand and gravel.
Coleman	7,091,425	7,850,753	Petroleum, natural gas, stone, natural gas liquids, clays.
Collin	63,012	120,302	Stone.
Collingsworth	3,295,900	3,478,100	Natural gas, petroleum.
Colorado	33,604,747	39,685,260	Natural gas, natural gas liquids, sand and gravel, petroleum.
Comal	3,779,843	W	Lime, stone.
Comanche	194,103	252,692	Natural gas, stone, petroleum.
Concho	1,341,590	1,453,315	Petroleum, natural gas, natural gas liquids.
Cooke	32,677,165	34,691,329	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Coryell	2,816	115,704	Stone, sand and gravel, petroleum.
Cottle	73,100	70,100	Petroleum.
Crane	158,798,630	171,544,673	Petroleum, natural gas liquids, natural gas.
Crockett	28,377,790	30,841,880	Petroleum, natural gas, natural gas liquids.
Crosby	1,301,400	404,500	Petroleum, natural gas.
Culberson	3,872,217	4,072,638	Petroleum, natural gas, barite.
Dallam	70,600	74,700	Natural gas.
Dallas	20,076,591	18,667,190	Cement, sand and gravel, stone, clays.
Dawson	27,365,110	28,993,986	Petroleum, natural gas, natural gas liquids, stone.
Denton	373,636	374,952	Petroleum, sand and gravel, natural gas, clays.
De Witt	14,142,530	14,347,615	Natural gas, petroleum, natural gas liquids, sand and gravel.
Dickens	136,800	104,800	Petroleum, natural gas.
Dimmit	775,400	822,200	Do.
Donley	33,000	----	
Duval	37,014,503	39,545,255	Petroleum, natural gas, salt, natural gas liquids, sand and gravel.

See footnotes at end of table.

Table 22.—Value of mineral production in Texas, by counties [1]—Continued

County	1965 [r]	1966	Minerals produced in 1966 in order of value
Eastland	$5,302,529	$5,164,902	Petroleum, natural gas liquids, natural gas, clays, stone.
Ector	236,411,283	253,137,479	Petroleum, natural gas liquids, natural gas, cement, stone, sand and gravel.
Edwards	24,200	37,780	Petroleum, stone.
Ellis	12,305,913	14,596,778	Cement, stone, clays.
El Paso	5,733,545	5,466,905	Cement, stone, sand and gravel.
Erath	1,951,430	2,128,735	Natural gas, natural gas liquids, petroleums, stone, sand and gravel.
Falls	20,012	309,111	Stone, sand and gravel, petroleum.
Fayette	1,690,957	1,545,755	Petroleum, sand and gravel, clays, natural gas, stone.
Fisher	19,068,019	19,974,616	Petroleum, natural gas liquids, natural gas, gypsum, clays.
Floyd	900	W	Sand and gravel, petroleum.
Foard	3,047,200	3,193,400	Petroleum, natural gas.
Fort Bend	38,643,460	40,057,368	Petroleum, sulfur, natural gas, salt, natural gas liquids, clays, sand and gravel, stone.
Franklin	13,377,620	13,898,685	Petroleum, natural gas liquids, natural gas.
Freestone	3,180,304	3,325,741	Natural gas, stone, petroleum, natural gas liquids, clays.
Frio	4,916,250	5,269,992	Petroleum, natural gas, natural gas liquids.
Gaines	102,399,586	109,637,026	Petroleum, natural gas, natural gas liquids, sodium sulfate, stone, sand and gravel.
Galveston	54,074,673	56,284,327	Petroleum, natural gas, natural gas liquids, shell, clays, sand and gravel.
Garza	15,229,000	16,140,800	Petroleum, sand and gravel, natural gas.
Gillespie	114,005	222,009	Gypsum, sand and gravel, soapstone, stone.
Glasscock	3,389,300	3,593,200	Petroleum, natural gas.
Goliad	10,342,700	10,991,384	Natural gas, petroleum, natural gas liquids, stone.
Gonzales	1,227,900	1,369,738	Natural gas, petroleum, clays, sand and gravel, stone.
Gray	53,365,710	56,359,776	Petroleum, natural gas liquids, natural gas.
Grayson	25,423,191	27,576,735	Petroleum, natural gas, natural gas liquids, stone, sand and gravel.
Gregg	81,070,150	86,841,505	Petroleum, natural gas liquids, natural gas.
Grimes	-----	30,100	Stone.
Guadalupe	9,305,118	9,947,146	Petroleum, sand and gravel, clays, natural gas
Hale	6,628,310	7,047,008	Petroleum, natural gas, natural gas liquids.
Hamilton	97,768	83,416	Natural gas, stone, petroleum.
Hansford	26,937,182	28,273,788	Natural gas liquids, natural gas, petroleum helium.
Hardeman	5,035,569	4,945,754	Petroleum, gypsum, natural gas liquids, natural gas.
Hardin	25,400,440	26,787,501	Petroleum, natural gas, natural gas liquids, sand and gravel.
Harris	107,724,820	117,378,859	Petroleum, cement, natural gas liquids, natural gas, lime, salt, sand and gravel, clays.
Harrison	17,412,522	18,260,370	Petroleum, natural gas, natural gas liquids, coal, clays.
Hartley	1,002,700	1,061,300	Natural gas, petroleum.
Haskell	10,954,500	11,617,300	Petroleum, natural gas.
Hays	W	53,864	Sand and gravel, stone.
Hemphill	2,016,300	2,136,700	Petroleum, natural gas.
Henderson	10,520,283	11,390,281	Natural gas, petroleum, natural gas liquids, clays, sand and gravel.
Hidalgo	33,143,165	35,804,261	Natural gas, natural gas liquids, petroleum, sand and gravel, stone, clays.
Hill	715,266	962,602	Lime, stone, petroleum.
Hockley	48,799,700	51,876,391	Petroleum, natural gas liquids, natural gas.
Hood	70,200	70,900	Natural gas, sand and gravel.
Hopkins	8,064,342	8,121,680	Natural gas, petroleum, natural gas liquids, clays.
Houston	5,497,340	5,799,688	Petroleum, natural gas liquids, natural gas, sand and gravel.
Howard	56,126,150	59,819,178	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Hudspeth	388,983	553,930	Talc, stone, gypsum.
Hunt	146,220	189,200	Natural gas, stone.
Hutchinson	47,200,883	50,042,476	Petroleum, natural gas liquids, natural gas, sand and gravel, salt, stone.
Irion	3,284,540	3,384,440	Petroleum, natural gas liquids, natural gas.
Jack	15,314,100	16,527,855	Petroleum, natural gas, natural gas liquids, stone.
Jackson	52,297,040	55,146,674	Petroleum, natural gas, natural gas liquids.
Jasper	2,182,080	2,343,965	Petroleum, natural gas, lime, clays, sand and gravel.
Jefferson	64,508,150	73,046,639	Petroleum, sulfur, natural gas, natural gas liquids, salt, sand and gravel, clays.

See footnotes at end of table.

Table 22.—Value of mineral production in Texas, by counties [1]—Continued

County	1965 [r]	1966	Minerals produced in 1966 in order of value
Jim Hogg	$19,248,890	$19,148,488	Petroleum, natural gas, natural gas liquids, sand and gravel.
Jim Wells	68,833,090	75,402,108	Petroleum, natural gas, natural gas liquids, stone.
Johnson	1,674,865	W	Lime, stone.
Jones	12,647,370	13,318,785	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Karnes	15,667,304	18,087,096	Petroleum, natural gas, uranium, natural gas liquids, stone.
Kaufman	1,781,546	2,181,565	Petroleum, stone, natural gas.
Kendall	245,114	-----	
Kenedy	12,282,560	13,149,854	Natural gas, petroleum, natural gas liquids.
Kent	34,810,210	36,914,115	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kerr	63,000	W	Sand and gravel, stone.
Kimble	31,900	59,500	Sand and gravel, natural gas, petroleum.
King	3,813,600	4,039,700	Petroleum, natural gas.
Kleberg	102,817,412	109,423,186	Petroleum, natural gas, natural gas liquids, stone.
Knox	6,124,500	6,495,200	Petroleum, natural gas.
Lamb	709,440	691,086	Petroleum, stone, natural gas.
Lampasas	47,069	74,019	Stone, sand and gravel.
La Salle	1,164,400	1,234,200	Petroleum, natural gas.
Lavaca	12,394,774	10,590,917	Natural gas liquids, natural gas, petroleum, sand and gravel.
Lee	45,400	48,100	Petroleum, natural gas.
Leon	6,592,320	6,993,128	Petroleum, natural gas, natural gas liquids.
Liberty	41,085,173	43,587,367	Petroleum, sulfur, natural gas, natural gas liquids.
Limestone	2,361,879	2,841,328	Natural gas, sand and gravel, petroleum, clays, stone.
Lipscomb	9,778,300	10,363,400	Petroleum, natural gas.
Live Oak	22,758,350	23,739,941	Natural gas, natural gas liquids, petroleum.
Llano	2,273,562	353,167	Stone, sand and gravel.
Loving	11,569,800	12,268,000	Petroleum, natural gas.
Lubbock	1,069,084	1,045,000	Petroleum, sand and gravel, natural gas.
Lynn	1,629,400	1,727,900	Petroleum, natural gas.
McCulloch	W	1,468,635	Sand and gravel, stone.
McLennan	7,569,709	6,550,127	Cement, sand and gravel, stone, clays, petroleum.
McMullen	9,645,120	10,238,049	Natural gas, petroleum, natural gas liquids.
Madison	3,985,940	4,225,059	Natural gas, petroleum, natural gas liquids, stone.
Marion	4,126,680	4,374,376	Petroleum, natural gas, natural gas liquids.
Martin	6,044,100	6,409,900	Petroleum, natural gas.
Mason	23,000	48,000	Sand and gravel.
Matagorda	50,491,146	58,794,975	Natural gas, petroleum, natural gas liquids, sulfur, shell, sand and gravel, clays.
Maverick	2,222,140	2,426,156	Petroleum, natural gas liquids, natural gas.
Medina	1,100,000	1,165,393	Petroleum, clays, natural gas.
Menard	285,400	302,700	Petroleum, natural gas.
Midland	54,398,310	60,075,284	Petroleum, natural gas liquids, natural gas.
Milam	W	W	Coal, petroleum.
Mills	17,600	345,526	Stone.
Mitchell	4,962,300	5,346,130	Petroleum, stone, natural gas, sand and gravel.
Montague	21,950,230	28,900,299	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Montgomery	29,080,010	30,821,635	Petroleum, natural gas liquids, natural gas, sand and gravel.
Moore	50,392,749	58,639,583	Natural gas liquids, helium, natural gas, petroleum.
Morris	W	W	Iron ore.
Motley	1,011,800	1,040,500	Petroleum, sand and gravel, natural gas.
Nacogdoches	3,902,548	4,360,697	Natural gas, iron ore, natural gas liquids, clays, stone, petroleum.
Navarro	7,177,161	7,491,036	Petroleum, natural gas, clays, sand and gravel, stone.
Newton	6,024,920	6,230,228	Petroleum, natural gas, natural gas liquids.
Nolan	28,739,439	30,317,103	Petroleum, cement, natural gas, natural gas liquids, gypsum, stone, sand and gravel.
Nueces	83,766,941	87,521,089	Natural gas, petroleum, natural gas liquids, cement, lime, shell, sand and gravel.
Ochiltree	23,833,450	25,434,964	Petroleum, natural gas, natural gas liquids.
Oldham	W	W	Sand and gravel, clays.
Orange	12,303,305	11,840,466	Petroleum, natural gas, cement, natural gas liquids, clays, sand and gravel.
Palo Pinto	3,324,903	4,086,576	Natural gas, natural gas liquids, petroleum, stone, clays, sand and gravel.
Panola	44,768,550	46,556,305	Natural gas, natural gas liquids, petroleum.
Parker	2,755,793	3,125,250	Natural gas liquids, natural gas, stone, clays, petroleum, sand and gravel.

See footnotes at end of table.

Table 22.—Value of mineral production in Texas, by counties [1]—Continued

County	1965 [r]	1966	Minerals produced in 1966 in order of value
Pecos	$68,169,601	$72,704,293	Petroleum, natural gas, natural gas liquids, sand and gravel.
Polk	5,283,362	5,435,100	Petroleum, natural gas.
Potter	50,395,112	52,146,824	Natural gas, natural gas liquids, cement, helium, sand and gravel, stone, petroleum.
Presidio	8,250	W	Mercury, perlite.
Rains	664,400	703,100	Natural gas.
Reagan	18,891,490	21,496,082	Petroleum, natural gas liquids, natural gas.
Red River	65,900	69,900	Petroleum.
Reeves	11,137,180	11,892,539	Petroleum, natural gas, natural gas liquids, sand and gravel.
Refugio	76,189,500	80,848,136	Petroleum, natural gas, natural gas liquids.
Roberts	5,834,500	6,181,200	Natural gas, petroleum.
Robertson	147,300	38,300	Petroleum, sand and gravel.
Runnels	12,167,040	12,738,476	Petroleum, natural gas liquids, natural gas, stone.
Rusk	60,754,010	64,592,284	Petroleum, natural gas liquids, natural gas, clays.
Sabine	7,000	----	
San Augustine	600	1,600	Sand and gravel, petroleum.
San Jacinto	1,868,300	2,124,200	Petroleum, natural gas, sand and gravel.
San Patricio	44,280,910	47,636,822	Petroleum, natural gas, natural gas liquids, stone, sand and gravel, clays.
San Saba	103,790	----	
Schleicher	12,020,310	13,288,497	Petroleum, natural gas, natural gas liquids.
Scurry	99,851,160	106,738,100	Petroleum, natural gas liquids, natural gas, stone, sand and gravel, clays.
Shackelford	9,871,480	10,466,727	Petroleum, natural gas, natural gas liquids.
Shelby	818,600	866,400	Natural gas, petroleum.
Sherman	18,745,700	19,837,500	Do.
Smith	9,149,600	9,869,145	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Somervell	W	W	Sand and gravel.
Starr	28,099,789	30,077,470	Petroleum, natural gas, natural gas liquids, pumicite, clays.
Stephens	8,933,410	10,004,605	Petroleum, natural gas, natural gas liquids, stone.
Sterling	5,776,500	6,126,000	Petroleum, natural gas.
Stonewall	19,960,360	21,000,769	Petroleum, natural gas liquids, natural gas.
Sutton	1,180,400	1,249,200	Natural gas, petroleum.
Tarrant	7,678,060	7,189,650	Cement, sand and gravel, stone, sodium sulfate.
Taylor	18,160,887	19,358,498	Petroleum, natural gas liquids, natural gas, stone, sand and gravel, clays.
Terrell	6,916,816	7,734,114	Natural gas, natural gas liquids, sand and gravel.
Terry	18,829,868	18,910,839	Petroleum, sodium sulfate, natural gas.
Throckmorton	7,838,600	8,301,200	Petroleum, natural gas.
Titus	11,951,800	12,675,100	Do.
Tom Green	6,930,110	7,400,590	Petroleum, natural gas, natural gas liquids, sand and gravel.
Travis	3,648,286	3,956,395	Lime, stone, sand and gravel, petroleum.
Trinity	71,193	12,400	Natural gas, clays.
Tyler	2,582,900	2,740,000	Petroleum, natural gas, sand and gravel.
Upshur	9,208,600	9,774,600	Petroleum, sand and gravel.
Upton	66,140,060	71,557,339	Petroleum, natural gas liquids, natural gas.
Uvalde	W	3,578,338	Asphalt, stone, sand and gravel, basalt.
Val Verde	411,200	439,200	Natural gas, petroleum, sand and gravel.
Van Zandt	28,450,522	30,553,017	Petroleum, natural gas liquids, salt, natural gas.
Victoria	24,785,330	27,045,923	Petroleum, natural gas, natural gas liquids, sand and gravel.
Walker	125,032	126,560	Natural gas, petroleum, clays.
Waller	26,577,750	28,826,144	Natural gas liquids, natural gas, petroleum, sand and gravel.
Ward	91,183,678	97,578,256	Petroleum, natural gas, natural gas liquids, sodium sulfate, stone, salt, gypsum, sand and gravel.
Washington	653,000	923,102	Petroleum, stone, natural gas.
Webb	11,461,576	11,613,096	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Wharton	79,844,134	83,255,368	Sulfur, petroleum, natural gas, natural gas liquids, sand and gravel, clays.
Wheeler	9,520,220	10,099,214	Petroleum, natural gas liquids, natural gas.
Wichita	35,595,420	37,653,151	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Wilbarger	18,136,710	19,239,161	Do.
Willacy	10,214,150	10,885,410	Petroleum, natural gas, natural gas liquids.
Williamson	5,253,567	8,221,523	Stone, lime, sand and gravel, petroleum.
Wilson	2,048,814	2,149,258	Petroleum, clays, natural gas.

See footnotes at end of table.

Table 22.—Value of mineral production in Texas, by counties [1]—Continued

County	1965 [r]	1966	Minerals produced in 1966 in order of value
Winkler	$88,584,710	$94,040,651	Petroleum, natural gas, natural gas liquids.
Wise	34,528,432	38,214,209	Natural gas, petroleum, natural gas liquids, stone, clays.
Wood	55,069,915	58,184,517	Petroleum, natural gas liquids, natural gas, clays, sand and gravel.
Yoakum	62,016,894	66,323,979	Petroleum, natural gas liquids, natural gas, salt.
Young	14,016,670	14,861,049	Petroleum, natural gas, natural gas liquids, stone, sand and gravel.
Zapata	5,024,800	5,323,500	Petroleum, natural gas.
Zavala	1,286,000	1,362,300	Natural gas, petroleum.
Undistributed	20,772,217	17,320,255	
Total	4,718,128,000	5,019,750,000	

[r] Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] The following counties were not listed because no production was reported in 1965 or 1966: Armstrong, Bailey, Bandera, Castro, Deaf Smith, Delta, Fannin, Hall, Jeff Davis, Kinney, Lamar, Parmer, Randall, Real, Rockwall, and Swisher.

for the Texas Highway Department. United Carbon Co. recovered carbon black from liquid hydrocarbons at its Aransas Pass furnace plant. Six oil wells and 13 gas wells were completed; three oil and five gas wells proved to be discovery wells.

Bastrop.—The county ranked second in value of clay produced in 1966. Elgin-Standard Brick Manufacturing Co. mined clay from open pits for manufacture of fire brick, building brick, and mortar. Elgin Butler Brick Co. mined clay from open pits to produce both building and fire brick, and Payne Brick Co. mined clay from open pits for building brick manufacture. Contractors quarried and crushed limestone for riprap and sand and gravel for paving purposes for the Texas Highway Department.

Bee.—The oil and gas industry drilled 48 wells that resulted in 15 oil wells and six gas wells. One oil and two gas wells were recorded as discoveries. Natural gas liquids were recovered at the gasoline plant of Tidewater Oil Co. and at the cycle plants of Pan American Petroleum Corp. and the Houston Natural Gas Production Co. Limestone was produced for concrete aggregate by Heldenfels Bros.

Bexar.—The county ranked first in value in clay and stone and second in cement in 1966. Of 27 wells drilled, 13 were completed as oil wells and one as a gas well. Lavaca Gathering Co. recovered natural gas liquids at its Junction gasoline plant. Refineries of Flint Chemical Co., Howell Refining Co., and Monarch Refining Co., with a combined capacity of nearly 16,000 barrels of crude per day, processed crude oil. Portland cement was produced at the San Antonio plants of Capitol Aggregates, Inc., Kaiser Cement and Gypsum Corp., and San Antonio Portland Cement Co. The latter two companies also produced masonry cement. Miscellaneous clay was mined from open pits for cement manufacture by San Antonio Portland Cement Co., and for light-weight aggregate by Barlite Inc.-Barrett Industries and Featherlite Co. of San Antonio. The three San Antonio-based producers quarried limestone for cement manufacture. McDonough Bros., Inc., quarried limestone near Beckman for riprap, concrete aggregate, railroad ballast, and alkali manufacture. Limestone for concrete aggregate was sold to the Texas Highway Department by Barrett Industries and Olmos Rock Products Corp.

Brazoria.—The county was the State's leading producer of natural gas, lime, and salt, ranked third in total mineral value and fourth in natural gas liquids in 1966. The oil and gas industry drilled 76 wells completing 15 as oil wells and six as gas wells. Natural gas liquids were recovered at four gasoline plants having a combined daily capacity of over 600 million cubic feet. Phillips Petroleum Co. processed crude oil at its 95,000-barrel-per-day Sweeny refinery. A subsidiary, Phillips Chemical Co., operated a petrochemical plant adjacent to the refinery. The Dow Chemical Co. produced lime from shell and recovered salt from a salt dome. Magnesia from sea water was used in production of magnesium compounds and

magnesium chloride. Ethyl-Dow Chemical Co. recovered bromine from sea water to produce ethylene dibromide. Periclase (refractory magnesia) was prepared from magnesia slurry furnished by The Dow Chemical Co. at the Freeport plant of E. J. Lavino & Co.

Phillips Petroleum Co. and Houston Natural Gas Production Co. were building a million-cubic-foot-per-day processing plant to produce 22,000 gallons per day of ethane, propane, butane, and other liquids. Shell Oil Co. built a 189-million-cubic-foot-per-day refrigerated absorption plant in the Block 288 field to recover 100,800 gallons of ethane per day, 55,400 gallons of propane per day, and 80,200 gallons of other liquids per day. Dow-Badische Co. expanded acrylate monomer capacity from 20 to 40 million pounds per year at its Freeport plant. Acrylate monomer is used in making plastics and is an intermediate in production of drugs, cosmetics, dyes, and insecticides. Monsanto Co. was building a 75-million-pound-per-year phthalic anhydride unit and added a 140-million-pound-per-year acrylonitrile unit to increase total plant capacity to 410 million-pounds-per-year at its Chocolate Bayou complex. Phelan Sulphur Co. was building a 150,000 long ton per year Frasch sulfur plant on Damon Dome. Nalco Chemical Co. expanded facilities to produce 65 million tons of tetraethyl and tetramethyl lead. A. P. Green Refractory Co. was building a periclase plant near Freeport to utilize magnesium hydroxide slurry from Dow Chemical Freeport plant. Dow Chemical increased ammonia capacity from 300 to 600-tons-per-day and was adding magnesium metal capacity by modernizing its line of electrolytic cells and activating idle capacity. Tuloma Gas Producing Co. expanded its Texas City ammonia capacity.

Brewster.—A limited quantity of mercury was produced from five mercury prospects. Carbonaceous shale for soil conditioner and agricultural mineral supplement was produced by Manning Minerals Corp. Fluorspar imported from Mexico was treated at the flotation mill of Framspar, Inc., at Alpine. Mexican fluorspar which was processed at the Boquillas mill in Boquillas, Mexico, was trucked to storage silos of Dow Chemical at Marathon.

Burnet. — High-purity limestone was shipped to the glass and chemical industries by Pure Stone Co. Texas Construction Co. quarried and prepared limestone for riprap, metallurgical flux, concrete aggregate, filtering, and aglime. Graphite ore was mined from open pits and concentrated at a mill of Southwestern Graphite Co. Granite was quarried, crushed, and sized for construction uses by Texas Construction Materials Co. and Texas Crushed Stone Co. Texas Granite Corp. quarried and processed granite for architectural and monument use; screenings from the operation were used for paving.

Calhoun.—Six oil wells and 12 gas wells were completed in drilling a total of 49 wells. Shell was dredged by Bauer Dredging Co. for concrete aggregate and quicklime. Alcoa used the lime in making alumina. Aluminum metal was prepared from Surinam and Dominican Republic bauxite ores at the electrolytic reduction works of Alcoa. Natural gas liquids were recovered at five gasoline plants and one cycle plant with a combined capacity of over 220 million cubic feet. Cities Service Oil Co. expanded its San Antonio Bay gasoline plant by 12.4 million cubic feet per day to recover 12,300 gallons of ethane per day, 11,700 gallons of propane per day, and 13,900 gallons of mixed butane and gasoline liquids per day. Vinyl acetate monomer was manufactured at the Long Mott plant of National Starch and Chemical Corp. Union Carbide Corp. produced acetylene, butadiene, ethylene, propylene, and styrene, and numerous intermediate petrochemicals at its Seadrift plant.

Cameron.—Mineral production was limited to petroleum and natural gas. The mills of Magnet Cove Barium Corp. and Victoria Gin Co., Inc. ground barite, clay, talc, fluorspar, and phosphate rock. The barite was imported from Mexico and Ireland. Petrochemical derivatives such as acetic acid, acetic anhydrides, and methyl and ethyl ketones were produced at the Brownsville petrochemical plant of Union Carbide Corp. Agricultural fertilizers, insecticides, and fungicides were prepared at plants of Agricultural Chemicals, Kipfer Chemical Co., Niagara Chemical Division of FMC Corp., and Swift & Co.

Cass.—Brown iron ores were mined for pig iron and steel manufacture by Lone Star Steel Co. and by Mathis & Mathis for use as trace mineral additives. Sulfur was

recovered from sour natural gases of the Queen City field by National Sulphur Co. and from the Bryans Mill field by Shell Oil Co. Of 28 holes drilled 20 were completed as oil wells with five being discovery wells. Breckenridge Gasoline Co. recovered natural gas liquids at its Lodi gasoline plant.

Chambers.—The county was the State's third largest producer of salt in 1966; other minerals produced included petroleum, natural gas, shell, and natural gas liquids. Shell was recovered from shallow bays by W. D. Haden Co. and Parker Bros. & Co., Inc., for use as concrete aggregate, poultry grit, in production of magnesium metal and portland cement, and as a filler in paper and paint. Diamond Alkali Co. recovered brine from the Barbers Hill Salt Dome for making chlorine and sodium compounds. There were 68 wells drilled resulting in 22 oil and eight gas completions. Natural gas liquids were recovered at gasoline plants of Humble Oil & Refining Co., United Gas Pipeline Co., and Warren Petroleum Corp. Crude oil was refined at the 8,500-barrel-per-day refinery of Union Texas Petroleum Division of Allied Chemical Corp.

Cherokee.—Brown iron ores were mined by L. B. Haberle Mining Corp. and Jennings & Halbert for use in cement manufacture. Clay for fire brick was mined from open pits by General Refractories Co. Major Brick Co. mined and processed clay for building brick. Ball clay, used in floor and wall tile, was mined from open pits by Southern Clay Products, Inc. Natural gas liquids were extracted at the Neches gasoline plant of Humble Oil & Refining Co.

Colorado.—The county ranked first in sand and gravel production. Building and paving sand and gravel were produced by Horton & Horton, Texas Construction Materials Co., Thorstenberg Materials Co., and at a new operation of Parker Bros. & Co., Inc. Superior Sand & Gravel Co. was building a new washing plant near Eagle Lake. Natural gas liquids were recovered at the Tenneco Oil Co. gasoline plant and at the Shell Oil Co. cycling plant. The latter company completed a 285-million-cubic-foot-per-day refrigerated absorption plant to replace its Sheridan and Provident City plants. Daily recovery at the new plant would be 55,000 gallons of ethane, 195,000 gallons of propane, and 416,200 gallons of other liquids. The oil and gas industry drilled 20 wells; one oil and 10 gas wells were completed.

Comal.—The county ranked fifth in value of stone and lime produced in 1966. Limestone was quarried and prepared for riprap, metallurgical flux, mineral food, asphalt filler, and concrete aggregate by Servtex Materials Co. and U.S. Gypsum Co. The latter company converted large quantities of crushed limestone to quicklime and installed a highly automated lime kiln at its New Braunfels plant to increase production about 50 percent.

Crane.—The county ranked fourth in total mineral value and third in production of oil in 1966. The oil and gas industry drilled 179 wells and completed 117 as oil and 10 as gas producers. Six gasoline plants with installed capacity of over 450 million cubic feet per day recovered natural gas liquids from a number of county gasfields. Sulfur was recovered at the Sand Hills plant of National Sulphur Co. and Warren Petroleum Corp., from Crane plant of Phillips Petroleum Co., and the Waddell plant of Warren Petroleum Corp.

Duval.—The Chemical Division of Pittsburgh Plate Glass Co. produced brine from wells near Benavides. The county was the State's second largest producer of salt. Natural gas liquids were recovered at the gasoline plants of Mobil Oil Co. and Humble Oil & Refining Co. and at the cycle plant of Trinity Gas Corp.

Eastland.—The county ranked fourth in value of clay produced. Miscellaneous clay was mined from open pits by Texas Lightweight Aggregate Co. and Featherlite Corp. for lightweight aggregate and by Texeramics Inc. for floor and wall tile. Cisco Pottery acquired Cisco Flowerpot plant of N. D. Gallagher during the year. Natural gas liquids were recovered at three gasoline plants having a combined daily capacity of 20 million cubic feet.

Ector.—The county ranked first in natural gas liquids and second in oil production and total mineral value. The oil and gas industry drilled 179 wells, completing 143 as oil wells and 20 as gas wells. Shell Oil Co. refined crude oil at its 24,500-barrel-per-day refinery located at Odessa. El Paso Natural Gas Co. and Rexall Drug & Chemical Co. operated a petrochemical

plant producing ethylene, propylene, polyethylene, and other chemical derivatives. Carbon black was recovered from natural gas at the Odessa channel plant of Sid W. Richardson Carbon & Gasoline Co. Natural gas liquids were recovered at six gasoline plants and one cycle plant having a combined daily capacity of nearly 650 million cubic feet. Sulfur was recovered at five gasoline plants. Rexall Chemical Co. expanded polyethylene capacity of its Odessa plant from 190 to 300 million pounds per year and polypropylene capacity by 10 million pounds per year. General Tire & Rubber Co. Chemical Plastics Division expanded polymerization, monomer recovery, and coagulation capacities at its Odessa Synthetic Rubber & Latex plant. El Paso Products Co. was building a 180-ton-per-day nitric acid plant at Odessa. Limestone was quarried and prepared for concrete aggregate by Permian Sand & Gravel Co., Inc. Southwestern Portland Cement Co. quarried and processed limestone for portland and masonry cement.

Ellis.—The county ranked third in cement output. Portland and masonry cements were produced at the Midlothian plants of Texas Industries Inc. and the new 1.4-million-barrel-per-year plant of Gifford Hill Portland Cement Co. Both cement companies mined clay and quarried limestone for use in cement. Texas Industries Inc. expanded its Midlothian cement plant from 3 to nearly 5 million barrels per year. Limestone was quarried and crushed for concrete aggregate by four contractors for the Texas Highway Department. Miscellaneous clays were mined from open pits for building brick by Ferris Brick Co. and Acme Brick Co. and for building brick and floor and wall tile by Barron Brick Co. Armstrong Cork Co. built a new glass plant to manufacture beverage bottles at Waxahachie.

El Paso.—Portland and masonry cements were produced by Southwestern Portland Cement Co. Limestone, used for concrete aggregate, was quarried and prepared by Vowell Material Co. and by contractors for Texas Highway Department. McMillan Quarry Inc. quarried and prepared limestone for concrete aggregate and for riprap. Quartzite was quarried and processed for concrete aggregate by H & H Materials, Inc. Building and paving sand and gravel and fill sand were mined from open pits by El Paso Sand Products, Inc., H & H Materials, Inc., and by contractors for Texas Highway Department. Crude oil was refined at the 65,000-barrel-per-day El Paso refinery of Standard Oil Co. of Texas and at the 16,000-barrel-per-day refinery of Texaco Inc. Copper and lead ores and concentrates were smelted at the El Paso Smleter of Asarco. Zinc oxide was recovered from slags at the company's zinc fuming plant. Electrolytic and fire refined copper was produced at the Nichols refinery of Phelps Dodge Refining Co. Asarco built an 850-foot waste exhaust stack at a cost of $1.5 million at its El Paso smelter. Reinforcing rod and structural steel shapes were produced at the Vinton steel mill of Border Steel Mills, Inc.

Fort Bend.—The county ranked third in sulfur output. Frasch sulfur was produced from Orchard Dome by Duval Corp. Jefferson Lake Sulphur Co. marketed sulfur from stocks. Natural gas liquids were recovered at one gasoline plant. Brine was pumped from wells near Missouri City by United Salt Corp. Texas Lightweight Aggregate Co. mined shale by open pit methods near Missouri City for making lightweight aggregate. Contractors quarried and prepared limestone for concrete aggregate and produced unwashed sand and gravel for paving purposes for Texas Highway Department.

Gaines.—The county was the fourth largest oil producer and was sixth in total mineral value in 1966. The oil and gas industry completed 62 oil wells and six gas wells out of 93 wells drilled. Natural gas liquids were recovered at the Seminole gasoline plant of Phillips Petroleum Co. and the West Seminole gasoline plant of Cities Service Oil Co. Columbian Carbon Co. recovered sulfur from sour natural gas and produced carbon black from natural gas. Natural salines were recovered from Cedar Lake brines at the Seagraves plant of Ozark-Mahoning Co. Limestone was quarried and processed for concrete aggregate by Pioneer Pavers, Inc.

Galveston.—The oil and gas industry drilled 39 wells, completing 21 oil wells and three gas wells. Natural gas liquids were recovered at the Alta Loma gas processing plant of Margaret Hunt Trust Estate. Three oilfields, Gillock-South, High

Island, and Hull, produced more than 1 million barrels of crude oil each in 1966. Crude oil was processed at the 172,000-barrel-per-day refinery of American Oil Co., and 43,000-barrel-per-day refinery of Marathon Oil Co., and the 40,000-barrel-per-day refinery of Texas City Refinery, Inc. Pan American Petroleum Corp. was building a 30-million-cubic-foot-per-day refrigerated absorption plant to recover 16,700 gallons of ethane-propane mix per day and 35,300 gallons of butane and other liquids per day. United Gas Pipe Line Co. was building a 40-million-cubic-foot-per-day refrigeration-carbon expander plant near Galveston Bay to yield 33,000 gallons of gasoline and LP gas daily. Clay was recovered from open pits by Ideal Cement Co. and Gulf Coast Portland Cement Co. for use in portland and masonry cements. Shell was dredged from adjoining shallow bays by Horton & Horton for concrete aggregate, poultry grit, and cement.

Texas City Refining Co. was building a new propane-propylene splitter at its Texas City refinery to produce 100 million-pounds-per-year of 92 percent propylene. Marathon Oil Co. was building two new process units to double the propane-propylene capacity and to add cumene capacity. Complex tin ores from Bolivia were processed at the Texas City smelter of Wah Chang Corp. Other smelter products included tungsten, titanium, tantalum, and other rare metals.

Gregg.—Natural gas liquids were recovered at four gasoline plants. Crude oil was processed at the 500-barrel refinery of Dallawax Co., the 500-barrel plant of Tetrolite Corp., and the 5,500-barrel refinery of Premier Oil refining Co. Texas Eastman Co., Division of Eastman Kodak Co., increased polyethylene capacity to 250-million-pounds-per-year and polypropylene capacity to 90-million-pounds-per-year. Watex Chemical Co. planned a 5,000-to 7,000-barrel-per-day waste crude oil process plant near Longview. Kilgore Ceramics Corp. expanded vitrious china and plumbing fixture facilities at its Kilgore plant.

Harris.—Harris County was the nucleus of the largest industrial complex in Texas and the southwest because of an abundance of essential natural resources, excellent harbor facilities, and adequate truck, rail, and water transportation systems that included the Houston ship channel and the intercoastal waterway. The industrial complex included major resource-oriented industries such as petroleum refining, industrial and organic chemicals, steel, cement, sulfur, and salt. Crude oil, natural gas, natural gas liquids, clay, lime, sand and gravel, and salt, were produced in the county; sulfur was recovered, imported gypsum was calcined, and barite was ground for oil well drilling mud.

The county led in cement output and ranked fifth in total mineral value and fourth in salt production. Six refineries—Crown Central Petroleum Corp., Humble Oil & Refining Co., Shell Oil Co., Signal Oil & Gas Co., Sinclair Refining Co., and Texas Asphalt and Refining Co.—with a combined daily capacity of 700,000 barrels, processed both domestic and foreign crude oils. Natural gas liquids were recovered at five gasoline plants with a combined capacity of 280 million-cubic-feet-per-day and two cycling plants with combined capacity of 90 million-cubic-feet-per-day recovered natural gas liquids. Carbon black was recovered from hydrocarbon liquids at the Eldon furnace plant of J. M. Huber Corp. The oil and gas industry drilled 61 wells and completed 25 oil and 11 gas wells.

Portland and masonry cements were produced at the Houston plants of Ideal Cement Co., Lone Star Cement Corp., Trinity Portland Cement Division of General Portland Cement Co., and Gulf Coast Portland Cement Co. Major markets were in the Houston metropolitan area, east Texas, and the central gulf coast. Raw materials were primarily from local sources. J. M. Cordell & Sons, Inc., Houston Brick & Tile Co., Acme Brick Co., Andy Cordell Brick Co., and Aztec Brick Co. mined clay from open pits for building brick. Lime was manufactured from shell by Champion Papers, Inc., Armco Steel Corp., and U.S. Gypsum Co. Building and paving sand and gravel were produced by Albers Bank Sand Co., Horton & Horton, and Parker Brothers & Co., Inc. Various producers furnished pit run sand and gravel for highway maintenance. Slag from the Sheffield blast furnaces was crushed and prepared for road material by Houston Slag Material Co. Salt was mined by underground methods from a salt dome near Hockley by United Salt Corp. and was recovered as

brine from wells by Texas Brine Corp. Shell Chemical Co., Signal Oil & Gas Co., Sinclair Refining Co., and Stauffer Chemical Co. recovered sulfur from refinery offgases. Most of the sulfur was used in sulfuric acid for the gulf coast oil refining, petrochemical, and steel producing and fabricating industries. Crude perlite from other States was expanded by Perlite of Houston, Inc., and Filter-Media Inc. The expanded material was used as insulation, building plaster, concrete aggregate, and as a filter aid. Crude vermiculite from Montana and Africa was expanded for concrete aggregate and building plaster by Vermiculite Products, Inc.

Armco Steel Corp. operated its Houston steel mill, using iron ore pellets and foreign ores for blast furnace feed. The Milwhite Co., Inc., and Baroid Division of National Lead Co. ground barite, fluorspar, talc, bentonite, and celestite.

Henderson.—Henderson County ranked third in value of clay production. Harbison-Walker Refractories Co. mined clay for manufacture of fire brick, refractory shapes and mortar. Texas Clay Products, Inc., Acme Brick Co., and Athens Brick Co., Inc., processed fire clay for building brick. Athens Tile & Pottery Co. mined miscellaneous clay for art pottery. Crude oil was refined at the 500-barrel-per-day Trinidad refinery of Ida Gasoline Co. Natural gas liquids were recovered at three gasoline plants. The oil and gas industry completed 14 gas wells and one oil discovery well from 23 wells drilled.

Building and paving sand and gravel were produced from two pits by Southwest Construction Materials Co.

Hidalgo.—Mineral production included petroleum, natural gas, natural gas liquids, clay, sand and gravel, and limestone. Eight oil wells and 32 gas wells were completed out of 63 wells drilled by the oil and gas industry. Crude oil was refined at the La-Blanca refinery of Permian Corp. and at the McAllen refinery of Rado Refining Co. Natural gas liquids were recovered at gasoline plants of Coastal States Gas Producing Co., Shell Oil Co., Sinclair Oil & Gas Co., Tenneco Oil Co., and Anchor Gasoline Corp. Limestone was quarried and crushed for concrete aggregate by Heldenfels Bros. Building and paving sand and gravel were mined and processed from open pits by The Fordyce Co. Miscellaneous clay was used to manufacture building brick by Valley Brick & Tile Co. Valley Chemical Corp. was building a 150-ton-per-day ammonia unit and a 350-ton-per-day fertilizer mixer near Mission.

Howard.—The oil and gas industry completed 89 oil wells out of 103 wells drilled. Carbon black was recovered from hydrocarbon liquids at the Dixon furnace plant of Cabot Carbon Co. and the Odessa furnace plant of Sid Richardson Carbon & Gasoline Co. Crude oil was processed at the Big Spring refinery of Cosden Oil & Chemical Co. The company expanded daily capacity of benzene by 2,000 barrels and cyclohexane capacity by 530 barrels. Natural gas liquids were recovered from the East Vealmoor gasfield by Reef Corp. R. E. James Gravel Co., Inc., and others processed building and paving sand and gravel. Contractors quarried and prepared limestone for concrete aggregate for the Texas Highway Department.

Hudspeth.—Mineral production was limited to gypsum, talc, and rhyolite in 1966. The county was the leading talc producer with six companies reporting production—Lone Star Talc Corp., Pioneer Talc Co., United Sierra Division of Cyprus Mines Corp., Southern Clay Products, United Dallas Ceramics, and West Tex Talc Co. Much of the crude talc was ground at a mill located at Allamoore for ceramic material, rubber and roofing compounds. Gypsum, used as a retaredr in cement, was mined from an open pit near Allamoore by Southwestern Portland Cement Co. Gifford-Hill, Inc., quarried and crushed rhyolite for riprap and roofing granules.

Hutchinson.—The oil and gas industry completed 20 oil wells and 10 gas wells of 35 wells drilled. Carbon black was recovered at the furnace plant of Phillips Petroleum Co. and at the furnace channel plant of J. M. Huber Corp., both located near Borger. Natural gas liquids were recovered at eight gasoline plants. Crude oil was processed and refined at the 85,000-barrel-per-day Borger refinery of Phillips Petroleum Co. The company recovered brine from salt beds located in the area. Phillips Petroleum Co. was building a multimillion-pound-per-year tetramethylene sulfone unit at its Borger chemical complex. Buta-

diene, butylene, and propylene were produced at Phillips Chemical Co.'s butadiene plant and synthetic rubber was produced at the company's Plains copolymer plant.

Jefferson.—Of 55 wells drilled, 15 were completed as oil wells and 10 as gas wells. The county had the largest concentration of crude oil refining capacity and was the second largest Frasch sulfur producer in the Nation. Sulfur was recovered by the Frasch process from Fannett Dome and Spindletop Dome by Texas Gulf Sulphur Co. Refinery off-gases were processed for sulfur recovery at the Atreco plant of Atlantic Refining Co., the Port Arthur plant of Gulf Oil Corp., and the Beaumont plant of Olin Mathieson Chemical Corp. San Jacinto Gas Processing Corp. and Union Texas Petroleum Co. extracted natural gas liquids. Texas Brine Corp. recovered brine from a salt dome for chlorine and sodium chemicals. Beaumont Brick Co., Inc., mined clays for building brick. Materials, Inc., was building a 200,000-ton-per-year burned clay aggregate plant at Beaumont for production of road base material.

Mobil Chemical Co. was building a 75-million-pound-per-year terephthalic acid unit at Beaumont and planned a second unit of the same size for 1967 installation. Mobil Oil Co. was modernizing and expanding its Beaumont refinery to include a 120,000-barrel-per-day atmospheric and vacuum crude distillation unit and a 1-million-pound-per-year steam-generation powerplant. Goodrich Gulf Chemical Co. expanded plant capacity of polybutadiene at Port Neches to 60,000-tons-per-year. Goodyear Tire & Rubber Co. expanded polyisoprene capacity to 45,000 long tons per year and increased finishing facilities at its Beaumont plant. Celanese Chemical Co. expanded methylethyl ketone capacity to 40-million-pounds-per-year. Gulf Oil Corp. increased alkalinazation capacity of its Port Arthur refinery by 12,000 barrels-per-day. Sinclair-Koppers Co. increased polyethylene capacity to 200-million-pounds-per-year and polystyrene capacity to 300-million-pounds-per-year at Port Arthur. E. I. du Pont de Nemours & Co., Inc., increased ammonia capacity of its Baumont plant by 1,000-tons-per-day.

Karnes.—Three oil wells and 13 gas wells were completed of 35 wells drilled. Gasoline plants of Warren Petroleum Corp., Shell Oil Co., and United Gas Pipe Line Co. recovered natural gas liquids. Sulfur was recovered from processed gas by Shell Oil Co. and Warren Petroleum Corp. Susquehanna-Western, Inc. mined uranium ore from several open pits for processing at its Falls City mill.

Kleberg.—Mineral fuels dominated the county's mineral industry. The county ranked second in natural gas liquids output and third in natural gas. Natural gas liquids were recovered at the gasoline and cycle plant of Humble Oil & Refining Co. and at the May gasoline plant of Cities Service Oil Co. Humble Oil & Refining Co. expanded its King Ranch gasoline plant to 1.7 billion-cubic-feet-per-day and its liquid recovery to 75,700 barrels-per-day. The oil and gas industry drilled 102 wells and completed 74 oil wells and seven gas wells. Limestone was quarried and crushed for concrete aggregate by Heldenfels Bros.

Llano.—Premier Granite Quarries quarried and processed monumental and architectural granite. Texas Crushed Stone Co. crushed granite for use as riprap, roadstone, and concrete aggregate. Marble and other igneous rocks were processed for roofing granules by Marble Products Co. of Georgia. Graphilter Corp. prepared graphite schist for filter media.

McLennan.—Nonmetallic mining dominated the county's mineral industry with petroleum contributing to a lesser degree. Portland and masonry cements were produced at the Waco plant of Universal Atlas Division of U.S. Steel from limestone and clays mined from open pits. Waco Aggregate Co. mined clay for building brick and lightweight aggregate. Limestone was quarried and prepared as concrete aggregate by various contractors for Texas Highway Department and the U.S. Army Corps of Engineers. Building and paving sand and gravel was mined from numberous pits in and around Waco by Southwest Construction Materials Co., Kleberg Sand & Gravel Co., C. F. Binner & Son, and Neeley Sand & Gravel, Inc. Cities Service Oil Co. was building an 82-million-cubic-foot-per-day gasoline plant at Waco to produce 22,000 gallons of propane per day, 18,000 gallons of butane per day, and 7,600 gallons of gasoline per day.

Matagorda.—The county's mineral industry consisted of mineral fuels and

nonmetallic mineral production. Of 48 wells drilled by the oil and gas industry, nine were completed as oil wells and 12 as gas wells. Natural gas liquids were recovered at two gasoline and one cycle plant. Coastal States Gas Producing Co. and Brazos Oil & Gas Co. completed a 500-million-cubic-foot-per-day refrigerated absorption plant near Bay City. Pan American Petroleum Corp. transferred a 110-million-cubic-foot unit from its No. 1 East Bay City field to Willacy County. Miscellaneous clay for building brick was mined from open pits by Sunset Brick & Tile Inc. Matagorda Shell Co., Inc. recovered shell from shallow bays for use as concrete aggregate and in making alkali, magnesium metal, and lime.

Midland.—Mineral fuels dominated mineral activity in the county. The Sprayberry Trend Area oilfield was responsible for nearly 40 percent of the county's total oil production. The industry drilled 56 wells, completing 39 as oil wells and 15 as gas wells. Five gasoline plants, with a combined total capacity of nearly 100-million-cubic-feet-per-day, and one cycle plant of 50-million-cubic-feet-per-day capacity recovered natural gas liquids from the Dora Roberts, Virey, War-San, Pegasus, Azalea, Tex-Harvey, and various other county gasfields. Operators were Cities Service Oil Co., Mobil Oil Co., Sinclair Oil & Gas Co., Phillips Petroleum Co., and Warren Petroleum Corp. Mobil Oil Co. expanded its Pegasus gasoline plant by 70-million-cubic-feet to produce 168,000 gallons of liquids per day. Crude perlite from adjoining States was expanded and processed by Perlite Industries, Inc., for use as building plaster, insulation, soil conditioner, and lightweight concrete aggregate.

Milam.—Industrial Generating Co. mined and processed lignite from open pits for use as fuel in its steam-electric plant supplying power for the Rockdale Aluminum Reduction works of Aluminum Company of America. Alcoa produced aluminum ingots and alloys from alumina shipped from the company's Point Comfort refinery. The company completed an aluminum powder plant and was building a high-speed continuous-casting unit adjacent to its Rockdale reduction works. The oil and gas industry drilled 36 wells and completed 32 as oil wells.

Montgomery.—Carbon black was recovered from petroleum distillates at the Conroe No. 63 furnace plant of Columbian Carbon Co. Natural gas liquids were recovered from the Conroe gasfield at gasoline plants of Humble Oil & Refining Co. and Midland Gasoline Corp., from the Bender gasfield by Sinclair Oil & Gas Co., from the Lake Creek gasfield by Superior Oil Co., and from various county gasfields by Warren Petroleum Corp. Jefferson Chemical Co., jointly owned by Texaco Inc. and American Cyanamid Co. was expanding morpholene facilities at its Conroe chemical plant. The material is used as a corrosion inhibitor, an emulsifier for cosmetics and waxes, and as an intermediate in synthetic rubber and lubricants.

Moore.—Mineral activity included production of mineral fuels and helium. The county ranked third in production of natural gas liquids in 1966. Continental Carbon Co. recovered carbon black from liquid hydrocarbon at its Sunray furnace plant. Natural gas liquids were recovered from eight gasoline plants located in the west Pan Handle and Texas-Hougaton gasfields. Shamrock Oil & Gas Corp. processed crude oil at its 29,500-barrel-per-day McKee refinery. The company also recovered sulfur from off-gases and sour natural gas at its McKee refinery. Zinc ores and concentrates from other States and foreign countries were smelted at the Machovec horizontal retort zinc smelter of American Zinc Co. of Illinois. Helium was recovered at the Bureau of Mines Exell plant and at the Dumas plant of Phillips Petroleum Co. The Dumas plant helium production was purchased by the Federal Government and stored in the Cliffside gasfield in Potter County.

Navarro.—Mineral production consisted of mineral fuels, clay, limestone, and sand and gravel. The oil and gas industry drilled 67 wells completing 52 as oil wells. Whiteselle Brick & Lumber Co. mined miscellaneous clay for brick and heavy clay products. Contractors quarried and processed limestone for riprap and concrete aggregate for the U.S. Army Corps of Engineers and processed paving gravel from open pits for Texas Highway Department. Chattanooga Glass Co. was building a $2 million addition to its beverage bottle plant at Corsicanna.

Nolan.—A diversified mineral industry included mineral fuels, cement, stone, gypsum, and sand and gravel production. The county ranked fifth in cement and first in gypsum production. The oil and gas industry completed 18 oil wells out of 31 wells drilled. Crude gypsum was mined from open pits near Sweetwater and processed into wallboard, plaster, and other building products by the Flintkote Co. and U.S. Gypsum Co. Lone Star Cement Corp. quarried limestone from open pits for use in portland and masonry cement at its Mary Neal plant. Hillsdale Gravel Co. mined and processed building and paving sand and gravel from open pits.

Nueces.—The county ranked second in the State in value of lime production and fourth in natural gas. Seven refineries—having a combined daily capacity of nearly 230,000 barrels per day—included Coastal States Petrochemical Co., Hess Oil & Chemical Corp., Howell Refining Co., Pontiac Refining Corp., Southwest Oil & Refining Co., Suntide Refining Co., and Associated Oil & Gas Co. Celanese Chemical Co. operated a plant at Bishop to produce synthetic organic chemicals, acytic acid, acetone, methanol, and numerous other methyl, ethyl, propyl, and butyl derivatives. The oil and gas industry drilled 237 wells, completing 54 oil wells and 92 gas wells. Natural gas liquids were recovered from county gasfields by four cycling plants and seven gasoline plants with a combined daily capacity of nearly 720 million cubic feet.

Celanese Chemical Co. was building a 50-million-pound-per-year addition to its 100-million-pound-per-year formaldehyde plant and a new 50-million-gallon-per-year methanol unit at its Bishop petrochemical complex. At its Corpus Christi refinery, Suntide Refining Co. was building a 10,500-barrel-per-day ultraforming process unit, converting a polymerization unit to produce cumene, and was expanding its paraxylene capacity to 200 million-pounds-per-year. Coastal States Gas Producing Co. was building a 100-million-cubic-foot-per-day processing plant near Corpus Christi. Wayne W. Wilson was building a vinyl plastic plant to coat gravel for decorative purposes. Coastal States Petrochemical Co. was building a 65-million-pound-per-year paraxylene unit at Corpus Christi, and adding an aromatic extraction unit to recover 8 million gallons of benzene per year, 32 million gallons of toluene per year, and 40 million gallons of xylene per year. Pittsburgh Plate Glass Co. prepared quicklime and hydrated lime from shell for soil stabilization, alkali production, and chrome chemical manufacture. Centex Corp. prepared portland and masonry cements from shell. Corpus Christi Shell Co. and General Dredging Corp. dredged shell from shallow bays bordering Nueces County. Building and paving sand and gravel were processed by Heldenfels Bros. and M. P. Wright, Jr. Crude barite from domestic and foreign sources was crushed and ground for use in drilling muds at the Corpus Christi plant of Baroid Division of National Lead Co.

Orange.—Marathon Oil Co. and Union Texas Petroleum Division of Allied Chemical Corp. recovered natural gas liquids from Phoenix Lake and North Port Neches gasfields. Goodrich-Gulf Chemical Inc. was building a plant to produce various synthetic rubbers. Phillips Petroleum Co. expanded the carbon black capacity of its Echo plant. Carbon black was recovered from liquid hydrocarbon at the furnace plant of Phillips Chemical Co. Alpha Portland Cement Co. was building a new 2.4-million-barrel-per-year plant near Orange with completion expected in 1967. Texas Sand Pit marketed paving sand.

Panola.—County mineral production was limited to mineral fuels. The industry drilled 32 wells, completing two as oil wells and 18 as gas wells. Five gasoline plants with a combined daily capacity of nearly 900 million-cubic-feet recovered natural gas liquids from the Carthage gasfield. San Jacinto Gas Processing Corp. completed a 300-million-cubic-foot-per-day refrigerated absorption plant to replace the 450-million-cubic-foot-per-day plant destroyed by fire in 1965.

Pecos.—Mineral fuels production was the principal mineral activity in the county. The Yates oilfield produced in excess of 1 million barrels of crude oil. Natural gas liquids were recovered from treatment of natural county gas at several gasoline plants. Mobil Oil Co. completed a 550-million-cubic-foot-per-day refrigerated absorption plant in the expanding Coyanosa field. Several contractors produced paving sand and gravel for highway construction and maintenance.

Potter.—Helium was recovered from natural gas at the Government-owned and operated Amarillo plant which also refined crude helium produced by both Government-operated and private plants. The county was the State's second largest producer of natural gas. Crude oil was refined at the 19,000-barrel-per-day Amarillo refinery of Texaco Inc. Natural gas liquids were recovered from the West Panhandle gasfield at Fain and Turkey Creek plants of Amarillo Oil Co. Texas Sand & Gravel Co. and Panhandle Gravel West, Inc., furnished building and paving sand and gravel. Limestone was quarried for use in cement by Southwestern Portland Cement Co. Various contractors mined limestone for riprap and for concrete aggregate.

Reagan.—Mineral activity was limited to mineral fuels in 1966. The industry drilled 465 wells, completing 453 as oil wells. Natural gas liquids were recovered from Big Lake gasfield by Dorchester Gas Producing Co., from Sprayberry gasfield by El Paso Natural Gas Co., and from Barnhart gasfield by Northwest Production Corp. The latter company also recovered sulfur from sour gas at its gasoline recovery plant at Barnhart.

San Patricio.—The oil and gas industry drilled 67 wells, completing 11 oil wells and 20 gas wells. Natural gas liquids were recovered from county gasfields at eight gas processing plants having a combined daily capacity of over 300 million cubic feet.

Foreign bauxite ore was converted into alumina at the San Patricio plant of Reynolds Metals Co. The company was expanding the alumina capacity of the operation by installing the largest rotary kiln in the aluminum industry. The alumina was reduced to metal at the company's reduction works adjacent to the alumina plant. Centex Cement Corp. mined clay for use in portland cement. Heldenfels Bros. and Claude Hughes quarried and prepared limestone for concrete aggregate. Building and paving sand and gravel was produced by the Fordyce Co.

Stephens.—The oil and gas industry drilled 59 holes, completing 22 as oil wells and 15 as gas wells. Gasoline plants of Breckenridge Gasoline Co., Lone Star Producing Co., Petroleum Corp. of Texas, Southwestern Gas Products Co., and Warren Petroleum Corp. recovered natural gas liquids from treatment of natural gas. McWood Corp. was building a gas processing plant in the Jill field to recover 5,500 gallons of liquids per day.

Tarrant.—Portland and masonry cements were produced from limestone quarried in the vicinity of the Fort Worth cement plant of Trinity Portland Cement, Division of General Portland Cement Co. Limestone (Austin Chalk) was quarried and prepared as concrete aggregate by several contractors for Texas Highway Department. Building and paving sand and gravel and fill sand were supplied by Bryan-Ferguson Sand & Gravel Co., Harston Gravel Co., Inc., Fort Worth County Engineers, Fort Worth Sand & Gravel Co., and Southwest Construction Material Co. Contractors marketed paving sand and gravel to the Fort Worth City Engineer and the Texas Highway Department. Perlite from other States was expanded and processed as a filler in mortar and masonry cements and as a filter aid by Sil-Flo Corp. Crude mica and scrap mica were ground and prepared for various industrial uses by the Western Mica Corp. Sodium sulfate was recovered as a by-product at the Fort Worth chemical and fertilizer plant of American Cyanamid Co.

Taylor.—Crude oil was refined at the Abilene refinery of Premier Oil & Refining Co. The oil and gas industry drilled 135 wells, completing 73 as oil wells and one as a gas well. Abilene Brick Co. mined miscellaneous clay for use in building brick. Whites Mines, Inc. quarried and crushed limestone for concrete aggregate. Building and paving sand and gravel were prepared from open pits by Atlas Sand & Gravel Co. and Caton Sand & Gravel Co. Natural gas liquids were recovered from the Regular gasfield in Taylor County by Gulf Central Oil & Gas Co. and McWood Corp., and from various county gasfields by Valera Oil Co.

Travis.—The county was the third leading lime producer in 1966. Austin White Lime Co. quarried and calcined high-calcium limestone to lime. Markets included masonry cement, soil stabilization, alumina refining, paper and pulp filler, and water purification. The company also produced raw limestone for metallurgical flux and agricultural lime (aglime). Several contractors quarried limestone for concrete aggregate for Texas Highway Department.

Building and paving sand and gravel and fill sand were prepared by Capitol Aggregates, Inc., and by contractors for the Texas Highway Department.

Upshur.—Big Sandy Sand Co. mined and processed sands for molding, furnace, and other industrial uses. Air Products and Chemical, Inc. was building a 400-ton-per-day oxygen plant to supply oxygen to furnaces of Lone Star Steel Co.

Upton.—The industry drilled 47 wells, completing 38 as oil wells and two as gas wells. The Sprayberry Trend Area oilfield that extends into Reagan County produced over 3 million barrels of crude oil. The Pegasus oilfield, which extends into Midland County, and the McCamby oilfield accounted for an excess of 1 million barrels each. Six gasoline plants with a combined daily capacity of 170 million-cubic-feet recovered natural gas liquids from processing natural gas. Hunt Oil Co. expanded its Wilshire gasoline-processing plant to 30 million-cubic-feet-per-day to produce 35,000 gallons of liquids per day.

Uvalde.—Rock asphalt was quarried and prepared for highway construction and maintenance by Uvalde Rock Asphalt Co. and White's Uvalde Mine. Basalt was quarried and prepared for concrete aggregate and roadstone by Trinity Concrete Products Co. Building and paving sand and gravel was prepared by D & D Gravel Co. and by several contractors for Texas Highway Department. Contractors quarried and prepared limestone as concrete aggregate for Texas Highway Department.

Van Zandt.—The county was the second largest salt producer. Union Oil Co. of California recovered natural gas liquids from the Van gasfield. American Petroleum Corp. recovered natural gas liquids and sulfur from the Edgewood gasfield. Rock salt was mined and prepared for various industrial and home uses by Morton Salt Co.

Victoria.—Natural gas liquids were recovered at gasoline plants of Houston Natural Gas Production Co. and Shell Oil Co. Sunray DX Oil Co. completed a new 40-million-cubic-foot-per-day refrigerated absorption plant to recover 42,000 gallons of liquids per day. E. I. du Pont de Nemours & Co., Inc., operated its Victoria petrochemical plant producing adiponitrile and polyethylene resins. Big Three Industrial Gas & Equipment Co. produced liquefied nitrogen, oxygen, and argon for local industrial gas markets.

Ward.—The oil and gas industry drilled 107 wells, completing 70 as oil wells and five as gas wells. Natural gas liquids were recovered from the North Ward-Estes and other county gasfields by gasoline plants of Cabot Corp., El Paso Natural Gas Co., and Warren Petroleum Corp. Ozark-Mahoning Co. prepared salt cake (natural saline) from brine and dry salt beds at its Monahans plant. Paving gravel was sold to the Texas Highway Department by several commercial producers. Gypsum used as a retarder in cement, was mined from open pits by Permian Sand & Gravel. Montex Chemical Co. recovered salt and brine for use by the oil and gas industry.

Webb.—Natural gas liquids were recovered at the 200-million-cubic-foot-per-day gasoline plant of Phillips Petroleum Co. Laredo Brick & Tile Co. mined and processed clay for building brick. Aldape Sand & Gravel Co. and Solis Sand & Gravel Co. supplied building and paving gravel. Antimony oxide and antimony metal were extracted from foreign ores and secondary materials at the Laredo smelter of Texas Mining & Smelting Division of National Lead Co.

Wharton.—Natural gas liquids were recovered at Wes Bernart gasoline plant of Tidewater Oil Co. The company was the State's principal producer of sulfur. Texas Gulf Sulphur Co. recovered sulfur by the Frasch process at Boling Dome. Calag Co., Inc. mined clay for use in heavy clay products. Contractors mined paving sand and gravel from open pits for the Texas Highway Department and Wharton County Highway Department.

Williamson.—The county was the State's third largest producer of stone and fifth largest of lime. Four companies quarried and processed limestone for architectural and building purposes, and for fill and concrete aggregate. One company sold limestone for whiting and miscellaneous filler uses. Another company mined and processed limestone for aglime and metallurgical purposes. Round Rock Lime Co. and White Stone and Lime Co. quarried and processed limestone to quicklime and hydrated lime.

Wise.—The oil and gas industry drilled 87 wells, completing 41 as oil wells and 24 as gas wells. Natural gas liquids were re-

covered at gas processing plants of Cities Service Oil Co., Upham Oil & Gas Co., and Warren Petroleum Corp. Acme Brick Co. mined clay from open pits for use in building brick. The county was the State's second largest stone producer. Bridgeport Stone Co., Crushers, Inc., Gifford-Hill & Co., Inc., Trinity Concrete Products, and Wescall-Waymix, Inc. quarried and prepared limestone for concrete aggregate, asphalt filler, riprap, and aglime.

Wood.—The oil and gas industry drilled 35 wells, completing 11 oil wells and two gas wells. Natural gas liquids were recovered from Manziel gasfield by ARKLA Chemical Corp., from Quitman gasfield by Caska Corp., and from Hawkins gasfield by Humble Oil & Refining Co. Pan American Petroleum Corp. recovered natural gas liquids and sulfur from sour gas of the West Yantis gasfield. Fire clay, mined from open pits near Winnsboro, was used to produce fire brick by A. P. Green Refractories Co. Big Sandy Sand & Gravel Co. supplied building, paving, molding, and other types of sands.

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 Herman W. Sheffer [1] and William C. Henkes [2]

A new record for mineral production value of $444.3 million was attained in 1966. The increase of $12.7 million over that of 1965 resulted from increases in metal and nonmetal values, $16.7 million and $4.6 million, respectively.

With the metal group continuing to lead Utah mineral economy, copper again was the leading commodity. The value of copper output, $192 million, was second only to the 1956 State high for copper production value and comprised 43 percent of the total value of mineral production. Increased production value for copper, gold, lead, silver, vanadium, and zinc more than offset the decreased value of iron ore, molybdenum, and uranium ore output.

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Table 1.—Mineral production in Utah [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Carbon dioxide (natural)—thousand cubic feet	86,201	$6	94,006	$7
Clays [2]—thousand short tons	149	332	89	252
Coal (bituminous)—do	4,992	31,811	4,635	26,763
Copper (recoverable content of ores, etc.)—short tons	259,138	183,470	265,383	191,978
Gem stones	NA	75	NA	75
Gold (recoverable content of ores, etc.)—troy ounces	426,299	14,921	438,736	15,356
Iron ore (usable)—thousand long tons, gross weight	2,139	14,229	1,956	13,478
Lead (recoverable content of ores, etc.)—short tons	37,700	11,762	64,124	19,385
Lime—thousand short tons	189	3,470	200	3,640
Natural gas (marketed)—million cubic feet	71,616	8,952	69,366	8,809
Petroleum (crude)—thousand 42-gallon barrels	25,298	66,045	24,112	63,760
Salt—thousand short tons	384	3,591	427	3,770
Sand and gravel—do	10,032	10,464	12,368	12,937
Silver (recoverable content of ores, etc.) thousand troy ounces	5,636	7,287	7,755	10,028
Stone—thousand short tons	r 2,328	r 4,765	2,246	4,269
Sulfur ore—long tons	2,156	3	----	----
Uranium ore—short tons	377,989	9,014	236,860	5,169
Vanadium—do	387	1,353	353	1,519
Zinc (recoverable content of ores, etc.)—do	27,747	8,102	37,323	10,824
Value of items that cannot be disclosed: Asphalt and related bitumens, cement, clays (fire clay and halloysite), fluorspar, gypsum, magnesium chloride (1966), molybdenum, natural gas liquids, perlite, phosphate rock, potassium salts, pumice, and pyrites (1966)	XX	[3] 51,939	XX	[4] 52,243
Total	XX	r 431,591	XX	444,262

r Revised. NA Not available. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes fire clay and halloysite; included with "Value of items that cannot be disclosed."
[3] Value of metals and mineral fuels, $31,416,000; value of nonmetals, $20,523,000.
[4] Value of metals and mineral fuels, $29,331,000; value of nonmetals, $22,912,000.

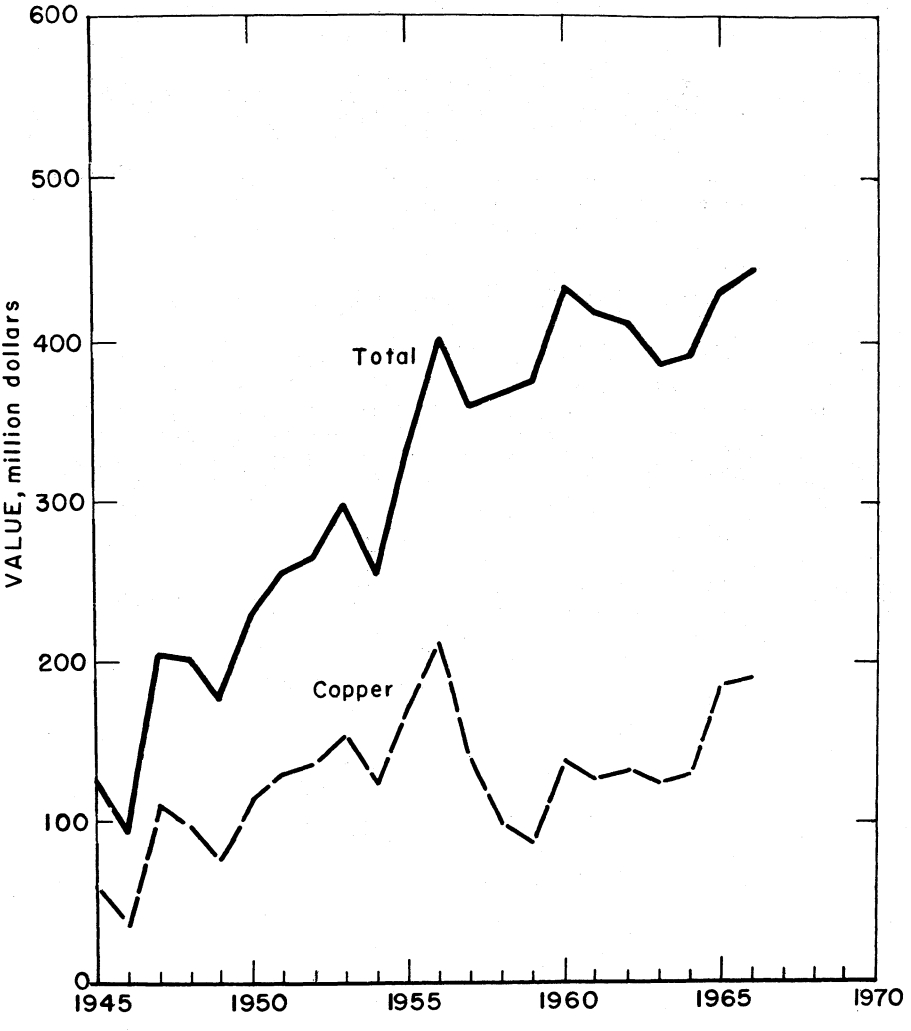

Figure 1.—Value of copper, and total value of mineral production in Utah.

Table 2.—Value of mineral production in constant 1957–59 dollars
(Millions)

Year	Value [1]
1957	$350
1958	379
1959	372
1960	421
1961	415
1962	404
1963	377
1964	371
1965	388
1966	392

[1] Data for 1958, 1960–65 revised.

Despite decreases in the value of gilsonite, natural gas, petroleum, and coal production, the value of mineral fuels output as a group amounted to 24 percent of the State total. Carbon dioxide, liquefied-petroleum (LP) gases, and natural gasoline production increased in value.

Gains in production value of phosphate rock and potassium salts more than offset the decreased value of eight commodities in the nonmetals group and resulted in a net increase in value for nonmetallics of $4.6 million (11 percent).

Employment and Injuries.—Final employment and injury data for 1965 and preliminary data for 1966, excluding all mineral fuels industries except the coal and asphalt (gilsonite) industries, compiled by the Bureau of Mines are shown in table 3.

Legislation and Government Programs.—The Office of Minerals Exploration (OME) granted Thomas P. Miller of Salt Lake City a loan to explore for silver in Box Elder County. The total cost of the work was estimated at $78,800; Government participation was 75 percent.

The Great Salt Lake Authority, in cooperation with Kennecott Copper Corp., completed transportation of classified tailings material from Kennecott's Arthur concentrator to the southeastern shore of Great Salt Lake. Approximately 450,000 tons of tailings was pumped through a 12-inch pipeline to the project site to form an approach road, a jetty, and a terminal island in the lake. The project was conducted to determine the feasibility and economics of transporting, depositing, and consolidating classified mill tailings to form dike structures; to determine the permanence and stability of the structures against water, wave, and wind erosion; to develop criteria for the design of future dikes; and to provide a test plot where agricultural specialists could experiment with the growth of useful crops and protective vegetation in this type of soil.

Prospecting permits on 38,000 acres of coal-bearing public lands in Kane County were converted to leases by Resources Co., a project-development company owned jointly by Arizona Public Service Co., San Diego Gas & Electric Co., and Southern California Edison Co. The utility companies proposed building a $500 million coal-burning powerplant on the Kaiparowits Plateau of southern Utah.

According to a Federal Bureau of Public Roads report,[3] Utah completed 193.5 miles of road that met Interstate highway standards. An additional 59.6 miles was improved to standards adequate for present traffic.

In the fiscal year ending June 1966, Utah awarded $71 million for highway construction: $57.1 million for Interstate contracts, $10.1 million for Federal-Aid Primary and Secondary (ABC) contracts, and $3.8 million for 100-percent State-financed contracts. Contract plans for 1967 were $72.1 million total: $56.2 million for Interstate, $14.7 million for ABC, and $1.2 million for State financed.[4]

[3] Bureau of Public Roads. Quarterly Report on The Federal-Aid Highway Program, Dec. 31, 1966. Press Release BPR 67–5, Feb. 1, 1967.

[4] Engineering News-Record. State Highway Department's Construction Contracting Plans for 1967 . . . and Budgets for Maintenance: Highway Construction Spending Will Reach For a Record This Year. V. 178, No. 12, Mar. 23, 1967, pp. 24–25.

Table 3.—Employment 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
1965:								
Coal	1,495	212	317	2,524	2	92	37.24	8,382
Metal	5,055	307	1,550	12,402	6	235	19.43	3,582
Nonmetal	980	279	273	2,184	3	111	52.20	11,845
Sand and gravel	513	206	106	856	1	22	26.88	7,566
Stone	451	243	110	878	---	12	13.66	268
Native asphalt	239	246	59	470	1	19	42.53	14,954
Total	8,733	277	2,415	19,314	13	491	26.10	5,446
1966: [p]								
Coal	1,500	204	305	2,400	5	87	38.33	13,769
Metal	4,955	307	1,521	12,171	10	215	18.49	5,997
Nonmetal	970	274	266	2,129	6	114	56.36	17,978
Sand and gravel	520	197	103	830	---	19	22.89	520
Stone	450	258	116	923	---	12	13.00	4,037
Native asphalt	189	271	51	410	---	17	41.42	387
Total	8,584	275	2,362	18,863	21	464	25.71	7,880

[p] Preliminary.

REVIEW BY MINERAL COMMODITIES

METALS

Beryllium.—The Anaconda Company made a small shipment of beryllium ore from the Spor Mountain property of Topaz-Beryllium Co., an Anaconda subsidiary, to its pilot plant operation at Anaconda, Mont. The company continued its rotary-drilling program near Spor Mountain. The Brush Beryllium Co. shipped a small amount of ore for metallurgical testing from the Spor Mountain area to the company plant at Elmore, Ohio.

Copper.—Utah was ranked second to Arizona in copper output in the Nation. Production increased in value by 5 percent, chiefly because of increased output from the open pit mine of the Utah Copper Division of Kennecott Copper Corp., again the largest copper-producing mine in the Nation. The other leading copper-produc-

Table 4.—Mine production of gold, silver, copper, lead, and zinc, in terms of recoverable metals [1]

Year	Mines producing		Material sold or treated [2] (thousand short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Troy ounces (thousands)	Value (thousands)
1957-61 (average)	48	1	26,838	327,404	$11,459	4,958	$4,506
1962	25	-----	29,981	311,924	10,917	4,628	5,022
1963	31	-----	27,035	285,907	10,007	4,791	6,128
1964	28	-----	25,279	287,674	10,069	4,552	5,886
1965	34	-----	32,887	426,299	14,921	5,636	7,287
1966	33	-----	34,515	438,736	15,356	7,755	10,028
1864-1966	NA	NA	[3] 1,145,054	18,204,024	537,368	841,192	644,200

Year	Copper		Lead		Zinc		Total value (thousands)
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	
1957-61 (average)	200,668	$119,933	40,350	$9,646	38,753	$8,894	$154,438
1962	218,018	134,299	38,199	7,029	34,313	7,892	165,159
1963	203,095	125,107	45,028	9,726	36,179	8,321	159,289
1964	199,588	130,131	40,249	10,545	31,428	8,548	165,179
1965	259,138	183,470	37,700	11,762	27,747	8,102	225,542
1966	265,383	191,978	64,124	19,385	37,323	10,824	247,571
1864-1966	9,537,281	4,075,721	5,336,723	746,551	1,717,687	326,636	6,330,476

NA Not available.
[1] Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings, or slimes retreated; and ore, old tailings, or copper precipitates shipped to smelters during the calendar year indicated.
[2] Does not include gravel washed or tonnage of precipitates shipped.
[3] Figures estimated for certain years before 1901.

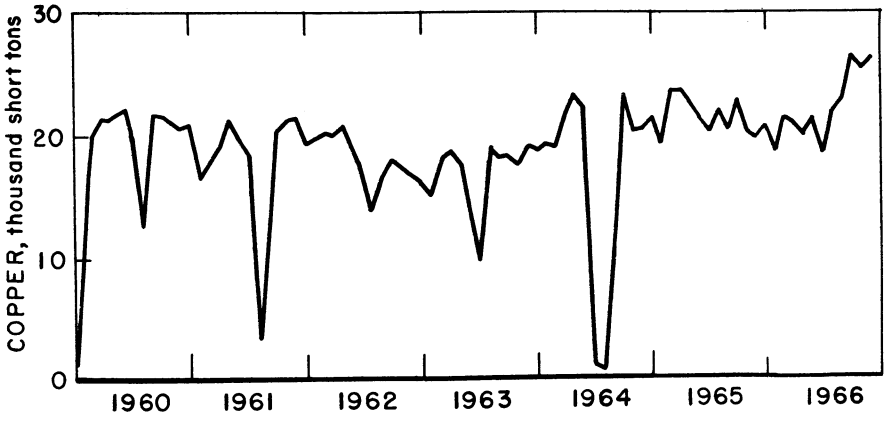

Figure 2.—Mine production of copper in Utah, by months, in terms of recoverable metals.

Table 5.—Mine production of gold, silver, copper, lead, and zinc in 1966, by counties, in terms of recoverable metals

County	Mines producing [1] (lode)	Lode material sold or treated [2] (short tons)	Gold		Silver	
			Troy ounces	Value	Troy ounces	Value
Beaver	5	115,442	681	$23,835	168,122	$217,382
Iron	1	[3] 128,683	[3] 1,074	[3] 37,590	[3] 2,114,477	[3] 2,734,018
Juab	1	1,713	437	15,295	26,557	34,338
Millard	1	2	-----	-----	2	3
Piute	1	(3)	(3)	(3)	(3)	(3)
Salt Lake	5	33,811,639	372,762	13,046,670	4,005,490	5,179,098
San Juan	5	25,047	-----	-----	992	1,283
Sanpete	1	(3)	(3)	(3)	(3)	(3)
Summit	5	204,095	2,024	70,840	504,765	652,661
Tooele	5	39,613	163	5,705	271,123	350,562
Utah	1	(3)	(3)	(3)	(3)	(3)
Wasatch	2	132,500	61,595	2,155,825	663,883	858,401
Total:						
1966	33	34,458,734	438,736	15,355,760	7,755,411	10,027,746
1965	34	32,886,664	426,299	14,920,465	5,635,570	7,286,792

County	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
Beaver	2,845	$2,058,507	25	$7,421	16	$4,480	$2,311,625
Iron	[3] 40	[3] 28,394	[3] 23,346	[3] 7,057,541	[3] 8,264	[3] 2,396,661	[3] 12,254,204
Juab	3	1,845	55	16,763	-----	-----	68,241
Millard	-----	-----	(4)	60	(4)	87	150
Piute	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Salt Lake	260,473	188,426,385	25,775	7,791,828	15,580	4,518,302	218,962,283
San Juan	671	485,618	-----	-----	-----	-----	486,901
Sanpete	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Summit	157	113,538	5,587	1,688,905	6,623	1,920,540	4,446,484
Tooele	269	194,667	3,066	926,958	2,182	632,678	2,110,570
Utah	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Wasatch	925	668,964	6,270	1,895,209	4,658	1,350,907	6,929,306
Total:							
1966	265,383	191,977,918	64,124	19,384,685	37,323	10,823,655	247,569,764
1965	259,138	183,469,704	37,700	11,762,400	27,747	8,102,124	225,541,485

[1] Operations at slag dumps and old mill or miscellaneous cleanups not counted as producing mines; various uranium mines from which copper was recovered as a byproduct not included as they were in the mine count of uranium.
[2] Excludes tonnage of copper precipitates shipped and uranium ore milled.
[3] Production of Iron, Piute, Sanpete, and Utah Counties combined to avoid disclosing individual company confidential data.
[4] Less than ½ unit.

ing mines, American Mining Co. Bawana mine, United States Smelting Refining and Mining Co. (USSR&M Co.) U.S. and Lark mine, and Hecla Mining Co. Mayflower mine, also had increased production. Copper came from 28 mines in 10 counties.

The $100 million expansion program of Utah Copper was to be completed by the second quarter of 1967. The program included an expansion of facilities to effect a 20-percent increase in mining, concentrating, and smelting capability, and to increase recovery of precipitate copper obtained from leaching overburden dumps from 150,000 to 400,000 pounds per day.

Atlas Minerals Division, Atlas Corp., moved a copper-concentrate circuit to recover byproduct copper from Mexican Hat to its Moab mill. The process involved an acid leach and solvent extraction of the copper.

The Anaconda Company conducted exploratory drilling at its copper property in Carr Fork Canyon, southwest of Salt Lake City.

A drilling program for copper was conducted at the Cactus mine.

Gold.—Although gold output from the Utah Copper Bingham Canyon mine decreased slightly, the Hecla Mining Co. Mayflower mine, the USSR&M Co. U.S. and Lark mine, and the United Park City Mines Co. United Park City mines had increases in production. These increases resulted in an overall gain of 12,500 troy ounces. Gold, obtained principally as a byproduct from copper and lead-zinc ores, was produced from 23 mines in nine counties.

New Park Mining Co. discontinued its exploration program for gold-silver ore and closed its Mammoth mine 90 miles south of Salt Lake City. On a lease basis, Hecla Mining Co. continued to produce ore containing gold, silver, copper, lead, and zinc from the New Park Mining Co. Mayflower mine.

Iron Ore.—Iron ore production came from six mines, all in Iron County near Cedar City: The Blowout, Comstock, and Duncan mines of CF&I Steel Corp. (CF&I); the Desert Mound mine operated by United States Steel Corp. (USS); and the Iron Springs mine and McCahill-Thompson Alluvial mine operated by Utah Construction & Mining Co. In addition to operating its own mines, Utah Construction & Mining Co. also acted as a contract miner for CF&I in the Cedar City area. USS was the leading producer. The ore (direct shipping

Table 6.—Mine production of gold, silver, copper, lead, and zinc in 1966, by classes of ore or other source materials, in terms of recoverable metals

Source	Number of mines[1]	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Lode ore:							
Dry gold-silver	2	37,635	715	31,822	389,400	110,900	-----
Dry silver	7	121,800	898	241,669	127,600	169,400	93,500
Total	9	159,435	1,613	273,491	517,000	280,300	93,500
Copper	5	[3] 17,701	364,928	3,049,400	440,409,100	-----	-----
Copper-lead-zinc and uranium[2]	[3] 1	[4] 126,333	61,517	640,166	2,691,600	11,830,800	8,475,600
Lead	6	2,271	51	22,301	18,600	467,500	189,300
Lead-zinc	15	531,033	10,616	3,765,056	3,333,100	115,218,300	63,605,700
Total	25	34,277,338	437,112	7,476,923	446,452,400	127,516,600	72,270,600
Other lode material:							
Copper precipitates	3	56,428	-----	-----	83,777,200	-----	-----
Copper cleanup	(5)	16	3	37	3,500	-----	-----
Copper-lead-zinc cleanup	(5)	1	-----	42	100	1,100	200
Lead cleanup	(5)	11	-----	13	-----	7,900	-----
Lead-zinc mill cleanup and zinc slag[2]	(5)	21,933	8	4,905	15,400	442,100	2,281,600
Total	3	78,389	11	4,997	83,796,200	451,100	2,281,800
Total lode material	33	34,515,162	438,736	7,755,411	530,765,600	128,248,000	74,645,900

[1] Detail will not necessarily add to totals because some mines produce more than one class of material.
[2] Combined to avoid disclosing individual company confidential data.
[3] Excludes the mine count of uranium mines from which copper was recovered as a byproduct.
[4] Excludes uranium ore tonnage.
[5] From properties not classed as mines.

Table 7.—Mine production of gold, silver, copper, lead, and zinc in 1966, 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 (pounds)	Lead (pounds)	Zinc (pounds)
Lode:					
Concentration, and smelting of concentrates:					
Ore[1]	436,930	5,624,472	445,896,300	84,404,000	59,016,800
Cleanings	2	422	100	8,800	11,500
Total	436,932	5,624,894	445,896,400	84,412,800	59,028,300
Direct-smelting:					
Ore	1,795	2,125,942	643,000	43,392,900	13,347,300
Copper precipitates	-----	-----	83,777,200	-----	-----
Cleanings and old slag	9	4,575	18,900	442,300	2,270,300
Total	1,804	2,130,517	84,439,100	43,835,200	15,617,600
Other:					
Leaching of copper ore	-----	-----	430,100	-----	-----
Grand total	438,736	7,755,411	530,765,600	128,248,000	74,645,900

[1] Includes uranium ore concentrate.

and concentrated) averaged 52.7 percent iron and was used almost entirely in producing pig iron and steel.

Lead.—Lead production increased 26,500 tons in quantity and $7.6 million in value over the 1965 totals. Each of the five largest producing mines had increases in production; most notable was that of the Burgin mine of Kennecott Copper Corp. In order of rank, the five largest producing mines were the U.S. and Lark mine of USSR&M Co.; the Burgin mine, Tintic Division, Kennecott Copper Corp.; the Mayflower mine, Hecla Mining Co.; United Park City mines, United Park City Mines Co.; and the Ophir mine, USSR&M Co., (McFarland & Hullinger, lessee). Total lead production came from 23 mines in 11 counties.

Table 8.—Usable iron ore shipments

(Thousand long tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	3,476	$24,984
1962	2,630	18,242
1963	1,881	12,900
1964	2,082	14,306
1965	2,139	14,229
1966	1,956	13,478
1906–66	74,719	355,423

United Park City Mines Co. began sinking a 900-foot shaft at its Ontario mine near Park City, which was to be completed by early 1967. The introduction of a modified hydraulic stope-fill system in the fall of 1966 improved the method of ore extraction and use of this technique was to be expanded.

USSR&M Co. completed the first part of a major improvement and development project at the Lark section of its U.S. and Lark mine. Included was the installation of new hoisting equipment to service lower levels of the mine and deepening of the main incline shaft to provide access to new working levels at 4,500 and 4,750 feet. According to the company's annual report, silver-lead-zinc ores totaling 36,000 tons, an increase of 40 percent, was produced from the Ophir mine and processed at the Midvale flotation mill. Ore processed through the Midvale mill during 1966 was 29 percent more than in 1965, The lead and zinc concentrates produced, which also contained gold, silver, and other metals, were shipped for further treatment to the lead smelter at Tooele and to the Anaconda zinc plant in Montana.

Magnesium Chloride.—An accelerated development program was conducted to utilize brines from the Kaiser Aluminum & Chemical Corp. Bonneville plant for producing primary magnesium metal. Magnesium chloride obtained from the salt-water brines was shipped to the company magnesium facilities at Tulsa, Okla.

Molybdenum.—Molybdenum production, 4 percent less than that in 1965, was by-product recovery of molydenum sulfide from copper ore processed by Utah Copper. A large portion of the molybdenum sulfide recovered was converted to molybdic oxide in the newly completed plant of Kennecott Copper near Garfield.

Rhenium.—Kennecott Copper Corp. began producing ammonium perrhenate in the newly completed section of its molybdic oxide plant near Garfield. For additional refining and processing into rhenium metal products, the rhenium compound was shipped to Chase Brass & Copper Co., Inc., a Kennecott subsidiary.

Selenium.—Output of selenium, recovered as a byproduct of the electrolytic refining of copper by Kennecott at Magna, increased 27 percent.

Silver.—Silver production increased 38 percent. Nearly all producers increased their outputs; the most notable gain was made from the Burgin mine of Kennecott Copper Corp. Silver was produced from 30 mines in 12 counties. The five leading silver-producing mines in order of output were the Kennecott Copper Corp. Utah Copper mine and Burgin mine, USSR&M Co. U.S. and Lark mine, Hecla Mining Co. Mayflower mine, and United Park City Mines Co. United Park City mines.

Other major silver producers were the USSR&M Co. (McFarland & Hullinger, lessee) Ophir mine; American Mining Co., Bawana mine; Escalante Silver Mines Co., Inc., Escalante mine; McFarland & Hullinger, Ontario dump; Deer Trail Mines & Arundel Mining Co., Deer Trail mine; Wortley Co., Daly West mine and dump; Cardiff Industries, Inc., Cardiff mine; and New Park Mining Co., Mammoth mine.

Uranium Ore.—Production continued to decline because of the reduction in procurement of uranium concentrate by the U.S. Atomic Energy Commission (AEC)

through the stretchout program. Output was from 207 operations (13 more than in 1965) in five counties. The average grade of ore fell from 0.29 percent (5.7 pounds per ton) in 1965 to 0.26 percent (5.3 pounds per ton) in 1966. San Juan County produced 80 percent of the uranium output of the State; Emery and Grand Counties produced 12 and 7 percent, respectively.

Atlas Minerals operated several underground mines in the Big Indian, White Canyon, and Green River areas. In the Big Indian area, the ore was mined by the room-and-pillar or longwall method with a front-end loader. The firm purchased all of Charles Steen's remaining interest in the famed Mi Vida claims and the uranium interests of E. E. Lewis, Inc., in the Green River District. The company plant at Moab processed company-owned ores as well as ores of 37 independent producers.

Rio Algom Mines, Ltd., Toronto, Canada, signed an agreement with Humeca Exploration Co., Salt Lake City, giving the former the right to explore Humeca uranium claims south of Moab during a 3-year option and right to purchase the claims.

An increased need for uranium in private reactors, used for scientific experiments and power production, caused a modest boom in uranium exploration. Atlas Minerals, Kerr-McGee Corp., and Humeca Exploration Co. carried out separate exploration programs in the Lisbon Valley of San Juan County.

Uranium ore reserves in Utah at yearend were approximately 1.5 million tons, based on the estimate of the AEC as of January 1, 1966, and on 1966 production. The reserves, ranked third in the Nation after those of New Mexico and Wyoming, included only material metallurgically amenable to treatment.

Vanadium.—The quantity of vanadium metal in vanadium pentoxide recovered from uranium ores was 353 tons, 9 percent less than in 1965. Lower output resulted from the decrease in uranium production. An increase in the weighted value of vanadium pentoxide resulted in an increase of $166,000 in total value.

For custom milling of a wider variety of ores, Atlas Minerals installed a vanadium circuit, in addition to the existing recovery units at its Moab uranium plant. Operation of the circuit was to begin early in 1967.

Uranium ores and their contained vanadium values, mined in Garfield, Grand, and San Juan Counties, were processed at plants outside of the State, principally at Grand Junction, Rifle, and Uravan, Colo., and Shiprock, N.Mex. The quantity and value of the vanadium recovered were credited to the mineral production of Utah.

Zinc.—Production of zinc increased 35 and 34 percent, respectively, in quantity and value. All of the leading producers reported increased output. The U.S. and Lark mine of USSR&M Co. continued as the leading producer, followed by Kennecott Copper Corp. Burgin mine, United Park City Mines Co. United Park City mines, Hecla Mining Co. Mayflower mine,

Table 9.—Mine production of uranium ore, by counties [1]

County	1965				1966			
	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]
Beaver	2	W	W	W	---	---	---	---
Emery	26	28,314	r 115,111	$437,912	32	27,466	63,586	$184,582
Garfield	37	1,615	10,651	45,071	23	W	W	W
Grand	27	21,256	132,720	565,722	36	17,019	91,767	378,148
Juab	1	W	W	W	---	---	---	---
Piute	4	W	W	W	6	W	W	W
San Juan	97	314,186	r 1,858,485	7,812,738	110	190,538	1,085,323	4,550,242
Undistributed	---	12,618	43,316	152,270	---	1,837	12,882	55,694
Total	194	377,989	r 2,160,283	9,013,713	207	236,860	1,253,558	5,168,666

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

[1] Receipts at mills based on data supplied to the Bureau of of Mines by AEC.

[2] F.o.b. mine value; base price, grade premiums, and exploration allowances. Calculated according to AEC Circular 5, revised, price schedule.

USSR&M Co. (McFarland & Hullinger, lessee) Ophir mine, Deer Trail Mines & Arundel Mining Co. Deer Trail mine, and International Smelting and Refining Co. (IS&R) Murray slag dump. A total of 21 mines in nine counties produced zinc.

Ore from the USSR&M Co. U.S. and Lark mine was shipped to the company mill at Midvale, where it was crushed, ground, and floated to produce lead and zinc concentrates.

Plata Verde Mining Co. continued its drilling program for lead-zinc-silver ore at the Horn Silver mine, San Francisco district. Zinc oxide ore was mined and stockpiled at the site for future treatment in a hydrometallurgical plant being constructed in Salt Lake City. The Tintic lead property south of the Horn Silver mine was drilled to outline additional quantities of lead-zinc-silver ore.

MINERAL FUELS

Petroleum production represented 60 percent of the value of mineral fuels produced during the year; coal ranked second.

Asphalt and Related Bitumens.—Gilsonite production decreased 24 percent. American Gilsonite Co., the largest producer, mined gilsonite from open pit and underground mines at Bonanza in Uintah County. Substantially less gilsonite was pumped to the company refinery at Fruita, Colo., and there was a significant reduction in gasoline and diesel fuel production. A diversification into other products, such as heterocyclic nitrogen compounds, was begun. Standard Gilsonite Co. and Ziegler Chemical & Mineral Corp. also produced gilsonite in Uintah County; the latter company also produced gilsonite at the Castle Peak mine, Duchesne County.

Carbon Dioxide.—The one carbon dioxide well at Farnham Dome, Carbon County, yielded 94 million cubic feet of carbon dioxide, a 9-percent increase over the 1965 production.

Coal (Bituminous).—Coal was produced from 25 mines (six less than in 1965) in six counties; the largest production (73 percent) came from Carbon County.

All production came from underground mines in which coalseam thicknesses ranged from 54 to 240 inches. Of the total coal mined, 1.1 million tons (24 percent) was cut by machines. Of this amount, 940,000 tons was drilled by mobile drills; the remainder was drilled by hand-held and post-mounted drills. Continuous-mining machines loaded 76 percent of the coal; 23 percent was loaded by mobile loading machines; and the remainder by self-loading conveyors, scraper loaders, and hand-loaded face conveyors. A total of 3 million tons (66 percent) of the coal produced was cleaned either by wet jigs, chance cone, heavy media, or flotation methods. Ninety-one percent of the coal produced was shipped by rail, the remainder by truck. Sixty-four percent of the coal was sold on the open market at an average of $4.84 per ton compared with an average of $7.44 per ton for coal not sold in the open market.

Table 10.—Coal (bituminous) production, by counties

(Short tons)
(Excludes mines producing less than 1,000 short tons)

County	1965	1966
Carbon	3,779,041	3,379,907
Emery	1,100,714	1,170,402
Iron	36,101	3,500
Kane	1,802	1,719
Sevier	61,427	64,739
Summit	12,918	15,063
Total	4,992,003	4,635,330

Independent Coal & Coke Co. developed a system to promote increased safety. Hydraulic jacks, to provide adequate roof support, and gas monitors, to determine gas concentrations every 20 minutes as required by mining regulations, were installed on the front of its continuous mining machines.

Utah Construction & Mining Co. purchased leases on 7,500 acres of coal land in Kane County from W. J. Smirl and C. W. Swapp of Kanab.

Negotiations to purchase Peabody Coal Co. by Kennecott Copper Corp. were authorized by the officers of the companies. Completion of the transaction was contingent on satisfactory tax rulings, clearance by various Government authorities, and satisfactory financial arrangements.

According to the company's annual report, United States Fuel Co., a wholly owned subsidiary of USSR&M Co., owner and operator of the King mine and preparation plant, produced 633,300 tons of coal, an increase of more than 6 percent. Fossil resin concentrate from coal processed in the plant also was recovered.

Utah Railway Co., also wholly owned subsidiary of USSR&M Co., operated a 95-mile rail line, served four coal mines, and employed diesel locomotives and a fleet of 50- and 70-ton hopper cars to move 700,000 to 800,000 tons of coal annually. The trackage connected with The Denver & Rio Grande Western Railroad Co.

Natural Gas.—Nine counties produced natural gas, one more than in 1965; San Juan County led with an output of 28.0 billion cubic feet, displacing Uintah County which was second with 27.4 billion cubic feet; Grand County produced 8.1 billion cubic feet. San Arroyo field, Grand County, had the largest production of natural gas of any field in the State. Marketed natural gas declined 3 percent because of a combination of depletion of the older reservoirs and the importation of gas from fields in southern Wyoming, recently connected by pipeline to the Utah market.

State and Federal Government agencies received $864,500 in royalties paid on natural gas production; of this amount, $304,800 was from production on Indian lands, $506,800 from Public Domain, and $52,900 from State lands.[5] The State, however, was to receive 37.5 percent of the royalties paid on Public Domain, as provided for in the Mineral Leasing Act of 1920.

Annual estimates of the American Gas Association (AGA) and the American Petroleum Institute (API)[6] gave Utah gas reserves of 1.4 trillion cubic feet at year-end, virtually unchanged from 1965.

Natural Gas Liquids.—Output of natural gas liquids continued to decline as older reservoirs were depleted. The Aneth plant of El Paso Natural Gas Co., San Juan County, was again the major producer. Uintah County had two plants: Chevron Oil Co., Western Division, at Red Wash and Warren Petroleum Corp. at Vernal. Daggett County had one plant operated by Mountain Fuel Supply Co. at the Clay Basin field.

Union Oil Company of California began construction of a refrigerated-absorption liquids-extraction plant at the Lisbon field, San Juan County. With a designed input capacity of 50 million cubic feet of gas per day, the plant was to produce daily 50,000 gallons of propane, 40,000 gallons of butane, and 15,000 gallons of natural gasoline. Completion was scheduled for June 1967.

API and AGA[7] estimated the State reserves of natural gas liquids at 380 million barrels, an increase of 15.7 million barrels.

Petroleum.—Output of crude oil declined slightly; all of the principal producing counties, with the exception of Garfield, had lower output. For the first time, as a result of Bridger Lake discovery, Summit County reported oil production. San Juan County continued to be ranked first in oil output with 66 percent of the State total.

The leading producing oilfield was the Greater Aneth area, San Juan County, with an output of 10.2 million barrels; the area included the Aneth, Cahone Mesa, McElmo Creek, Ratherford, and White Mesa fields. The Greater Red Wash area in Uintah County (including the Red Wash, Walker Hollow, White River, and Wonsits-Wonsits Valley fields) was second with 6.7 million barrels. Lisbon field (3.9 million) and Ismay (1.1 million), both in San Juan County, were next in productivity.

Royalties paid to State and Federal agencies on petroleum production totaled

Table 11.—Crude petroleum production, by counties

(Thousand 42-gallon barrels)

County	1965	1966	Principal fields in 1966 in order of production
Box Elder	(1)	(1)	Rozel Point.
Carbon	2	2	Peters Point.
Daggett	2	5	Clay Basin.
Duchesne	166	145	Monument Butte, Undesignated, Castle Peak.
Emery	25	16	Grassy Trail, Ferron.
Garfield	126	224	Upper Valley.
Grand	209	162	Long Canyon, Salt Wash, Agate.
San Juan	17,077	15,948	Lisbon, McElmo Creek, Aneth, Ratherford.
Summit	---	241	Bridger Lake.
Uintah	7,691	7,368	Red Wash, Wonsits-Wonsits Valley, Ashley Valley.
Washington	---	1	Virgin.
Total	25,298	24,112	

[1] Less than ½ unit.

Source: Utah Oil & Gas Conservation Commission.

[5] State of Utah. Oil & Gas Conservation Commission, 1966 Total Royalty Payments, 8 pp.

[6] The Oil and Gas Journal, V. 65, No. 14, Apr. 3, 1967, pp. 128–131.

[7] Work cited in footnote 6.

Table 12.—Drilling for petroleum in 1966, by counties

County	Oil	Gas	Dry	Total	Footage
Exploratory completions:					
Daggett	---	---	2	2	18,915
Duchesne	7	---	3	10	65,348
Emery	---	---	3	3	19,626
Grand	---	1	2	3	10,916
Kane	---	---	1	1	4,466
San Juan	4	---	18	22	134,360
Summit	1	---	---	1	15,754
Uintah	3	1	21	25	106,953
Utah	---	---	1	1	405
Wasatch	---	---	1	1	6,060
Total	15	2	52	69	383,803
Development completions:					
Duchesne	1	---	3	4	21,667
Grand	1	5	2	8	20,560
San Juan	9	---	5	14	60,553
Summit	1	---	---	1	15,390
Uintah	42	---	4	46	252,349
Total	54	5	14	73	371,019
Total all drilling	69	7	66	142	754,822

Source: Committee on Statistics of Drilling, American Association of Petroleum Geologists.

$8,401,884; of this, $4,722,194 was paid on production from Indian lands, $3,236,891 from Public Domain, and $442,799 from State lands.[8] As for natural gas, 37.5 percent of the royalties received from Public Domain was to be returned to the State.

Overall drilling declined by 16 percent: development drilling was down by 36 wells; however, wildcat drilling increased by nine wells. As in 1965, Uintah County led the State with the most development and exploratory wells. The wildcat success ratio was down, 24.6 percent compared with 26.7 percent in 1965.

Utah's five refineries processed 34.8 million barrels of crude oil, of which 26.2 million came from out of State and 8.6 million was produced locally. Of the out-of-State receipts, Colorado supplied 18 million and Wyoming 8 million. Out-of-State shipments, mostly to California (12.3 million), totaled 16.8 million barrels.

Three of the refineries in the State completed expansion or improvement projects during the year. American Oil Co. built a 5,500-barrel-per-day hydrotreating plant for naphtha feed at Salt Lake City. At Woods Cross, Caribou Four Corners Oil Co. expanded its daily crude oil capacity from 2,300 to 3,300 barrels, increased its catalytic reforming capacity from 750 to 3,250 barrels per day, and added a 2,000-barrel-per-day Isomax hydrocracking unit. Phillips Petroleum Co., also at Woods Cross, expanded its daily crude oil capacity by 5,000 barrels, to 20,000 barrels, and built a 1,500-barrel-per-day hydrotreating unit.

Most significant discovery of the year was the Bridger Lake field by Phillips Petroleum Co. The discovery well, No. 1 Bridger Lake Fork Unit A, sec 25, T3N, R14E, was completed in late January; initial potential, flowing, was 2,753 barrels of 40.3° API oil per day. Producing intervals were 15,504 to 15,517 feet and 15,555 to 15,584 in the Dakota formation (Cretaceous). At yearend, a second well had been completed and a third was being drilled.

Gulf Oil Corp. had an important discovery in Duchesne County. The well, No. 2 Ute Tribal, sec 8, T4S, R5W, flowed 1,230 barrels of 45° API oil and 1.3 million cubic feet of gas per day from the Wasatch formation (Tertiary) in the 7,366- to 8,122-foot interval.

NONMETALS

Barite.—Yuba Minerals & Milling Co., Salt Lake City, ground crude barite for use in well drilling. The crude barite, supplied by D. A. Mining Co. and Tom Norris, came from Nevada.

Cement.—Output of cement decreased in quantity and value. Ideal Cement Co. at Devil's Slide in Morgan County continued to be the major producer of portland ce-

[8] Reference cited in footnote 5.

Table 13.—Oil and gas discoveries in 1966

County and field	Well	Operator	Location			Producing formation	Gross producing interval (feet)	Total depth (feet)	Initial production		Date of completion	Remarks
			Section	Township	Range				Barrels of oil per day	Thousand cubic feet of gas per day		
Duchesne County:												
Duchesne	No. 1 Ute-Tribal	Gulf Oil Corp	9	4 S	4 W	Wasatch	8,029–8,500	8,500	119	-----	July 22	Pumped. New pay.
Wildcat	No. 2 Ute-Tribal	do	8	4 S	5 W	do	7,366–8,122	8,122	1,230	1,310	Oct. 14	Flowed. New field.
Nutter Canyon	No. 1-13 Ute-Tribe	Shamrock Oil & Gas Corp.	13	5 S	4 W	Green River	4,093–5,097	6,055	160	-----	July 25	Pumped. New field.
San Juan County:												
Bluff	No. 12 Bluff Unit	Continental Oil Co	30	39 S	23 E	Desert Creek	5,680–5,694	7,200	31	-----	May 25	Deeper pool test.
South Ismay	No. 29-B3 Ismay	Union Oil Company of California	29	40 S	26 E	Ismay	5,306–5,375	5,550	146	187	Oct. 5	Extension test.
Boundary Butte	No. 15 English WN	Sinclair Oil & Gas Co.	16	43 S	22 E	Coconino	1,146–1,152	4,802	156	-----	Dec. 6	Deeper pool extension test.
Summit County:												
Bridger Lake	No. 1-A Bridger Lake Fork Unit	Phillips Petroleum Co.	25	3 N	14 E	Dakota	15,504–15,517 15,555–15,584	15,754	2,753	-----	Jan. 28	Flowed. New field.
Uintah County:												
Red Wash Area	No. 212 (41-8F) Red Wash	Chevron Oil Co	8	8 S	24 E	Mancos	9,159–9,522	10,050	20	1,400	July 12	Flowed. New pay.
Stagecoach	No. 10-23 Stagecoach	Belco Petroleum Corp.	23	8 S	21 E	Wasatch	5,077–5,086	5,356	493	259	Dec. 21	Extension well.

Source: State of Utah, Oil & Gas Conservation Commission. Yearly Well Completion Report, Wells Completed or Abandoned. January–December 1966. Petroleum Information Corp. 1966 Resume, Oil and Gas Operations in the Rocky Mountain Region.

ment and the only producer of masonry cement. Portland Cement Company of Utah at Salt Lake City also produced portland cement.

Most of the cement was bulk shipped by truck; the remainder was shipped by rail. More than 66 percent was used by ready-mixed concrete producers; other users were highway contractors, concrete product manufacturers, building material dealers, and other contractors.

Clays.—Clay output decreased substantially; however, fire clay and halloysite production did not decline as much as that of bentonite, fuller's earth, and miscellaneous clays. Clays were produced at 19 operations in nine counties, and were largely used as a catalyst in oil refining, followed closely by the manufacture of building brick and lightweight aggregate. Other principal uses of Utah clays were in refractories at foundries, as raw material in manufacturing vitrified sewer pipe, as a filler in fertilizers, and for filtering mineral oils.

Fluorspar.—Shipments of fluorspar, for use at steel mills, increased 7 percent and came entirely from the Spor Mountain area in Juab County.

Gypsum.—Production of gypsum decreased slightly in quantity and value. Bestwall Gypsum Division, Georgia-Pacific Corp., and United States Gypsum Co. near Sigurd in Sevier County produced gypsum from open pit mines. Principal uses were in manufacturing wallboard, lath, plasters, and decorative materials. Sam Bowman produced a small quantity of gypsum from a mine near St. George in Washington County for agricultural uses.

Lime.—The quantity and value of quicklime and hydrated lime output increased 6 and 5 percent, respectively. Seven operations in five counties produced 200,000 short tons. U.S. Lime Division, The Flintkote Co., was the principal producer, followed by Utah Marblehead Lime Co. Principal uses of quicklime were in copper-ore concentrating, sugar refining, and in food and food byproducts. Hydrated lime was used principally in petroleum refining.

Sixty-nine percent of the lime produced was used in Utah. Out-of-State shipments were principally to Nevada, California, Wyoming, Washington, Colorado, and Canada.

Perlite.—The North Pearl Queen quarry of Henry Shoo Co. was the only source of crude perlite in the State.

Phosphate Rock.—Agricultural and industrial uses accounted for all of the phosphate rock mined and processed in the State. Phosphate rock production continued to rise; San Francisco Chemical Co. increased production. During the year FMC Corp. shut down the Jeffs mine in Rich County to permit completion of an expansion program.

San Francisco Chemical Co. operated two mines near Randolph in Rich County and another mine north of Vernal in Uintah County. The phosphate rock mined in Rich County was processed at the company Leefe plant at Sage, Wyo. Phosphate concentrate from the plant near Vernal was hauled by truck and stored in a 12,000-ton-capacity steel and concrete storage teepee at Phoston. The concentrates were loaded from the teepee into Union Pacific Railroad Co. cars for shipment to Western customers.

Potash.—With an increase in production by Texas Gulf Sulphur Co. (TGS) at Moab, output of potassium salts almost doubled in 1966. TGS announced that potash mining at Moab was nearing the initial production goal of 4,000 tons per day. The company also announced plans to construct a crystallizer facility to produce about 450 tons of product per day from fine material that had not been recovered because it was not salable. West Toledo Mines Co. had new leases for over 6,000 acres on potash property adjacent to the TGS operation near Moab.

Pumice.—Production of pumice decreased 67 percent. The principal producer was Melvin Bradshaw, operating near Milford. Pumice also was mined by Thompson Block Co. at the Pumice Hole mine near Milford. The product was used as an aggregate in concrete.

Pyrites.—Pyrites shipped by IS&R from its Tooele stockpile was sold to The Anaconda Company at Wabuska, Nev., for use in manufacturing sulfuric acid.

Salt.—Salt production increased 11 percent. Solar evaporation of water from Great Salt Lake, which contained 25 percent dissolved salts (75 percent of which was sodium chloride), provided the bulk of the total quantity. The remainder of

the State production was in the form of rock salt from mines north of Redmond.

Principal uses of evaporated salt were in manufacturing chlorine and other chemicals; as livestock feed; for water softening; and by meat packers, tanners, and casing manufacturers. Most of the rock salt was used as livestock feed. Twenty-two percent of the evaporated salt was used in Utah. Salt also was shipped to 22 other States, principally to Colorado, Idaho, Montana, Oregon, Washington, and Wyoming.

Sand and Gravel.—Sand and gravel from 195 operations in 27 of the 29 counties increased 23 percent in quantity and 24 percent in value. Three counties, Davis, Salt Lake, and Utah, accounted for 60 percent of the State total. Road construction was the principal use for sand and gravel, accounting for 7.2 million tons of gravel and 1.3 million tons of sand. The second largest use was in building construction, which accounted for 3.2 million tons. Other uses were for fill, railroad ballast, and industrial applications.

Government-and-contractor operations (Federal, State, county, and municipal) produced 63 percent of the construction

Table 14.—Sand and gravel production in 1966, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value
Beaver	177	$179
Box Elder	572	589
Cache	171	220
Carbon	43	72
Daggett	W	W
Davis	1,056	1,203
Duchesne	W	W
Garfield	44	62
Grand	23	23
Iron	282	338
Juab	123	123
Kane	109	59
Millard	20	20
Morgan	154	169
Piute	21	22
Rich	39	41
Salt Lake	4,526	4,695
San Juan	149	148
Sanpete	123	125
Sevier	92	94
Summit	828	865
Tooele	685	615
Uintah	433	428
Utah	1,795	1,895
Wasatch	W	W
Washington	167	177
Weber	598	636
Undistributed	138	139
Total	12,368	12,937

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

Table 15.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	1,101	$1,234	1,053	$1,209
Paving	407	414	167	200
Railroad ballast	---	---	1	1
Fill	68	43	76	38
Other	1	2	1	3
Industrial:				
Molding	3	7	---	---
Blast	1	4	[1] 22	[1] 25
Fire or furnace	(2)	(2)	(1)	(1)
Engine	7	18	8	20
Other (unground)	[2] 25	[2] 36	---	---
Foundry (ground)	---	---	5	14
Total	1,613	1,758	1,333	1,510
Gravel:				
Construction:				
Building	1,205	1,275	1,830	2,194
Paving	2,304	2,661	1,167	1,328
Railroad ballast	2	1	34	24
Fill	84	68	198	109
Other	---	---	1	1
Miscellaneous	375	469	24	28
Total	3,970	4,474	3,254	3,684
Total sand and gravel	5,583	6,232	4,587	5,194

Table 15.—Sand and gravel sold or used by producers, by classes of operations and uses—Continued

(Thousand short tons and thousand dollars)

Class of operation and use	1965		1966	
	Quantity	Value	Quantity	Value
Government-and-contractor operations:				
Sand:				
Building	3	3	---	---
Paving	215	233	1,170	1,184
Fill	---	---	37	19
Total	218	236	1,207	1,203
Gravel:				
Building	459	318	287	335
Paving	3,485	3,489	6,065	6,095
Fill	287	189	222	110
Total	4,231	3,996	6,574	6,540
Total sand and gravel	4,449	4,232	7,781	7,743
All operations:				
Sand	1,831	1,994	2,540	2,713
Gravel	8,201	8,470	9,828	10,224
Total	10,032	10,464	12,368	12,937

[1] Fire or furnace combined with blast sand to avoid disclosing individual company confidential data.
[2] Fire or furnace sand combined with "Other (industrial)" sand to avoid disclosing individual company confidential data.

sand and gravel. More gravel (79 percent of the total) than sand was produced; 89 percent of the sand and gravel produced was washed, sized, or otherwise processed. Nearly all of the commercially produced sand and gravel was transported by truck; some was shipped by rail.

Stone.—Stone, from 67 operations, decreased 4 percent in quantity. The largest production of stone was in Utah County, followed in order of output by Morgan, Tooele, and Salt Lake Counties. Commercial operations was the source of 91 percent of the tonnage; almost all the stone was crushed and broken. Crushed limestone was the principal commercial stone produced (94 percent of the total); 112,000 tons of crushed and broken sandstone and small amounts of crushed and broken miscellaneous stone were produced. Principal uses of crushed limestone were as a flux, as a raw material in manufacturing cement and lime, for refractories, in road construction, and in controlling coal dust in coal mines.

Dimension limestone was used as building stone; crushed and broken sandstone was used as riprap, in road construction, as aggregate in precasting, and as a refractory stone.

Sulfur Ore.—Sulfur ore was not mined during 1966. The Garfield plant of Kennecott Copper Corp. manufactured sulfuric acid from sulfur dioxide produced during the smelting of metal sulfides. In May, Ralph M. Parsons Co. began construction of a new acid-recovery plant at Magna. Upon completion of the plant in 1967, a

Table 16.—Stone production in 1966, by counties

County	Short tons	Value
Beaver	31,524	$63,103
Box Elder	149,697	299,077
Cache	70,634	183,422
Daggett	825	1,650
Davis	4,591	9,182
Duchesne	7,743	15,486
Garfield	3	70
Iron	110	1,982
Juab	W	W
Kane	3	70
Morgan	526,474	837,607
Rich	551	1,102
Salt Lake	208,360	341,002
San Juan	20,562	41,154
Sanpete	66	2,400
Summit	32,994	65,988
Tooele	308,303	845,717
Uintah	150	600
Utah	W	W
Wasatch	W	W
Washington	W	W
Weber	22,030	44,060
Undistributed	861,350	1,515,525
Total	2,245,970	4,269,197

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

Table 17.—Stone sold or used by producers, by uses

Use	1965		1966	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough construction, short tons	W	W	W	W
Rubble, do	W	W	15	$60
Rough architectural, cubic feet	W	W	W	W
Sawed stone, do	16,771	$73,230	12,847	68,731
Dressed stone, do	1,550	5,550	-----	-----
Flagging, do	12,931	26,445	32,978	22,699
Total (approximate), short tons	3,400	131,422	3,947	126,480
Crushed and broken stone:				
Riprap, short tons	134,235	268,870	243,193	416,239
Metallurgical, do	930,378	1,673,066	893,656	1,435,204
Concrete and roadstone, do	260,753	512,786	109,361	197,257
Lime, do	258,272	729,140	248,893	597,796
Other, do	[1] 570,626	[1] 1,236,947	[2] 746,920	[2] 1,496,221
Total, do	2,154,264	4,420,809	2,242,023	4,142,717
Total stone (approximate), do	2,157,700	4,552,231	2,246,000	4,269,197

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

[1] Includes stone used in agriculture, cast-stone products, cement, coal dust, exposed aggregates, foundry, plaster sand, poultry grit, and terrazzo.

[2] Includes stone used in asphalt filler, cast-stone aggregates, cement, coal dust, decorative use, foundry, poultry grit, precasting, railroad ballast, roofing granules, slope protection, stone sand, stucco, and terrazzo.

Table 18.—Stone sold or used by producers, by kinds

Year	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
	Basalt and related rocks (traprock)		Granite		Limestone [1]		Marble	
1962	-----	-----	159,724	$336,207	1,608,466	$2,862,366	W	W
1963	-----	-----	15,704	253,225	1,716,450	3,219,167	W	W
1964	-----	-----	800	160,000	2,003,925	3,860,409	626	$17,255
1965	200	$800	W	W	1,852,365	3,733,580	461	11,145
1966	24	236	-----	-----	1,943,014	3,573,365	W	W
	Sandstone		Slate		Other stone [2]		Total	
1962	335,539	624,927	-----	-----	14,639	41,028	2,118,368	3,864,528
1963	611,628	524,713	-----	-----	2,106	43,200	2,345,888	4,040,305
1964	967,781	2,549,006	-----	-----	131,899	343,333	3,105,031	6,930,003
1965	202,141	499,364	1,660	82,360	100,821	224,982	2,157,648	4,552,231
1966	201,507	447,260	795	42,820	100,630	205,516	2,245,970	4,269,197

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

[1] Excludes dimension limestone; included with "Other stone."

[2] Includes dimension limestone.

larger proportion of the sulfur dioxide was to be recovered from the smelting process.

Atlas Minerals continued operating a small sulfuric acid plant at Mexican Hat. Most of the product was used in the company Moab mill; excess production was sold to consumers in southeastern Utah.

Talc.—Crude talc mined from the company mine at Dillon, Mont., was processed by Chas. Pfizer & Co., Inc. (formerly Tri-State Minerals, Inc.), at its plant near Ogden. The processed talc was used chiefly in manufacturing paint, ceramics, insecticides, and paper.

Vermiculite.—Vermiculite was exfoliated at the Salt Lake City plant of Vermiculite Intermountain, Inc., and used as an aggregate and in insulation and acoustical material.

REVIEW BY COUNTIES

Mineral production from Carbon, Iron, Salt Lake, San Juan, Uintah, and Utah Counties, collectively, amounted to 87 percent of the total mineral output value in the State. Production value in Salt Lake County alone accounted for 57 percent of the total. The largest variety of minerals and mineral products, 13 in all, was produced in Tooele County.

Beaver.—Mineral production value increased 24 percent, chiefly because of a 56-percent increase in the value of copper. Copper production represented 80 percent of the output value for the county. The county was ranked second behind Salt Lake County in copper production. Other commodities with large increases in output value were silver, gold, and stone. Lead, zinc, pumice, and sand and gravel declined sharply. The Bawana mine of American Mining Co. was the principal source of copper, gold, and silver. Lead and zinc came chiefly from the Horn Silver mine of Bellevue Mines and Horn Silver Mines,

Table 19.—Value of mineral production in Utah, by counties

County	1965	1966	Minerals produced in 1966 in order of value
Beaver	$2,073,217	$2,578,591	Copper, silver, sand and gravel, stone, gold, pumice, perlite, lead, zinc.
Box Elder	W	1,243,578	Sand and gravel, stone, lime, salt, petroleum.
Cache	W	W	Sand and gravel, stone, lime.
Carbon	26,380,296	21,257,554	Coal, natural gas, sand and gravel, carbon dioxide, petroleum.
Daggett	361,000	349,650	Natural gas, sand and gravel, natural gasoline, petroleum, stone.
Davis	W	1,212,182	Sand and gravel, stone.
Duchesne	W	756,371	Petroleum, gilsonite, sand and gravel, stone, natural gas.
Emery	6,055,845	5,803,916	Coal, uranium ore, natural gas, petroleum.
Garfield	420,902	729,756	Petroleum, sand and gravel, uranium ore, vanadium, stone.
Grand	4,742,534	7,656,325	Potassium salts, natural gas, petroleum, uranium ore, vanadium, sand and gravel.
Iron	14,775,734	14,004,961	Iron ore, sand and gravel, silver, coal, lead, copper, gold, stone.
Juab	1,512,491	1,509,223	Clays, sand and gravel, fluorspar, stone, silver, lead, gold, copper.
Kane	32,737	68,837	Sand and gravel, coal, stone.
Millard	53,644	20,150	Sand and gravel, zinc, lead, silver.
Morgan	W	W	Cement, stone, sand and gravel.
Piute	558,776	585,559	Zinc, lead, silver, gold, sand and gravel, clays, copper, uranium ore.
Rich	W	W	Phosphate rock, sand and gravel, stone.
Salt Lake	r 242,854,253	251,156,406	Copper, molybdenum, gold, lead, silver, sand and gravel, zinc, cement, salt, lime, stone, clays.
San Juan	59,497,254	54,684,645	Petroleum, uranium ore, natural gas, LP gases, vanadium, natural gasoline, copper, sand and gravel, stone, silver.
Sanpete	173,952	227,446	Sand and gravel, salt, clays, natural gas, stone, zinc, lead, silver.
Sevier	1,287,799	1,163,526	Gypsum, coal, clays, sand and gravel, salt.
Summit	5,476,719	6,163,526	Zinc, lead, sand and gravel, silver, petroleum, copper, coal, gold, stone, clays, natural gas.
Tooele	8,467,887	8,408,685	Lime, salt, lead, stone, zinc, sand and gravel, potassium salts, silver, copper, magnesium chloride, pyrites, clays, gold.
Uintah	30,742,751	29,604,838	Petroleum, gilsonite, natural gas, phosphate rock, sand and gravel, LP gases, natural gasoline, stone.
Utah	3,953,085	14,948,895	Lead, silver, zinc, sand and gravel, stone, lime, clays, copper, gold.
Wasatch	5,295,472	6,965,546	Gold, lead, zinc, silver, copper, stone, sand and gravel.
Washington	84,015	183,196	Sand and gravel, petroleum, stone, gypsum.
Wayne	27,000	---	
Weber	W	W	Sand and gravel, stone, clays.
Undistributed [1]	r 16,764,737	12,877,579	
Total	r 431,592,000	444,262,000	

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

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

Inc., and the Lincoln dump of Kent & Warren Outzen. No uranium or sulfur ore was produced during 1966. All of the perlite and pumice mined in the State was from Beaver County.

Box Elder.—Except for a limited amount of petroleum, nonmetals accounted for the bulk of the mineral output. Increased salt and stone production offset decreases in lime and sand and gravel production with a resulting overall gain in county output value. Lime produced by Utah-Idaho Sugar Co. was used entirely for processing sugar beets. Stone production, mostly crushed and broken sandstone used as riprap, came from nine operations in the county; sand and gravel was produced from seven operations.

Cache.—Substantial decreases in the three nonmetallic commodities produced in the county resulted in a 68-percent decrease in value of total mineral yield. Stone produced was chiefly crushed limestone used in manufacturing lime. The lime produced by The Amalgamated Sugar Co. was used in sugar refining. Sand and gravel from 10 operations was used mostly in building and road construction.

Carbon.—Despite a $5.1 million decline in value of mineral production, the county continued to rank fourth within the State. Although marketed natural gas decreased, a decrease in coal output was almost entirely responsible for the decline. The other commodities, carbon dioxide, petroleum, and sand and gravel, increased in output value. Despite the decrease in production, coal amounted to 98 percent of the total output value in the county and 73 percent of the coal output in the State. Coal came from 14 underground mines (four less than in 1965); Kaiser Steel Corp. continued to be the largest producer, followed by USS, Independent Coal & Coke Co., and Spring Canyon Coal Co. Coal was cleaned at the Carbon Fuel Co. plant, the Castle Gate washery, the Kaiser Steel preparation plant, the King mine plant, and the Wellington cleaning plant. It was shipped mainly by The Denver & Rio Grande Western Railroad Co.

Petroleum production was essentially the same as 1965, although the value of output increased slightly. Marketed natural gas was valued at $299,000.

Davis.—Only sand and gravel and stone, were produced; however, because of a nearly twofold increase in output value of sand and gravel, total mineral value for the county exceeded $1.2 million. Principal uses of sand and gravel were for paving, fill, and building construction. Stone output increased slightly.

Duchesne.—Although stone and sand and gravel were produced in 1966, total value of mineral output was lower than in 1965 because of large decreases in gilsonite and petroleum production. Natural gas production increased 72 percent. The county was ranked sixth in petroleum output, compared with fourth in 1965. Despite the decrease in production, petroleum output accounted for 51 percent of the total mineral output value.

Crude oil output declined to 145,000 barrels; gas production, however, increased by 28 million cubic feet. The county had seven successful wildcat oil wells; these included a significant new field discovery by Gulf Oil Corp. (the No. 2 Ute Tribal), a small new field discovery by Shamrock Oil & Gas Corp., and a new pay discovery by Gulf in the Duchesne field.

Emery.—Value of mineral production totaled $5.8 million, 4-percent below the total for 1965. The decrease was attributed mainly to the cessation of production of sand and gravel, stone, and vanadium and to a decline in uranium ore and petroleum production. Natural gas and coal production increased. Coal from nine underground mines accounted for 94 percent of the county mineral production value, and the county ranked second in coal output in the State. Principal producers in order of output were United States Fuel Co., USS, Cooperative Security Corp., and Heiner Coal Co.

Depletion of the reservoirs at Grassy Trail and Ferron fields caused petroleum production to decline 36 percent. The three exploratory wells drilled during the year were unsuccessful.

Garfield.—Petroleum production was the main source of a 73-percent increase in value of mineral production in the county. Full production from the Upper Valley field resulted in a 78-percent increase in crude oil output. According to the Utah Oil & Gas Conservation Commission, the county had two unsuccessful wildcat wells and one that was temporarily abandoned. Other commodities that increased in pro-

duction were sand and gravel and uranium ore. Only vanadium decreased in output.

Grand.—Continued production increases at the Cane Creek potash mine and mill of TGS accounted for a 61-percent increase in overall mineral output value.

Although uranium ore from 36 operations (nine more than in 1965) decreased by more than 4,000 short tons, the county was still ranked third in uranium production in the State. Vanadium from 20 operations almost doubled because of higher grade ore being processed.

Despite a 29-percent decrease in marketed natural gas, the county continued to be ranked third in output in the State. Petroleum production decreased 22 percent; the county dropped from third to fifth in rank for this commodity. Six of the eight development wells were successful; two wildcat wells were dry holes, and one a small gas producer.

Iron.—Value of iron ore output was $13.5 million (96 percent of the county total value) but declined 5 percent below that of 1965 and was chiefly the cause for a 5-percent decrease in total output value.

Gold, silver, and copper production increased; coal, stone, and sand and gravel production decreased.

The Escalante mine of Escalante Silver Mines Co., Inc., near Enterprise was the only source of copper, gold, lead, and silver.

The county was the only producer of iron ore in the State; all output came from open pit mines. The iron ore from five of the six operations near Cedar City was in the form of magnetite; that from the Desert Mound mine of USS was hematite mixed with small amounts of magnetite.

The only coal production came from the Webster mine and was shipped to consumers by truck.

Sand and gravel from six operations was used in road and building construction and for fill.

Juab.—Total mineral output value decreased less than 1 percent. The value of output for three commodities, gold, silver, and lead, increased. The value of copper, clays, fluorspar, and stone decreased. Zinc and uranium ore were not produced in 1966; sand and gravel, not produced in 1965, was produced in 1966.

Clay (halloysite) production by Filtrol Corp. was the principal source of the total output value in the county.

The main producer of fluorspar was Willden Fluorspar Co. from its Lost Sheep strip mine. Spor Bros. produced a small amount of fluorspar from its Fluoride mines, which was stockpiled.

The Mammoth mine of New Park Mining Co. near Eureka was the only source of gold, silver, copper, and lead.

Morgan.—Cement, sand and gravel, and stone were the only commodities produced in the county. Cement production decreased 11 percent in value, resulting in an overall decrease of 10 percent for the county. Stone production decreased slightly, but sand and gravel production increased. The county was ranked first in the State in cement output.

Piute.—Increased production of copper, lead, silver, and zinc at the Deer Trail mine of Deer Trail Mines & Arundel Mining Co. more than offset decreased production of clays, gold, and uranium ore, resulting in a 5-percent increase in total value of mineral output. Sand and gravel, not produced in 1965, was produced in 1966. Zinc led in output value in the county.

Rich.—The county was ranked first in phosphate rock production in the State. Phosphate rock from the Cherokee and Benjamin mines of San Francisco Chemical Co. accounted for most of the mineral output value. Sand and gravel production declined; stone was produced at one operation.

Salt Lake.—The $251.2 million of mineral production, a 3-percent increase over 1965, ranked the county first in the State as a mineral producer. In terms of production value it led the State in output of copper, gold, lead, molybdenum, sand and gravel, silver, and zinc, and ranked second in output of cement, lime, and salt. Copper production, 75 percent of the county value, represented a continued increase in quantity and value. The recovery of silver and selenium, associated with the copper ores in Bingham Canyon, also increased substantially in quantity and value; however, the recovery of associated gold and molybdenum decreased. Copper was produced from six other operations, principally the U.S. and Lark mine of USSR&M Co. This mine was also the leading producer of lead and zinc. Other major production of lead

and zinc came from the Murray slag dump by IS&R, the Cardiff mine by Cardiff Industries, Inc., and the Lavinia-Grizzly mine by Page E. Blakemore. In addition to lead and zinc, each of these operations produced small amounts of gold, silver, and copper.

In the nonmetals group sand and gravel accounted for the highest value of output. Some 45 operations supplied the output, most of which was used in road and building construction. Lime was produced by Kennecott Copper Corp. for copper ore concentration and by Utah-Idaho Sugar Co. for sugar refining. Stone from eight operations was used almost entirely in manufacturing cement and as a flux in smelting. Salt production by Morton Salt Co. at Saltair increased.

A new "water wagon" designed for dust control was placed in operation during April at the Kennecott 5,100-acre tailings pond near the Arthur and Magna concentrator plants. The water wagon weighed 295,000 pounds when loaded; carried 12,000 gallons of water; traversed dry surface areas of the ponds on 14 low-pressure, high-flotation tires; and sprayed water for 70 feet from each end.

Kennecott installed a new $20,000 observation building at the Bingham Canyon mine. The new facility included a large main level equipped with remotely operated sound and film apparatus to tell the copper pit story and a glass enclosed upper deck to house the traffic director of the pit operation.

San Juan.—Despite a $2.4 million decrease in petroleum output value and a $3.3 million decrease in value of uranium ore output, resulting in a $5.7 million decline, the county ranked second in the State in total value of mineral production. Output value of silver, copper, LP gases, natural gas, natural gasoline, sand and gravel, and vanadium increased.

The county was ranked first in production of petroleum, natural gas, and natural gas liquids, although output of LP gases and petroleum declined. Royalties paid on production of oil and gas in the county on Indian lands amounted to $4,896,085, on Public Domain $1,186,441, and on State lands $253,788. The McElmo Mesa field had two significant extension wells drilled during the year: The Monsanto Co., No. 3 South Ismay, sec 5, T41S, R26E, was completed for 2,295 barrels of 44° API oil per day; the No. 4 South Ismay, one-quarter mile northwest, was completed for 1,200 barrels of oil per day. Union Oil Company of California started construction of a 50-million-cubic-foot-per-day gasoline plant in the Lisbon field. The county had a very successful development drilling program, mostly in the McElmo Mesa field.

Although uranium ore was produced from 110 operations (13 more than in 1965), a 39-percent reduction in tonnage resulted from the stretchout program. Copper production was principally as a by-product from uranium ores processed by Atlas Minerals in Moab, and also from the Micro Copper Corp. Alpha Lucille mine and the Basinere Metals Copper claim and Four Aces mine. Sand and gravel, produced by crews of the State highway department and contractors for the Federal Bureau of Public Roads and Bureau of Land Management, was used entirely in road construction. Most of the stone was produced by Stratton Brothers Construction Co. for use in concrete and as roadmetal.

Sanpete.—Total value of mineral production increased 31 percent. Output of clay, sand and gravel, and salt increased, whereas that of silver, lead, zinc, stone, and natural gas decreased. Sand and gravel, the leading commodity, totaled 55 percent of the county value. The county highway department produced most of the sand and gravel for use in paving. The rock salt produced by Albert Poulson Salt Co. and Redmond Clay & Salt Co. was used chiefly in Utah by feed dealers. Bentonite produced by Redmond Clay & Salt Co. was used for reservoir lining and roofing material; miscellaneous clay mined by Azome Utah Mining Co. was used in fertilizers. Nonferrous metal production came entirely from the Blue Danube mine of Farrell Neilson Co. near Mt. Pleasant.

Gas production at the Joes Valley field decreased 24 percent.

Sevier.—Total value of mineral output decreased 2 percent. Gypsum, again the leading commodity in value of output, was followed by coal and clays.

All of the coal, produced from the underground Southern Utah Fuel No. 1 mine of Southern Utah Fuel Co., was shipped by truck.

Bentonite from the Redmond mine of Western Clay & Metals Co. was used as a

refractory in foundries, in filters, and in rotary-drilling muds. Fuller's earth mined from the company's Aurora mine was used in filtering mineral oils and exported. International Pipe and Ceramics Corp. and Interstate Brick Co. mined miscellaneous clay for manufacturing building brick.

Sand and gravel from seven operations was used mainly in road and building construction.

Salt produced by Redmond Clay & Salt Co. was used chiefly by government agencies for deicing roads.

Summit.—Despite decreases in production of clay and four of the five metals, total value of mineral output increased 14 percent. Initiation of petroleum production at Bridger Lake field by Phillips Petroleum Co. and increases in yield of lead, coal, sand and gravel, and stone stimulated the gain. The county was ranked eleventh in the State with a total production value of $6.2 million. Metals, again the chief source of value, comprised 72 percent of the total. Metals produced in order of value were zinc, lead, silver, copper, and gold; the United Park City mines of United Park City Mines Co. supplied the largest output of each. Other significant production of gold, silver, and copper was from the Ontario dump of McFarland & Hullinger and the Daly West mine and dump of Wortley Co. United Park City Mines Co., in a joint venture with Keystone Mining Co., produced the second largest amount of lead and zinc from the Keystone mine.

The most valued nonmetal was sand and gravel, used principally in paving; production increased 14 percent. Utelite Corp. near Peoa produced most of the shale for use as a raw material in manufacturing lightweight aggregate. The underground mine of Chappell Coal Co. was the source of coal in the county.

The county joined the ranks of oil-producing counties when the Bridger Lake field was discovered and developed. This deep field was considered one of the most important discoveries in the Rocky Mountain region. By yearend, two completed wells had yielded 241,000 barrels of oil.

Tooele.—Although increased output was reported for nine of the 13 commodities, produced in the county, total value declined 2 percent because of decreased production of potassium salts by Bonneville, Ltd., Division, Kaiser Aluminum & Chemical Corp. Leading commodities in decreasing order of output value were lime, salt, lead, stone, zinc, and sand and gravel. Magnesium chloride for magnesium metal was produced for the first time in Utah, by Bonneville, Ltd.

The county was ranked first in the State in output of lime and salt; lime was produced by two companies and salt by three. Pyrite concentrate was shipped from a stockpile by IS&R.

Most of the gold, silver, copper, lead, and zinc came from the Ophir mine of USSR&M Co. (McFarland & Hullinger, lessee). Other appreciable production of the metals came from the Tooele cold-slag dump of IS&R, the Argent mine of Silver Eagle Mining & Milling Co., and the Wandering Jew mine of Canyon Exploration Co.

Sand and gravel from eight operations was used mainly in paving and building.

Stone produced by The Flintkote Co., Utah Calcium Co., Inc., and Utah Marblehead Lime Co. was used chiefly in the production of lime and as a refractory (dolomite).

Solar-evaporated salt was produced by Hardy Salt Co., Solar Salt Co., and Utah Salt Co. Hardy Salt Co. constructed two 41-acre, salt-evaporation ponds at its Lake Point operation: Each of the ponds was to yield from 20,000 to 25,000 tons of salt annually.

Uintah.—The county was ranked first in gilsonite production and second in natural gas, natural gasoline, petroleum, LP gases, and phosphate-rock production.

All these commodities had declines in production except natural gasoline and phosphate rock. Although total mineral output value decreased by 4 percent, to $29.6 million, the county was ranked third in the State. Although decreasing in value, petroleum continued as the leading commodity, representing 66 percent of the total output value. Gilsonite, natural gas, and phosphate rock followed in order of output value.

Largest decreases occurred in gilsonite and natural gas, and stone production. Phosphate rock production value increased substantially; natural gasoline production increased slightly. Output of phosphate rock came entirely from the Vernal mine of San Francisco Chemical Co.

Exploratory drilling for oil and gas re-

sulted in a small gas discovery in the Red Wash area; however, the county led in development drilling with 46 wells of which 42 were successful.

Sand and gravel produced from five operations was used mainly for road construction.

Utah.—Total mineral output value increased nearly threefold to $14.9 million, ranking the county fifth in the State. Four commodities, lead most notably, had greater output values than stone, the leader in 1965. All of the gold, silver, copper, lead, and zinc was produced from the Burgin mine of the Tintic Division of Kennecott Copper Corp. Although quantity and value increased for each of the five metals, the largest increases in output value were made in lead, silver, and zinc.

Sand and gravel output value, amounting to $1.9 million, increased threefold. Production, from 23 sand and gravel operations, was used chiefly in road construction.

Stone (crushed limestone) was produced mostly by USS for use as a flux in manufacturing steel. Lakeside Lime & Stone Co. produced lime for construction, agricultural, chemical, and other industrial uses.

Wasatch.—Metals comprised more than 99 percent of the total value of mineral production in the county. The nearly $7 million in total value in 1966 represented a 32-percent increase over 1965. Production of each of the metals (gold, silver, copper, lead, and zinc)) increased. Sand and gravel and stone production decreased.

Gold, followed closely by lead and zinc, headed the metals in output value. Metals came chiefly from the Mayflower mine of Hecla Mining Co.; the only other producer was United Park City Mines Co. at its United Park City mine (major production from this mine was in Summit County).

Washington.—Utah's oldest oilfield, the Virgin field, yielded oil for the first time since 1961; total output for the year was 961 barrels. Production had been intermittent.

Weber.—The value of sand and gravel output increased, while stone and clay production value decreased 66 and 48 percent respectively, resulting in an overall 9-percent decline in the value of county mineral production. Sand and gravel from 13 operations was used in paving, building, and for fill. Stone (sandstone and miscellaneous) from four operations was used as riprap.

The Mineral Industry of Vermont

By Harold F. York [1]

The production of minerals in Vermont declined during 1966. Valued at $25.9 million, production was 5 percent less than that of 1965—the year of highest reported output. The loss was entirely in the value of stone output which accounted for 77 percent of the total mineral production, and was only partially offset by increases in the value of asbestos, sand and gravel, talc, clay, and peat. The production of sand and gravel and clay both reached record highs. Output of lime has been steady for the past 3 years, but has shown no indication of returning to the highs reached in the late 1940's and early 1950's. The value of talc has continued to climb from the low of 1954, but is still only slightly more than one-half of the record year, 1948. Asbestos production increased for the third consecutive year, but still remains below the record year of 1952.

[1] Geologist, Bureau of Mines, Pittsburgh, Pa.

Table 1.—Mineral production in Vermont [1]

Mineral	1965		1966	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Peat	780	$3	333	$5
Sand and gravel	2,084,000	1,670	2,323,000	1,744
Stone	2,591,178	21,564	2,649,716	19,926
Value of items that cannot be disclosed: Asbestos, clays, gem stones, lime, and talc	XX	4,155	XX	4,235
Total	XX	27,392	XX	25,910

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]	Year	Value [1]
1957	$21,930	1962	$24,614
1958	21,497	1963	23,919
1959	23,099	1964	25,542
1960	22,309	1965	27,108
1961	23,846	1966	[p] 25,364

[p] Preliminary.
[1] Data for 1957–65 revised.

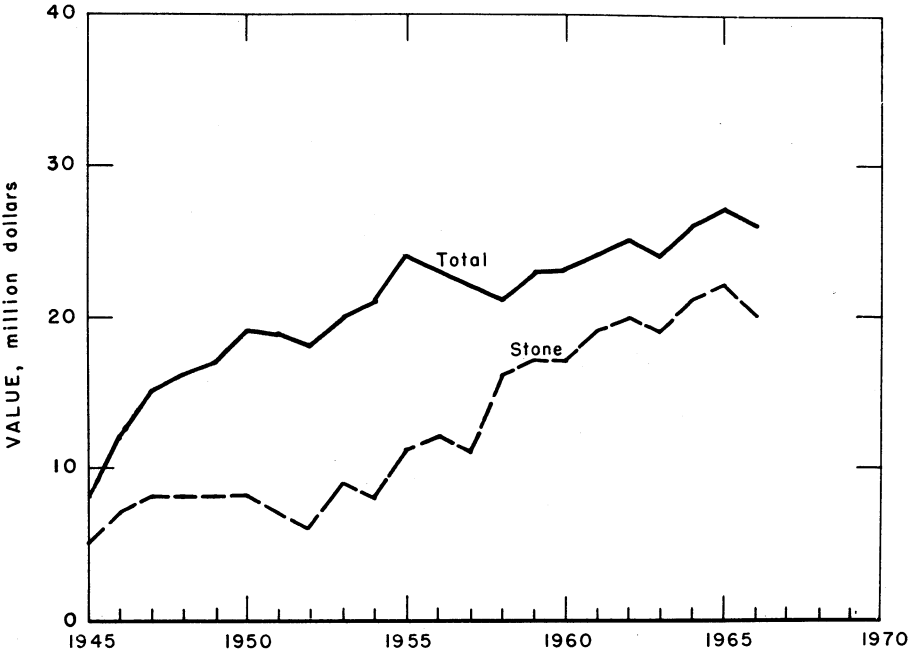

Figure 1.—Value of stone and total value of mineral production in Vermont.

Table 3.—Employment 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
1965:								
Nonmetal and peat	324	273	88	713	---	22	30.85	8,927
Sand and gravel	221	195	43	355	---	5	14.08	803
Stone	1,813	251	455	3,707	1	131	35.61	2,981
Total	2,358	249	586	4,775	1	158	33.30	3,707
1966: p								
Nonmetal and peat	310	277	86	693	---	16	23.09	1,042
Sand and gravel	210	189	39	327	---	8	24.46	554
Stone	1,875	254	476	3,914	---	136	34.75	1,339
Total	2,395	251	601	4,934	---	160	32.43	1,245

p Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Asbestos.—The output of asbestos from Orleans County increased slightly over the 1965 production, both in quantity and value. The average price per ton increased from $89.72 in 1965 to $90.54 in 1966. The Ruberoid Co., Vermont Asbestos Mines Division, produced chrysotile asbestos at Lowell. Twenty-four grades were produced for spinning, cement stock, paper stock, and other uses. Some serpentine waste rock was used for roadstone.

Clays.—Clays sold by producers in Vermont advanced 7 percent over the 1965 value, reaching a record high. In Addison County, the Vermont Kaolin Corp. produced kaolin for use in floor and wall tile, refractories, rubber, and other filler.

The Densmore Brick Co., Essex Junction, Chittenden County, produced and processed clay for manufacturing building brick.

Gem Stones.—Commercial dealers, hobbyists, and gem-collecting societies collected specimens of garnet, graphite, jasper, talc, and a variety of gem materials and other mineral specimens at various locations within the State.

Lime.—Hydrated lime was produced in Addison County for use in construction and by the chemical industry. Quicklime produced in Chittenden County was used mostly by the chemical and paper industries. Production during 1966 was about the same as in 1965, and was mostly from Chittenden County.

Mica, Reconstituted.—The Samica Corp. (subsidiary of Minnesota Mining & Manufacturing Co.) at Rutland, continued to manufacture this sheet material, using papermaking procedures. Made from specially delaminated natural mica scrap, this material replaces built-up mica in many applications, principally electrical insulation.

Peat.—During 1966, the value of peat production was almost twice that of the previous year. Reed sedge was the principal kind of peat produced and was used for general soil improvement. Reed sedge peat sold in bulk for an average of $13.08 per ton, while the packaged material was priced at an average of $21.36 per ton. Humus peat was sold in both bulk and package for potting soil and for general soil improvement. Bulk humus peat sold for $14.56 per ton; packaged material sold for $21.00 per ton, average.

Sand and Gravel.—Output of sand and gravel was 2.3 million tons, valued at $1.74 million, compared with 2.1 million tons and $1.67 million in 1965. Highway construction continued at an accelerated rate as indicated by the increased tonnages used by the State Highway Department. The average price per ton was $0.75, down $0.05 per ton from 1965.

Of all the sand and gravel produced, 20 percent was used for building, 72 percent for paving, 7 percent for fill, and the remainder for other purposes, including ice control and engine sand. Forty percent of the sand and gravel production was processed by washing and screening. Average price per ton of processed material was $1.31, compared with $1.38 in 1965.

Table 4.—Sand and gravel production by Government-and-contractor operations, by counties

(Thousand short tons)

County	1965	1966
Addison	44	---
Bennington	4	66
Chittenden	95	9
Essex	---	64
Franklin	166	89
Grand Isle	---	1
Lamoille	---	81
Orange	9	---
Orleans	50	50
Rutland	28	38
Washington	28	2
Windham	37	53
Windsor	206	644
Total	667	1,097

Twenty-six commercial operations reported production during 1966. Two operations produced over 100,000 tons, but less than 200,000 tons. Nine operators produced over 50,000 tons, 7 produced over 25,000 tons, and 8 produced less than 25,000 tons. Eleven operations accounted for 67 percent of the total commercial production.

Production was reported from each of the 14 counties. Windsor County led the State in production which, combined with that of Bennington County, was in excess of 1 million tons. Franklin and Washington Counties each produced over 150,000 tons. The following counties produced in excess of 100,000 tons: Addison, Caledonia, Lamoille, Orleans, and Windham.

Stone.—The output of stone remained at 2.6 million tons but value dropped to $19.9 million, $1.7 million less than 1965 because of a greater proportion of crushed stone in the total output. Granite and marble led in value of output followed by limestone, slate, and miscellaneous stone. In terms of value, Rutland was the leading producing county, followed by Washington, Windsor, Orange, Franklin, and Chittenden Counties.

Dimension granite's chief use was for monuments and for architectural purposes. Some was used for construction purposes, rubble, curbing and flagging. Crushed and broken granite was used for concrete aggregate and roadstone. Compared with 1965, granite production decreased 34 percent in quantity and 4 percent in value. Washington County led in production, followed by Orange County.

Rutland, Franklin and Chittenden Counties, in order of decreasing output, pro-

duced 668,000 tons of limestone valued at $3.2 million. Whiting, one of the principal uses for limestone, was used in the manufacture of paint and rubber filler, plastics, roofing, flooring, calking, chewing gum, fabrics, abrasives, gypsum, pottery, and miscellaneous other uses, including chemicals. Additional crushed limestone was used for concrete aggregate and roadstone, agricultural purposes, for riprap, and in the manufacture of paper, and as mineral food to supplement the calcium intake of dairy cows and hens. The Vermont Associated Lime Industries, Inc., limestone quarry in Addison County was idle during the year.

The output of marble more than doubled in tonnage, but declined 19 percent in value, reflecting an increase in the production of crushed marble and a decline in dimension stone. Rutland and Windsor Counties produced both dimension and crushed marble with Rutland County leading in both types. Most of the marble produced was cut and sawed for use as architectural stone. A large amount was also processed as dressed monumental stone. The average unit price per ton of dimension marble increased over that of 1965. Crushed marble which was used for flagging, chips, and for miscellaneous purposes was priced lower than in 1965.

The value of slate production was only slightly less than in 1965. Seventeen operators produced over 39,000 tons of dimension slate, valued at $2.6 million for flagging, and for structural and sanitary purposes. Although slate roofs are less common than in previous years, considerable dimension slate is still produced for this purpose, frequently to repair existing slate roofs. Slate was produced for floor tile and distinctive patio stones, in addition to that for use in electrical panels. Two operators produced crushed and broken slate for use as lightweight aggregate. Some sculpings and slate flagging were exported to Canada. All the slate production in Vermont was in Rutland County.

Almost 1.6 million tons of miscellaneous crushed stone for use in highway construction was produced by the Vermont Highway Department from operations in Bennington, Essex, Lamoille, Orleans, and Windsor Counties.

Talc.—Windsor County was the principal producer of talc in Vermont, followed by Lamoille and Windham Counties. Compared with 1965, tonnage increased less than 1 percent while value increased almost 5 percent. The Eastern Magnesia Talc Co., Inc., and the Vermont Talc Co. operated three mines for the production of crude talc for grinding and subsequent use in the manufacture of roofing, paper, toilet preparations, paint, insecticides, plastics, and textiles. Additional small amounts of talc were used for foundry facings and other purposes. The labor shortage reported to exist in 1965 was alleviated through a general wage increase.

REVIEW BY COUNTIES

Addison.—Sand and gravel was the most important mineral commodity produced in the county during 1966, followed by clay and lime. Valued at $124,000, the mineral output was less than 1 percent of the State total. The Champlain Construction Co., Middlebury, produced bank-run sand and gravel for building and fill purposes, and sand for paving. J. P. Carrara & Sons, Inc. also at Middlebury produced both processed and unprocessed sand and gravel. Washed and screened material was used for building and paving. Bank-run sand was used for fill purposes. Roy P. Shackett, Leicester, produced bank-run gravel for paving and fill.

The Vermont Kaolin Corp. produced kaolin from its open pit mine at Bristol. The operation was idle the latter part of 1966, and was purchased by the White Pigment Corp. of Proctor. Operations are expected to resume in late 1967.

At its New Haven plant, Vermont Associated Lime Industries, Inc., produced hydrated lime for construction and chemical and industrial purposes including paper filler, sewage treatment and water softening and purification.

Bennington.—Sand and gravel and stone were the only mineral commodities produced. Total value was $388,000. Sand and gravel output of 411,000 tons was 18 percent greater than it was in 1965, but the county remained in second place in production of this commodity in the State. At Shaftsbury, William E. Dailey, Jr. pro-

Table 5.—Value of mineral production in Vermont, by counties

County	1965	1966	Minerals produced in 1966 in order of value
Addison	$132,437	$123,700	Sand and gravel, clay, lime.
Bennington	W	388,065	Sand and gravel, stone.
Caledonia	W	W	Do.
Chittenden	1,294,618	W	Stone, sand and gravel, lime, clay.
Essex	-----	35,020	Sand and gravel, stone.
Franklin	W	W	Stone, sand and gravel.
Grand Isle	W	1,000	Sand and gravel.
Lamoille	W	W	Talc, sand and gravel, stone.
Orange	W	W	Stone, sand and gravel.
Orleans	W	W	Asbestos, sand and gravel, stone.
Rutland	11,404,577	W	Stone, sand and gravel.
Washington	W	W	Do.
Windham	146,000	161,984	Sand and gravel, talc, stone.
Windsor	2,084,203	W	Stone, sand and gravel, talc, peat.
Undistributed	12,330,397	25,199,886	
Total	27,392,000	25,910,000	

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

duced sand and gravel for construction purposes and sand for paving, all of which was processed by washing and screening. Some unprocessed gravel was used for fill. At its Manchester pit, the company produced building sand and gravel, paving sand, and unprocessed gravel for fill purposes. G & H Sand & Gravel Co., Inc., at Manchester Depot produced sand for building purposes, and gravel for paving and fill. The Vermont State Highway Department produced paving gravel, and also produced quartzite and other miscellaneous stone for concrete aggregate and roadstone.

Caledonia.—The Caledonia Sand & Gravel Co., Inc. St. Johnsbury, washed and screened sand and gravel for paving. Lawrence Sangravco, Inc., also at St. Johnsbury, processed sand and gravel for building and paving purposes at its pit at Guild Hall. The Vermont State Highway Department produced crushed granite for concrete aggregate and roadstone.

Chittenden.—The value of mineral production in Chittenden County was significantly less than the $1.3 million of 1965. Sand and gravel and stone, the principal commodities, both declined. The L. A. Demers Crushed Rock Co. produced crushed limestone at Colchester for use in concrete aggregate and road stone. At Winooski, the Vermont Associated Lime Industries, Inc., quarried and crushed limestone for agricultural purposes, and for the manufacture of quicklime for the paper industry. The Vermont Highway Department produced crushed limestone for concrete aggregate and roadstone.

At Burlington, W. C. Kirby, Contractor, processed sand and gravel for construction purposes, and gravel for paving. Bank run material was produced for fill purposes. The Hinesburg Sand & Gravel Co., Hinesburg, processed sand and gravel for paving. Campbell Construction, Inc., Williston, produced unprocessed sand for building purposes, and for fill. Ralph B. Goodrich, Inc., South Burlington, was idle during the year.

The Densmore Brick Co. produced clay for the manufacture of building brick at Essex Junction. The Kleen-Moss Co., Inc., Williston, did not produce peat during the year.

Essex.—The Vermont Highway Department produced sand and gravel for paving, and miscellaneous stone for concrete aggregate and roadstone.

Franklin.—Stone was the principal commodity produced, and with sand and gravel, comprised the entire mineral output. The value of stone produced was 20 percent less than in 1965. The Swanton Lime Works, Inc., produced crushed limestone for use as riprap, concrete aggregate and roadstone, agricultural purposes, and for other purposes including mineral food, terrazzo, and for use in paper mills. The State Highway Department produced crushed limestone for riprap, and concrete aggregate and roadstone.

The value of the output of sand and gravel declined 42 percent from that of 1965. The A. G. Anderson Co., Inc. at Highgate produced processed sand for building purposes and bank-run sand for

fill. Some washed and screened engine sand was also produced. At Swanton, Ray Dubois produced bank run material for paving. The Vermont Highway Department produced both processed and bank run sand and gravel for paving.

Grand Isle.—The Vermont State Highway Department washed and screened sand for paving. There was no production of stone during the year.

Lamoille.—Mineral production in the county increased 13 percent in value as a 2-percent decline in the value of talc production was more than offset by an increased output of sand and gravel, and stone for use in highway construction.

At the company's Johnson and Hammondsville mines, the Eastern Magnesia Talc Co., Inc., produced crude talc for grinding and subsequent use as filler in roofing, toilet preparations, paper, plastics, rubber, insecticides, textiles, and for other industrial purposes.

Kenneth Farr produced sand and gravel for building and paving from a pit near Morrisville. Albert S. Nadeau, at Johnson, washed and screened sand and gravel for construction purposes and paving. The State Highway Department produced sand and gravel, crushed granite, and other miscellaneous stone for use as concrete aggregate and roadstone.

Orange.—The value of mineral production increased slightly as the value of increased stone output was in excess of the decline in sand and gravel. The Rock of Ages Corp. (Pirie Division) quarried rough granite for monuments at Williamstown. The Levi Lemieux Gravel Pit at Williamstown produced bank run sand and gravel for fill. Willard B. Martin also recovered bank run gravel for paving at East Corinth. The Caledonia Sand & Gravel Co. pit at Ryegate was inactive.

Orleans.—Mineral production increased almost 4 percent in value over that of 1965. The output of asbestos was up slightly and more sand and gravel and stone were produced.

Vermont Asbestos Mines, Division of The Ruberoid Co., quarried and processed chrysotile asbestos at its quarry and mill located at Lowell. For its outstanding safety record in 1966, The Ruberoid Co. was awarded the Certificate of Achievement in safety. In the Quarry Group, the company compiled a total of 132,918 man-hours worked without a disabling injury.

At Danville, Howard G. Calkins produced both washed and screened and bank-run sand and gravel for building and paving. The Vermont State Highway Department also produced sand and gravel for paving purposes. Nationwide Granite Industries, Inc., formerly Irio Bianchi, recovered rough dimension granite for construction purposes.

Rutland.—Rutland County lead the State in value of minerals produced even though production declined 12 percent during 1966. Stone production consisting of marble, slate, and limestone, decreased 12 percent in value, while the value of sand and gravel output increased 20 percent over that of 1965.

At West Rutland, Green Mountain Marble Division of Georgia Marble Co. produced dressed cut dimension stone for use as both interior and exterior building stone, and for use in monuments, gravestones, and mausoleums. Exploration and development continued at the company's Meadow Quarry, also at West Rutland. The Vermont Marble Co., Proctor, produced both dimension and crushed marble operating five quarries, three mills, and two finishing plants. Rough dimension stone was produced for interior and exterior building purposes. Dressed dimension stone, sawed and cut, was processed for interior and exterior building, and for monuments. The firm also processed other stone types including travertine, labradonite, verde antique, and granite. Crushed and broken marble was produced for use as chips, flagging, and other miscellaneous purposes.

Eighteen operators produced slate during 1966, all within Rutland County. Dimension slate accounted for 61 percent of the tonnage and 95 percent of the value. Among the principal producers were the Vermont Structural Slate Co., Inc. Fair Haven, with quarries at Poultney and Fair Haven. The Fair Haven Slate Co., Inc. operated two quarries, both at Fair Haven. At Poultney, dimension slate was quarried by Green Mountain Slate Corp., Mike Taran, and Rising and Nelson Slate Co., Inc. The latter firm also operated quarries at Pawlet and West Pawlet. The John G. Hadeka quarry is at North Poultney. Hilltop Slate Co. of Middle Granville, N.Y., operated the quarry at Wells. Somich Bros.,

Granville, N.Y., produced slate at Pawlet. At Castleton, the Vermont Light Aggregate Corp. produced expanded slate for aggregate purposes.

The Vermarco Lime Co., West Rutland, produced crushed limestone at its Loveland quarry near Florence for use in concrete aggregate, roadstone, and for agricultural purposes. At its South Wallingford quarry, the White Pigment Corp., Proctor, quarried and crushed limestone for use primarily as filler in paint, rubber, flooring, plastics, and calking, and for other uses.

J. P. Carrara & Sons, Inc., processed sand and gravel for building and paving purposes. Some bank-run sand was used for fill. Unprocessed sand and gravel was produced for highway construction.

Washington.—Total mineral production was 10 percent less because of reduced output of sand and gravel and stone, but the county retained second place in the State for total value of minerals produced.

The output of dimension granite declined but more crushed granite was produced. Production of crushed granite for highway construction however decreased. Kelley Construction, Inc., subsidiary of Wells-Lamson Quarry Co., Inc. crushed granite for concrete aggregate and roadstone. Garand-Teed Quarries, Inc., Adamant, quarried rough dimension granite mainly for monuments and mausoleums. Rock of Ages Corp. at Barre, produced rough dimension stone, principally for monuments and mausoleums, from its quarries at Graniteville and Websterville. Some rough granite was produced at both quarries for architectural work. At the firm's E. L. Smith quarry, Graniteville, dressed granite was produced for curbing. The Wells-Lamson Quarry Co., Barre, recovered rough granite from its quarry at Websterville for monuments and mausoleums. Woodbury Quarries, Inc. mined granite at Woodbury for construction purposes. Dressed granite was fabricated for architectural work at the John Swenson Granite Co. The plant and parent company are located at Concord, N.H.

The Le Page Gravel Pit at South Barre produced bank-run sand and gravel for paving and fill. A. King's Pit, also at South Barre, produced bank-run sand and gravel for paving, and gravel for building and fill purposes. The Caledonia Sand & Gravel Co., Inc. of St. Johnsbury processed paving sand and gravel at its Plainfield pit.

Windham.—The mineral output of Windham County increased 11 percent over that of 1965. Brattleboro Sand & Gravel, Inc., Brattleboro, produced sand and gravel for building and paving. The Vermont State Highway Department produced mostly bank-run sand and gravel for paving. At Windham, the Vermont Talc Co. mined crude talc for grinding at its Chester plant.

Crushed granite was produced by the State Highway Department for concrete aggregate and roadstone.

Windsor.—Windsor County ranked third in mineral production during 1966. The value of the total output was 83 percent greater than in 1965, primarily because of increased output of stone, although production of sand and gravel and talc also increased, and the value of peat output almost doubled.

The Vermont Marble Co. quarried dimension marble at its Rochester quarry, for chips and flagging. At its Bethel quarry, the Rock of Ages Corp. recovered rough dimension granite for architectural work and for rubble. Miscellaneous stone was produced for concrete aggregate and roadstone by the State Highway Department.

Sharon Sand & Gravel Co., Inc. produced sand and gravel for building and paving at a pit near Sharon. The Hume Pipe Corp. recovered sand at Windsor for the manufacture of concrete pipe. Both processed and unprocessed sand and gravel was produced for the State highway construction program.

The Eastern Magnesia Talc Co., Inc., ground talc at its plant in Reading.

At Hartland, King's Pine Peat (Jack Comstock) recovered humus peat for general soil improvement and for potting soil. The output was sold both packaged and in bulk. Kirk's Green Mountain Peat, at Barnard, produced reed-sedge peat, both packaged and in bulk.

The Mineral Industry of Virginia

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

By David J. Kusler,[1] and James L. Calver [2]

A record-breaking output of coal more than offset value declines in other mineral commodities, so that the total value of 1966 mineral output in Virginia rose to a new high of $274 million, 2 percent greater than in 1965, the previous record high value year. About than two-fifths of the mineral commodities gained in value compared with a gain in value for over four-fifths in 1965. Slackened construction activity, particularly in residential housing and certain phases of highway construction, was reflected in decreased production of stone, cement, and gypsum. Of the total value of mineral production in Virginia 56 percent was contributed by fuels (52 percent in 1965), 41 percent by nonmetals (45 percent in 1965), and 3 percent by metals (3 percent in 1965).

Trends and Developments.—Virginia Electric and Power Co. reportedly will construct nuclear generating facilities at the Surry powerplant on the James River in Surry County. Two nuclear units are planned with a capability of approximately 800,000 kilowatts per unit; both units will be of the pressurized water reactor type.

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Table 1.—Mineral production in Virginia [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	1,415	$1,657	1,486	$1,813
Coal (bituminous)—do	34,053	139,291	35,565	153,341
Gem stones	NA	7	NA	7
Lead (recoverable content of ores, etc.)—short tons	3,651	1,139	3,078	930
Lime—thousand short tons	847	10,584	840	10,486
Natural gas—million cubic feet	3,152	942	4,249	1,275
Petroleum (crude)—thousand 42-gallon barrels	4	W	1	W
Sand and gravel—thousand short tons	15,322	18,019	17,191	16,635
Soapstone—short tons	3,549	9	3,989	10
Stone—thousand short tons	36,350	59,397	34,151	55,550
Zinc (recoverable content of ores, etc.) [2]—short tons	20,491	5,942	17,666	5,123
Value of items that cannot be disclosed: Aplite, portland cement, masonry cement, feldspar, gypsum, iron ore (pigment material), kyanite, salt, titanium concentrate (ilmenite and rutile), and values indicated by symbol W	XX	30,990	XX	29,127
Total	XX	267,977	XX	274,297

NA Not available. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed."
XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] 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.

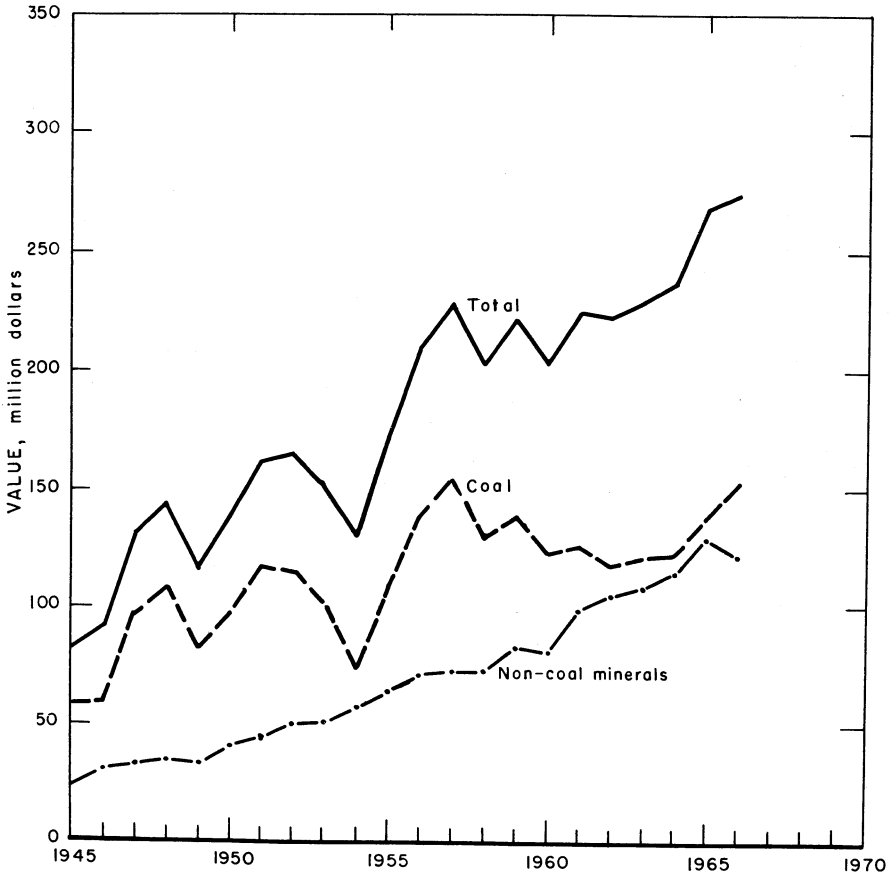

Figure 1.—Value of all minerals except coal, value of coal, and total value of all mineral production in Virginia.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Millions)

Year	Value [1]	Year	Value [1]
1957	$223	1962	232
1958	205	1963	241
1959	231	1964	247
1960	213	1965	280
1961	233	1966	[p] 283

[p] Preliminary.
[1] Data for 1960–65 revised.

Table 3.—Employment and injury experience in the mineral industries

Year and industry	Average men working daily	Days active (thousands)	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Frequency	Severity
1965:								
Coal	11,195	201	2,248	17,914	25	958	54.87	11,722
Metal	301	261	79	629	---	35	55.61	1,447
Nonmetal	688	276	190	1,531	---	47	30.71	891
Sand and gravel	629	227	143	1,197	---	31	25.91	486
Stone	4,172	263	1,096	9,052	2	216	24.08	2,050
Total	16,985	221	3,756	30,323	27	1,287	43.33	7,631
1966: p								
Coal	11,185	199	2,222	18,180	30	995	56.38	13,349
Metal	335	268	89	714	---	30	42.02	1,979
Nonmetal	665	274	182	1,457	---	47	32.26	879
Sand and gravel	610	250	153	1,366	---	31	22.69	450
Stone	4,295	271	1,162	9,626	---	194	20.15	725
Total	17,090	223	3,808	31,343	30	1,297	42.34	8,071

p Preliminary.

Construction is scheduled to begin in 1967, with completion expected in 1971.

Deepening of the Norfolk Harbor channel would mean an increase of up to 5 million tons in exports over the next 5 years, according to a prediction by Secretary of the Interior Stewart L. Udall. He also believes that the use of this major Virginia port by big coal-carrying supercarriers will mean a reduction in the delivered cost of coal abroad and will encourage export of this mineral commodity. About a $30 million output of coal mined in the Southern Appalachian area moves overseas through Norfolk every year.

The new transloading facility of General Coal Company at Appalachia, Virginia, became operative in late 1966, and is described in a recent publication.[3] In the immediate area served by the new facility there is no single mine having the capacity or fast loading ability to participate alone in unit train movement, but this transloading operation enables several mines to pool their capabilities and in so doing benefit economically. Coal is shipped to the transloader on an intransit freight rate, rotary dumped, stored in silos, and then reloaded rapidly into 6,000- and 10,000-ton unit trains. The over-all result is reduced delivered costs.

Various minerals, including gold, pyrite, pyrrhotite, copper, zinc, lead, arsenic, nickel, tin, tungsten, and barite occur in Virginia. A recently published report describes 496 mines and prospects and shows their location on an index map.[4] Most of the deposits were explored and mined many years ago and the source material used in this compilation dates back to 1837.

Development work preparatory to construction of a new mine by Island Creek Coal Co. has been started in the company's reserves of Pocahontas coal located in Buchanan County. The new mine is the third to be developed in these coal reserves which have been estimated to exceed half a billion tons of low-volatile coal. The first mine, the Beatrice Pocahontas mine, a joint venture with Republic Steel Corp., is one of the deepest coal mines in North America, but will be exceeded in depth by the newest mine. A second mine (the Virginia Pocahontas No. 1), started in mid-1965, is expected to be initially productive in late 1967; the third mine, the Virginia Pocahontas No. 2, is scheduled to begin production late in 1968 and achieve its full capacity of 2 million tons annually in 1971.

Output of lime, and consequently limestone, will increase as a result of expansion and modernization programs at several large lime producers in Virginia. Foote Mineral Co. is developing a second underground limestone mine at Kimballton, Giles County, with production expected in 1967. The output will be used in the company's adjacent lime plant. Production of lime will be substantially increased when a new kiln becomes operational in 1967. National Gypsum Co.'s Kimballton lime plant and limestone mine also is undergoing expansion. New facilities will include addi-

[3] Meador, Harry W., Jr. Transloading of Coal for Unit Trains. Min. Cong. J., May 1967, pp. 41–43.

[4] Luttrell, Gwendolyn W. Base and Precious Metal and Related Ore Deposits of Virginia. Virginia Div. Miner. Res. (Charlottesville, Va.), Miner, Res. Rept. 7, 1966, 167 pp.

tional mining and crushing equipment, an additional kiln (the third), and a complete dust-collecting system. Present capacity is expected to be almost doubled when the changes are completed. Olin-Mathieson Chemical Corp. began improvements at its Saltville Chemical complex in Smyth County. Included in the scheduled modernization, to be completed in 1968, are changes in soda-ash and lime production facilities to enable increased output of both products.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Spurred by the ever increasing demand for electrical energy, output of coal increased in five of the eight coal-producing counties and rose to 36 million short tons—4 percent more than in 1965, the previous record year. The value of mine output increased 10 percent over that of 1965; the greater than proportional value increase was due to a 5-percent rise in average value per ton ($4.31) in 1966 over the $4.09 in 1965. The total value ($153 million) was less than 1 percent lower than the $154 million reported in the peak value year, 1957. Production data includes coal produced from deposits within Virginia, whether the mine opening is or is not inside the State boundary and excludes operations producing less than 1,000 tons per year. Consequently, production data published by the Federal Bureau of Mines may differ somewhat from data published by the State.

Both high- and low-volatile bituminous coals were produced as well as a small quantity of semianthracite coal mined in Montgomery County. Of Virginia's coal tonnage 46 percent was produced in one county, Buchanan; where 62 percent of the State's coal mines were located. Four of the eight southwestern counties in which coal was mined—Buchanan, Dickenson, Russell, and Wise—accounted for 98 percent of the total output, compared with 97 percent in 1965.

Virginia's recordbreaking coal production was accomplished with 139 fewer mines of all types than in 1965. Underground production comprised 84 percent of the total output, 2 percent less than in 1965, but almost 400,000 additional tons of coal was mined with 151 fewer underground mines than the 1,153 active in 1965. The number of strip and auger mines rose to 65 and 65, respectively, compared with 56 and 62 in 1965. Of the total underground output, 67 percent was mechanically loaded, 10 percent higher than in 1965, 22 percent higher than in 1964, and 23 percent higher than in 1963. These increases reflect the trend toward modernization and mechanization in underground mining in Virginia.

A total of 265 mobile loading machines (88 more than in 1965) accounted for 59 percent of the mechanically loaded tonnage; 80 continuous mining machines (24 more than in 1965) accounted for 40 percent, and handloaded face conveyors accounted for the remaining 1 percent. Of the total coal mined, 49 percent was mechanically cleaned in 36 plants (three more than in 1965). Wet washing other than

Table 4.—Coal (bituminous) production and value, by counties

(Thousand short tons and thousand dollars)

County	1965		1966	
	Quantity	Value [1]	Quantity	Value [1]
Buchanan	15,291	$59,989	16,288	$67,344
Dickenson	8,835	37,604	9,339	40,010
Lee	499	2,157	433	2,016
Montgomery [2]	W	W	2	10
Russell	1,737	9,045	1,917	10,374
Scott	W	W	11	48
Tazewell	401	1,237	244	874
Wise	7,280	29,211	7,331	32,665
Undistributed [3]	10	48	-----	-----
Total	34,053	139,291	35,565	153,341

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

[1] Value received or charged for coal, f.o.b. mine, including selling cost. (Includes value for coal not sold but used by producer, such as mine fuel, and coal coked as estimated by producer at average prices that might have been received if such coal had been sold commercially).

[2] Semianthracite coal; quantity and value included in bituminous coal total.

[3] Includes data indicated by symbol W.

with jigs was the principal method of cleaning, accounting for 76 percent of the cleaned coal. Of the cleaned coal 44 percent was thermally dried. Of the total coal mined 38 percent was crushed. Of the total coal produced 15 percent was treated with dust-allaying and anti-freezing preparations, of which oil predominated (99 percent).

Coke.—Beehive coke was produced in six plants (five companies); one in Buchanan County and five in Wise County. There were 772 bee-hive ovens operational, 13 more than in 1965 of which 390 were rectangular- or horizontal-bed internal-combustion ovens. Machine drawn ovens numbered 650 and the number of hand-drawn ovens was 122. There were no slot ovens operated and no byproduct recovery was made. Production of coke was about 17 percent greater than in 1965, and the average value per ton increased $0.28 to $15.56 in 1966.

Petroleum and Natural Gas.—Natural gas production data in table 1 are reported to the Bureau of Mines by pipeline companies and are comparable with other State chapter data, although not necessarily with data reported by State agencies. Tazewell County led in output, accounting for 64 percent of the production reported by the State (58 percent in 1965); Buchanan and Dickenson produced 25 and 11 percent, respectively (28 and 14 percent, respectively, in 1965). Gas wells in the Berea (Mississippian) Sandstone produced 2,732 million cubic feet of gas in Tazewell County; producers were Consolidation Coal Co. and United Fuel Gas Co. Principal producers in Buchanan County were Ashland Oil & Refining Co., P & S Oil and Gas Corp., Cabot Corp., and United Fuel Gas Co., and the total county output was 1,071 million cubic feet. In Dickinson County Clinchfield Coal Co., Division of the Pittston Co., operated 41 gas wells producing 447 million cubic feet of gas during the first 10 months of 1966; there was no production during November and December because of a labor dispute in eastern Kentucky where the gas is marketed.[5] At the end of the year the American Gas Association estimated natural gas reserves in Virginia to be 37,586 million cubic feet—5,110 million cubic feet more than the estimate a year previous. During the year there were 104 producing gas wells compared with 99 in 1965, according to the Virginia Division of Mines and Quarries. Two gas wells were completed in 1966, one each in Buchanan and Tazewell Counties according to the American Association of Petroleum Geologists. The output of natural gas from Buchanan and Tazewell Counties was delivered to the pipelines of Consolidated Gas Supply Corp. and the Atlantic Seaboard Line; production from Dickenson County was delivered to the lines of the Kentucky-West Virginia Gas Co. Washington Gas Light Co. operated liquefied petroleum (LP) gas storage facilities in Fairfax County. Storage capacity in a mined cavity (granite) for propane was rated at 300,000 barrels.

The output of crude oil was 1,073 barrels, 2,544 barrels less than the 1965 production and 4,755 less than that of 1964. All the production was in Lee County. Five wells in the Rose Hill field produced 737 barrels and one well in the Ben Hur field produced 336 barrels. In the latter oil field, two new wells were started late in 1966. Three drill site locations have been made in the Ben Hur field for possible drilling in 1967.

At Yorktown (Goodwin Neck), The American Oil Co. operated a refinery with a crude oil capacity of 34,700 barrels per calendar day (as of January 1, 1966). Catalytic cracking and catalytic reforming capacity was 23,077 barrels and 7,300 barrels per day, respectively. Coking capacity was 13,730 barrels per day. Total daily gasoline output capacity was 21,920 barrels. Also at Yorktown, the American Oil Co. had under construction additional refining facilities with a crude oil distillation capacity of 4,300 barrels per day and catalytic reforming capacity of 500 barrels per day.

NONMETALS

Aplite.—Continuing an increasing trend, output and value of aplite were greater than in 1965. Production, chiefly for use in glass manufacture, was from Hanover and Nelson Counties.

Cement.—Shipments and total value of portland cement decreased 5 percent and 10 percent, respectively; the greater than proportional value decline due to a unit value $0.18 lower than in 1965. Masonry cement shipments declined by almost one-tenth, but the total value was moderately

[5] American Association of Petroleum Geologists Bulletin. V. 51/6, pt. 2, June 1967, pp. 1005–1006.

higher owing to a substantial increase in unit value in 1966. Portland cement plant capacity remained virtually unchanged during the year. Four plants manufactured cement; two made both portland and masonry cement, one made only portland, and one plant produced only masonry cement. The wet process of manufacturing portland cement was used by one plant, and two plants used the dry process. The cement was produced in Augusta, Botetourt, and Warren Counties and the city of Chesapeake.

The producers mined limestone, shale, clay, and calcareous marl for their own use. Materials purchased for use in cement manufacture included sand, oystershell, mill scale, various air-entraining compounds and a variety of grinding aids. Over four-fifths of the electrical energy used was purchased.

Types I and II (general use and moderate heat types) comprised the bulk of portland cement produced and marketed; a limited quantity of Type III (high-early-strength) cement was produced and shipped. Both air-entrained and non-air-entrained types were produced; the latter type accounted for the bulk of production. Most of the shipments were in bulk and made by railroad, but sizable shipments were also made by truck. Shipments of cement in containers (paper bags) were also sizable and were made by railroad and truck.

The distribution of portland cement for various consumer uses was as follows: 60 percent to ready-mixed concrete companies (66 percent in 1965); 18 percent to concrete products manufacturers (17 percent in 1965); 11 percent to contractors, including highway contractors (11 percent in 1965); 11 percent to other users, including building material dealers, Federal, State, and local government agencies, and miscellaneous customers (6 percent in 1965).

Marketing areas for portland cement, in order of decreasing shipments, were chiefly Virginia, North Carolina, West Virginia, Georgia, Alabama, Florida, South Carolina, and Maryland.

Clays.—New records were set for clay output and value in 1966, respectively 5 percent and 9 percent higher, than in 1965. The greater than proportional value increase was due to a $0.05 increase in the average value per ton ($1.17 per ton in 1965). Almost seven-tenths of the clay and shale output was consumed in brick manufacture, compared with slightly less than two-thirds in 1965. The principal uses for the balance were lightweight aggregate and the manufacture of portland cement; some was also consumed in the making of vitrified sewer pipe, flue linings, pottery, clay dummies (shot-hole tamping devices), and other clay products. Clay production was reported from 21 operations in 16 counties. The chief clay-producing counties in order of tonnage mined were Botetourt, Orange, Russell, Chesterfield, and Nansemond; in order of output value they were Orange, Botetourt, Prince William, Nansemond, and Chesterfield.

Feldspar.—Production was by the Clinchfield Sand and Feldspar Corp. from two mines in Bedford County. While quantity decreased slightly compared with that of 1965, the total value increased moderately due to an increase in the average market value. Mixed feldspar (soda and potash) was mined near the company processing and grinding mill in Bedford. In order of decreasing tonnage the mill output was marketed chiefly in Maryland, Ohio, Pennsylvania, New York, and Illinois principally for pottery and enamel manufacture, although smaller quantities were used in the manufacture of welding rod coatings, soap, and abrasives, and for brick glaze. The resources and economic aspects of feldspar and related feldspathic minerals, including aplite, in the United States east of the Mississippi River, are discussed in a recent publication.[6]

Gem Stones.—Gems and mineral specimens gathered by mineral collectors and hobbyists included agate, amazonite, blue corundum, lepidolite, olivine, staurolite, and unakite.

Gypsum.—Output of crude gypsum decreased, compared with that reported in 1965. Gypsum, mined near Chatham Hill, Smyth County, and at Plasterco, Washing-

[6] Feitler, Stanley A. Feldspar Resources and Marketing in Eastern United States. BuMines Inf. Circ. 8310, 1966, 41 pp.

Table 5.—Clays sold or used by producers

Year	Short tons	Value
1957–61 (average)	1,229,217	$1,250,545
1962	1,464,417	1,443,927
1963	1,410,098	1,558,327
1964	1,440,385	1,613,523
1965	1,415,397	1,657,229
1966	1,486,344	1,813,396

ton County, was calcined or otherwise processed and manufactured into plasterboard and other gypsum products by United States Gypsum Co. at its Plasterco plant. The company also processed imported gypsum at a plant near Norfolk for use in their products. Imported gypsum was processed by several firms in the Norfolk area for use as a land dressing.

Kyanite.—Production of crude kyanite ore and sales of the refined material to manufacturers of refractories and other ceramic products increased. Two mines and three processing plants were operated by the Kyanite Mining Corp. in Buckingham and Prince Edward Counties, and the company also operated a grinding and bagging plant in the latter county. Only a small part of the refined kyanite (Al_2SiO_5) is used in the raw state; the bulk of production is calcined to mullite, one of the most important refractory materials used in the ceramic industry. An informative discussion of the kyanite and mullite industry in Virginia, North America's leading producer of kyanite, appeared in a recent publication.[7]

Lime.—Both output and value of lime decreased slightly (1 percent) compared with that of 1965, the previous record year. Sales of building lime declined 13 percent, sales of agricultural lime declined 7 percent, and sales of lime for chemical and other industrial uses declined by less than 1 percent. All but 4 percent of the lime sold or used, including both quicklime and hydrated lime, was consumed in chemical or industrial use. Of the total production 91 percent was quicklime and the balance was hydrated lime. Nine companies in six counties and one independent city reported the production of primary lime. One company in Alleghany County reported production of regenerated lime and a limited production of primary lime calcined from purchased limestone. In decreasing order of output, Giles, Smyth, and Shenandoah Counties were the chief lime-producing areas. Processing equipment used in lime manufacturing included pot, shaft, and rotary kilns and batch and continuous hydrators. Fuels used included natural gas, bituminous coal, and coke. Uses for quicklime included agricultural lime; the manufacture of alkalies, calcium carbide, and paper; flux in steel and electrometallurgical operations; sewage and trade-wastes treatment; and miscellaneous applications. Hydrated lime was marketed principally for use in construction, purification and treatment of water, leather tanning, sewage and tradewastes treatment, and agriculture. Principal marketing areas included District of Columbia, Florida, Georgia, Kentucky, Maryland, North and South Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia.

Mica.—No production of crude mica was reported. Domestic and foreign mica were processed for use in paint, rubber, wallpaper, plastics, and other products, by Asheville Mica Co. and Mica Co. of Canada (N.Y.), Inc., both in Newport News.

Nitrogen Compounds.—Allied Chemical Corp., Nitrogen Division, Hopewell, produced nitrogen compounds such as ammonia, urea, and ammonium sulfate for use chiefly as fertilizer or fertilizer ingredients.

Perlite.—Perlite from the Western United States, and imported vermiculite, were processed by Virginia Perlite Corp., Hopewell, chiefly for use as a lightweight concrete aggregate and building plaster.

Salt.—Olin-Mathieson Chemical Corp.,

[7] Johnson, Stanley S. Virginia's Contribution to the Kyanite-Mullite Industry. Virginia Minerals, v. 13, No. 1, February 1967, pp. 1–7.

Table 6.—Lime sold or used by producers, by uses

Year	Agricultural		Building		Chemical and other industrial		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1957–61 (average)	W	W	W	W	W	$6,607,537	622,915	$7,026,621
1962	31,104	$426,476	2,816	$40,629	580,593	7,201,198	614,513	7,668,303
1963	W	W	W	W	603,325	7,582,738	638,800	8,058,415
1964	W	W	W	W	742,065	9,251,156	780,290	9,780,920
1965	W	W	W	W	808,751	10,079,996	847,196	10,583,984
1966	25,513	342,853	9,627	142,387	804,865	10,000,721	840,005	10,485,961

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

Saltville, Smyth County, produced chlorine, caustic soda, soda ash, and other chemicals from brine recovered from nearby captive salt wells. Production of salt was comparable with 1965 output. The company has begun a multimillion-dollar modernization program, including not only its chemical facilities but also its captive limestone and lime making operations near the Saltville plant. The aerial tramway used to transport limestone from a nearby mine to the plant will disappear as a Saltville landmark when proposed truck haulage is begun.

Sand and Gravel.—Output of sand and gravel reached a new high in 1966, but value was less than in 1965, the previous year of both record production and value. The output increased 12 percent while the value decreased 8 percent compared to production (15 million tons) and value ($18 million) reported in 1965. The decline in total value was due to the lower average value of $0.97 per ton ($1.18 in 1965) reported in 1966. Demand for sand and gravel used in building and road construction was largely responsible for the increase in output; production of commercial sand and gravel for these uses was substantially higher than in 1965.

Of the commercial production 80 percent (14 million tons) was used in building (26 percent) and paving (54 percent), compared with 78 percent (12 million tons) in 1965. Other sand and gravel uses included industrial silica applications (glass sand, engine sand, filler, and other uses), other construction uses (fill material) and miscellaneous and unspecified applications.

Commercial output comprised 99.4 percent of the total production and virtually all of the value. The remainder was State

Table 7.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	2,046	$2,518	2,305	$2,561
Paving	4,476	4,009	6,627	4,033
Fill	2,129	788	1,913	1,105
Other [1]	420	1,004	386	927
Total	9,071	8,319	11,231	8,626
Gravel:				
Building	1,738	3,285	2,218	3,732
Paving	3,647	5,929	2,649	3,675
Fill	744	375	W	W
Other [2]	101	105	986	564
Total	6,230	9,694	5,853	7,971
Total sand and gravel	15,301	18,013	17,084	16,597
Government-and-contractor operations:				
Sand:				
Paving	-----	-----	38	13
Fill	-----	-----	53	18
Total	-----	-----	91	31
Gravel:				
Paving	6	2	16	7
Fill	15	4	-----	-----
Total	21	6	16	7
Total sand and gravel	21	6	107	38
All operations:				
Sand	9,071	8,319	11,322	8,657
Gravel	6,251	9,700	5,869	7,978
Total	15,322	18,019	17,191	16,635

W Withheld to avoid disclosing individual company confidential data.

[1] Includes railroad ballast and filtration sand (1965), engine, glass, ground sand, and sand for other construction and industrial uses.

[2] Includes fill (1966) and gravel for miscellaneous and other uses.

and local Government production. Sand comprised 66 percent of the total commercial sand and gravel output and 52 percent of the commercial value. Of the total commercial sand and gravel output 83 percent was washed, screened, or otherwise prepared, compared with 69 percent in 1965. Of the commercial tonnage 68 percent was shipped by truck, and most of the remainder by waterway or railroad; a small quantity was used at the producing plant or transported by unspecified methods.

Production of sand and gravel was reported from 30 counties and 3 independent cities. In order of decreasing output, the principal sand-and-gravel-producing areas were city of Virginia Beach, Fairfax, Chesterfield, Henrico, and Prince George Counties. Over five-sixths of both the total output and value were contributed by these five producing areas.

Of the 60 commercial sand and gravel operations reporting in 1966 (51 in 1965), 5 had an output range of 1 million tons or over and accounted for 36.2 percent of the output; 1 had an output range of from 500,000 to 1 million tons and accounted for 5.2 percent; 28 had an output range of from 100,000 to 500,000 tons and accounted for 53.1 percent; 9 had an output range of from 50,000 to 100,000 tons and accounted for 3.5 percent; and 17 had an output range of up to 50,000 tons and accounted for 2 percent of production.

Soapstone.—Crushed and ground soapstone was produced by one firm in Franklin County. The principal uses of the product were insecticides and foundry facings. Soapstone used as a dimension stone is included with miscellaneous stone in the stone section of this chapter.

Stone.—Virginia's stone production in 1966 declined 6 percent in both output and value, interrupting the increasing trend shown over the past 8 years. Output of this commodity, the next most important after coal produced in the State, however, was still the second highest on record. Predominately responsible for the decline in output was a lessened demand for construction aggregates (concrete aggregate and roadstone); the output of stone for this use was over 2 million tons less than in 1965.

Many types of stone were mined or quarried in Virginia including limestone, granite, basalt (including traprock and diabase), sandstone, slate, calcareous marl, miscellaneuos stone, and marble, in order of decreasing output. Of the total stone output 72 percent was used as concrete aggregate and roadstone (74 percent in 1965); 12 percent was used in cement and lime manufacture; 3 percent was used as metallurgical fluxstone; and the remainder used as agricultural dressings, railroad ballast, riprap, stone sand, and in unspecified applications. Limestone, either as such or as lime, had additional application in the chemical (including metallurgical) glass and paper industries. Marine shell, most of which was dredged from the Chesapeake Bay area, together with a limited quantity obtained as a product of oyster and other mollusk processing, was used mainly as an aggregate in road construction, in the manufacture of cement and lime, and as agstone (agricultural liming material). Roofing granules were produced from crushed slate by a firm in Buckingham County. Output of limestone, granite, and basalt, the three leading stone types produced, accounted for over 90 percent of the total stone production. Crushed or broken material comprised virtually all (99.8 percent) of the total stone production and 92 percent of the total value. In terms of production, dimension stone accounted for 0.2 percent and in terms of value for 8 percent.

Over one-half of the limestone output and almost all of the granite were used as construction aggregates. Only a limited amount of dimension limestone and no dimension granite was reported in 1966. Limestone decreased moderately in output and value while granite increased moderately. Basalt (including traprock and diabase), the third leading stone produced in Virginia, decreased moderately in output and value due to decreased output of the crushed material; a limited amount of dimension basalt was produced. Output and value of crushed sandstone increased substantially; a limited quantity of dimension sandstone was also produced. Production and value of miscellaneous dimension stone, including soapstone and "Virginia Greenstone," decreased moderately; a limited output of the crushed miscellaneous stone was reported. While the output of dimension slate was 7 percent less than in 1965, the value rose by 12 percent due to higher prices paid for the fabricated products in 1966. Output and value of crushed slate increased; the more than proportional

value gain was due to a higher unit value in 1966. Output of calcareous marl, used in cement manufacture and agricultural applications, decreased. A limited output of crushed marble was processed for use as terrazzo.

Commercial stone production, including marine shell, was reported in 53 counties and one independent city (Chesapeake). The principal stone-producing counties, in terms of tonnage, were Shenandoah, Augusta, Botetourt, Rockingham, and Loudoun (Shenandoah, Frederick, Botetourt, Loudoun, and Augusta in 1965). In terms of product value, the most important counties were Giles, Shenandoah, Buckingham, Loudoun, and Botetourt (Frederick, Giles, Shenandoah, Loudoun, and Botetourt in 1965). Eleven counties (15 in 1965) produced more than 1 million tons of stone and there were 23 counties with output valued in excess of $1 million each (25 in 1965). Government-and-contractor stone was produced in seven counties, the same number as in 1965.

Sulfur.—Hydrogen sulfide was recovered from fuel gas and converted to sulfur by the American Oil Co. at its Yorktown refinery in York County. While shipments were less than in 1965, the value of shipments was higher.

METALS

Ferroalloys.—Ferromanganese was produced by blast-furnace reduction of imported ore by E. J. Lavino & Co., Division of International Minerals & Chemicals Corp. near Lynchburg.

Iron Ore (Pigment Material).—Crude brown and yellow iron-oxide pigments were produced from ore mined by one firm near Hiwassee, Pulaski County. This firm produced brown, red, and yellow natural iron-oxide pigments, and a variety of finished natural and manufactured pigments at operations near Hiwassee and Pulaski. The materials used for pigment manufacture included manufactured oxides, imported oxides, and iron oxides from local deposits. Iron-oxide pigments were also produced from imported hematite by another firm near Henry, Franklin County. Total marketed output of iron-oxide pigments increased moderately.

Table 8.—Stone sold or used by producers, by kinds and uses

Kind and use	1965		1966	
	Short tons	Value	Short tons	Value
Dimension stone:				
Sandstone: All uses	1,035	$15,453	W	W
Undistributed [1]	74,792	4,535,423	70,805	$4,387,033
Total	75,827	4,550,876	70,805	4,387,033
Crushed and broken stone:				
Basalt: Concrete and roadstone [2]	3,161,265	5,334,785	2,754,576	4,568,369
Granite:				
Concrete and roadstone	8,730,527	14,067,536	10,032,284	15,420,438
Riprap	90,291	190,740	[3] 265,376	[3] 420,053
Railroad ballast	130,770	174,488	W	W
Limestone:				
Fluxing stone	1,018,109	1,588,002	967,187	1,506,556
Concrete and roadstone	14,065,792	18,124,010	10,577,039	13,941,708
Railroad ballast	265,498	349,388	396,387	539,267
Agricultural	1,295,064	2,319,572	1,139,742	2,023,133
Miscellaneous [4]	5,230,764	9,560,465	5,289,689	9,189,955
Sandstone:				
Concrete and roadstone	W	W	1,140,308	1,255,931
Miscellaneous [5]	899,408	1,297,872	93,213	253,722
Undistributed [6]	1,386,956	1,839,617	1,424,272	2,044,215
Total	36,274,444	54,846,475	34,080,073	51,163,347
Grand total	36,350,271	59,397,351	34,150,878	55,550,380

W Withheld to avoid disclosing individual company confidential data.
[1] Includes sandstone (1966), basalt, limestone, slate, and miscellaneous stone.
[2] Includes stone sand (1966) and riprap.
[3] Includes railroad ballast.
[4] Includes riprap.
[5] Includes concrete and roadstone (1965), riprap, refractory, railroad ballast, and other uses.
[6] Includes miscellaneous stone (1966), calcareous marl, marble, shell, and slate.

Lead and Zinc.—Production of lead and zinc ore was limited to two mines in Wythe County, operated by one company. Although the mine operations were continuous throughout the year, output of crude ore was at a lower monthly rate; consequently, production of both lead and zinc was less than in 1965. Lead and zinc output declined 16 percent and 14 percent, respectively.

Titanium Concentrates.—Marketed production of titanium concentrates was slightly less than in 1965, but value of shipments was 4 percent lower due mainly to a lower unit value in 1966. Shipments and value of both ilmenite and rutile decreased. The declines were slight for ilmenite, and moderate for rutile. Ilmenite was produced by American Cyanamid Co., Pigments Division, in Amherst County, and both ilmenite and rutile were produced by M & T Chemicals, Inc., in Hanover County.

Table 9.—Mine production of recoverable lead and zinc

Year	Lead		Zinc	
	Short tons	Value	Short tons	Value [1]
1957–61 (average)	2,946	$699,024	22,187	$5,123,172
1962	4,059	746,856	26,479	6,140,705
1963	3,500	756,000	23,988	5,724,628
1964	3,857	1,010,534	21,004	5,699,645
1965	3,651	1,139,112	20,491	5,942,390
1966	3,078	930,479	17,666	5,123,140

[1] Recoverable zinc valued at the yearly average price of prime western-slab zinc, East St. Louis market. Value established after transportation, smelting, and manufacturing charges have been added to the value of ore at the mine.

REVIEW BY COUNTIES

Producers reported mineral production from 78 counties and 3 independent cities. Several reporting companies did not show a breakdown by area of origin. Consequently, the county table will not indicate all producing areas.

Limited production of sand and gravel for use in highway construction and maintenance by the Virginia Department of Highways was reported in Accomack, Augusta, Highland, Northampton, Northumberland, Page, Pittsylvania, and Rockbridge Counties.

Crushed limestone, in limited quantity, for use in road building and maintenance was produced in Clarke and Highland Counties by the Virginia Department of Highways. Limited quantities of crushed granite for construction uses were produced by the Public Works Department of the cities of Danville and Martinsville in Pittylvania and Henry Counties, respectively.

Albemarle.—Superior Stone Co., Division of Martin Marietta Corp., quarried and crushed granite for concrete aggregate, roadstone, and railroad ballast at its Red Hill and Rivanna quarries near Red Hill and Charlottesville, respectively. Charlottesville Stone Corp. crushed basalt, quarried near Shadwell, for concrete aggregate and roadstone. The quarry group of this company was awarded a Certificate of Achievement in Safety for operating throughout the year without a lost-time work injury. The Economy Cast Stone Co. crushed vein quartz at its Richmond plant from raw material quarried near Free Union. Vein quartz was also quarried near Boyd Tavern by Stone & Mineral Corp., and crushed at the company's plant near Syria. The output of both companies was used as exposed aggregate. Production of granite and quartz increased while the output of basalt decreased. Soapstone was quarried near Alberene and Schuyler, by Alberene Stone Division of The Georgia Marble Co. The output was prepared at the company's processing plant at Schuyler as dimension stone for laboratory and architectural uses. Sand and gravel was produced mainly for construction use by several operators near Charlottesville and White Hall.

Alexandria (City).—Newton Asphalt Co., Inc., and Virginia Sand and Gravel Co., Inc., processed sand and gravel mined in Fairfax County at their Alexandria plants. Herbert Bryant, Inc., crushed and ground

Table 10.—Value of mineral production in Virginia, by counties [1]

County	1965	1966	Minerals produced in 1966 in order of value
Accomack	$193,000	$42,000	Sand and gravel.
Albemarle	W	W	Stone, sand and gravel.
Alleghany	W	W	Stone.
Amherst	W	W	Titanium concentrate, sand and gravel.
Appomattox	101,447	79,177	Stone.
Augusta	W	6,433,660	Cement, stone, clays, sand and gravel.
Bath	2,000	----	
Bedford	W	W	Stone, feldspar.
Bland	18,772	15,632	Stone.
Botetourt	W	W	Cement, stone, clays.
Brunswick	W	W	Stone, clays.
Buchanan	[2] 59,989,326	[3] 67,343,568	Coal, natural gas, sand and gravel.
Buckingham	4,074,376	4,508,602	Stone, kyanite.
Campbell	1,616,359	W	Stone.
Caroline	W	W	Sand and gravel.
Carroll	----	W	Stone.
Charles City	W	W	Sand and gravel.
Chesapeake (City)	W	W	Cement, stone, lime.
Chesterfield	W	W	Sand and gravel, stone, clays.
Clarke	W	W	Stone.
Craig	W	W	Do.
Culpeper	W	W	Do.
Dickenson [4]	37,605,420	40,010,090	Coal, natural gas, clays.
Dinwiddie	W	W	Stone, clays.
Essex	----	W	Sand and gravel.
Fairfax	7,514,392	6,030,361	Sand and gravel, stone.
Fauquier	518,295	W	Stone.
Floyd	19,700	26,818	Do.
Fluvanna	W	W	Do.
Franklin	8,872	9,972	Soapstone.
Frederick	4,833,783	3,769,230	Stone, lime, sand and gravel, clays.
Giles	W	W	Lime, stone.
Gloucester	W	W	Sand and gravel.
Goochland	W	W	Stone.
Grayson	152,148	W	Do.
Greensville	W	W	Do.
Halifax	W	W	Do.
Hampton (City)	----	W	Sand and gravel.
Hanover	W	W	Stone, aplite, titanium concentrate.
Henrico	W	W	Sand and gravel.
Henry	W	W	Stone.
Highland	21,052	33,457	Stone, sand and gravel.
Isle of Wight	W	W	Lime, sand and gravel, stone.
King William	W	W	Sand and gravel.
Lee [5]	2,156,804	2,015,692	Coal, stone, petroleum.
Loudoun	2,889,809	2,682,435	Stone.
Louisa	W	W	Do.
Mecklenburg	W	W	Do.
Montgomery	W	W	Stone, clays, coal.
Nansemond	W	W	Stone, clays.
Nelson	W	W	Stone, aplite.
New Kent	W	W	Sand and gravel.
Northampton	W	W	Do.
Northumberland	----	11,000	Do.
Nottaway	W	W	Stone.
Orange	W	W	Clays.
Page	2,000	120,000	Sand and gravel.
Patrick	W	W	Do.
Pittsylvania	455,759	363,160	Stone, sand and gravel.
Powhatan	W	W	Stone.
Prince Edward	W	W	Kyanite, stone.
Prince George	W	W	Sand and gravel.
Prince William	W	W	Stone, clays.
Pulaski	W	W	Stone, iron ore (pigment material).
Rappahannock	W	W	Stone.
Roanoke	W	W	Stone, clays.
Rockbridge	1,311,756	1,259,386	Stone, sand and gravel, clays.
Rockingham	1,988,448	2,615,566	Stone, sand and gravel.
Russell	10,146,670	11,140,876	Coal, stone, clays.
Scott	1,116,398	1,111,676	Stone, coal.
Shenandoah	4,968,257	4,903,719	Stone, lime.
Smyth	W	W	Lime, salt, stone, sand and gravel, clays.
Spotsylvania	W	W	Sand and gravel, stone.
Stafford	W	W	Sand and gravel.
Sussex	58,000	71,000	Do.
Tazewell [6]	1,333,334	973,804	Stone, coal, natural gas, lime, clays.
Virginia Beach (City)	W	3,886,000	Sand and gravel.
Warren	W	W	Cement, stone.

Footnotes at end of table.

Table 10.—Value of mineral production in Virginia, by counties [1]—Continued

County	1965	1966	Minerals produced in 1966 in order of value
Washington	$1,840,052	$1,625,324	Stone, gypsum.
Westmoreland	W		
Wise	29,383,306	[7] 32,665,361	Coal, stone.
Wythe	8,359,077	W	Zinc, stone, lead, sand and gravel.
York	W	W	Sand and gravel.
Undistributed [8]	85,298,132	80,549,160	
Total	267,977,000	274,297,000	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] The following counties are not listed because no production was reported: Alexandria (City), Amelia, Arlington, Charlotte, Cumberland, Green, James City, King and Queen, King George, Lancaster, Lunenberg, Madison, Mathews, Middlesex, Richmond, Southampton, and Surray.
[2] Excludes natural gas; included with "Undistributed."
[3] Excludes sand and gravel and natural gas; included with "Undistributed."
[4] Excludes natural gas, clays; included with "Undistributed."
[5] Excludes stone and petroleum; included with "Undistributed."
[6] Excludes stone and natural gas, included with "Undistributed."
[7] Excludes stone; included with "Undistributed."
[8] Includes gem stones, natural gas, and values indicated by symbol W.

purchased oystershell for use as an agricultural liming material and poultry grit.

Alleghany.—Production of stone in the county decreased substantially, primarily because a producer active in 1965, was inactive in 1966. Liberty Limestone Corp. produced crushed limestone for concrete aggregate and roadstone at its Beaver Dam quarry and plant near Covington. The company was awarded a Certificate of Achievement in Safety for working throughout the year without a lost-time work injury. West Virginia Pulp & Paper Co., Covington, produced lime from purchased limestone and also regenerated lime in a natural-gas-fired rotary kiln for use in its paper manufacturing.

Amherst.—American Cyanamid Co., Pigments Division, mined ilmenite (iron titanium dioxide) for use in its titanium pigment plant at Piney River, Nelson County. Smiley Sand Co. dredged and processed construction sand from the James River near Lynchburg.

Appomattox.—The Commonwealth of Virginia quarried and crushed limestone for agricultural use at its State Lime Grinding Plant No. 2, near Oakville.

Augusta.—Lehigh Portland Cement Co. produced limestone and shale at a nearby quarry and pit for use in the manufacture of cement at its Fordwick plant. Both general-use and high-early-strength portland cement were produced by the dry process in three coal fired kilns of varying dimensions. A sizable quantity of masonry cement was also produced. Electric power was both generated and purchased. A Certificate of Achievement in Safety for operating throughout 1966 without a lost-time work injury was awarded to the company's quarry group.

Crushed limestone chiefly for concrete aggregate and roadstone was produced by Augusta Stone Corp., Belmont Trap Rock Co., Inc., and Valley Stone Corp., all near Staunton; Greenville Stone Corp., near Greenville; and Salem Stone Corp., near Burketown. Limestone for use as agricultural stone (agstone) was quarried and ground by the Commonwealth of Virginia at its State Lime Grinding Plant No. 1, near Staunton. Total commercial output of limestone was greater than in 1965. Vulcan Materials Co., Mideast Division, quarried and crushed stone near Spottswood for use as concrete aggregate and roadstone. Eastside Quarry near Waynesboro, produced crushed sandstone for sand-and-gravel uses. Certificates of Achievement in Safety for operating throughout 1966 without a lost-time work injury were awarded to the quarry groups of the Augusta Stone Corp. and Vulcan Material Co., Mideast Division.

North Mountain Brick of Virginia quarried shale near Buffalo Gap for use in its brick manufacturing plant near the quarry site.

D. M. Conner Sand Co., Inc., produced construction sand, mostly processed, near Stuarts Draft. Southwest Materials, Inc., produced crushed gravel near Vesuvius and Valley Sand and Gravel, Inc., produced sand and gravel near Waynesboro.

Bedford.—Limestone for concrete aggregate, roadstone, railroad ballast, and ag-

stone was quarried and crushed by Blue Ridge Stone Corp. at its Blue Ridge plant. Vein quartz was quarried by Nance Stone Co. and crushed at a plant near Lowry for use as exposed aggregate.

Clinchfield Sand & Feldspar Corp. mined mixed feldspar (soda and potash) at its Coles and Overacre mines; no output from the several other company mines in Bedford County was reported in 1966. The feldspar, ground at the company mill, near Bedford, was marketed chiefly for pottery manufacture; smaller quantities were also produced for use in enamel, weldingrod coatings, soap and abrasives, and glass manufacture. Production of crude marketable feldspar was slightly less than in 1965, but the unit value increased moderately.

Botetourt.—Limestone, for use in cement manufacture, was quarried and crushed by Lone Star Cement Corp., near Haymakertown. Both general-use and high-early-strength cement were manufactured by the dry process in four 9- by 340-foot rotary kilns; electric power was purchased. Non-air-entrained portland cement comprised the bulk of both production and shipments; masonry cement was also prepared and marketed. Production of limestone declined slightly, but Botetourt County continued to rank third in output among the limestone-producing counties; unit value was lower than in 1965. Limestone marketed for use as agstone, construction aggregate, fluxstone, fertilizer and asphalt filler, mineral food, chemical reagent in paper manufacture, and other chemical uses, was produced by Liberty Limestone Corp., at quarries near Buchanan and Rocky Point and James River Hydrate and Supply Co., Inc., near Buchanan. The Rocky Point and Sherwood quarries of Liberty Limestone Corp. were awarded Certificates of Achievement in Safety for working throughout 1966 without a lost-time work injury.

The county continued to rank first in output among the clay-producing counties in the State; output and total value increased slightly, compared with 1965. There was also a slight increase in unit value. Clay and shale for building brick and lightweight aggregate were produced by Webster Brick Co., Inc., and Weblite Corp. both with plants near Webster.

Brunswick.—Granite for concrete aggregate and roadstone was quarried and crushed by Southern Materials Co., Inc., near Rawlings, and Vulcan Materials Co., Mideast Division, near Lawrenceville. Production was substantially higher than in 1965, due to the output of the newly reporting producer (Vulcan Materials Co., Mideast Division) in 1966. Brick & Tile Corp., of Lawrenceville, mined clay and schist near Lawrenceville for use in the manufacture of brick.

Buchanan.—Buchanan County, as in previous years, led in coal production, accounting for 16.3 million tons or 46 percent of the State total. Production rose 7 percent, although there were 97 fewer active mines than in 1965. Of the 710 mines reporting production, 659 were underground mines, 17 were strip mines, and 34 were auger mines. Underground output, traditionally accounting for the bulk of the tonnage mined, was 88 percent of the total county production (92 percent in 1965). Leading producers in the county included Clinchfield Coal Co., Division of the Pittston Co., Harman Mining Corp., Beatrice-Pocahontas Co., and Jewel Ridge Coal Corp. The chief producing seams included Jewell, Pocahontas No. 3, Red Ash, and Splashdam.

Beehive coke was produced by Jewell Smokeless Coal Corp. at a plant near Vansant.

Production of natural gas was 9 percent less than in 1965. The total output of 1,071 million cubic feet was delivered to the pipelines of Consolidated Gas Supply Corp. and Atlantic Seaboard Co.

Howard L. Daniels Sand Co. produced and processed sand for construction and industrial use.

Buckingham.—Arvonia-Buckingham Slate Co., Inc., and LeSueur-Richmond Slate Corp., both with operations near Arvonia, quarried and processed slate for roofing, structural and sanitary slate, flagging, wall facing, and flooring tile. Crushed slate was also produced by Arvonia-Buckingham Slate Co., Inc., and marketed as roadstone. Blue Ridge Slate Corp. produced roofing granules from purchased crushed slate at its plant near New Canton. Production of dimension slate was less than in 1965, but value was greater, due to higher prices received for the dimensioned slate products in 1966. Output and value of the crushed material increased. Vein quartz for exposed aggregate was quarried near Centenary by Central Stone Co.

Kyanite was quarried, crushed, and beneficiated by Kyanite Mining Corp. at its

Willis Mountain mine, near Sprouses Corner, and processing plants near Dillwyn and Sprouses Corner. The refined material, mostly calcined into mullite, was marketed to manufacturers of refractories and other ceramic products. A subsidiary organization, Dixon Sand Co., marketed the sand (quartz) obtained in the beneficiation of the kyanite ore for industrial and construction applications.

Campbell.—Limestone was quarried and crushed principally for concrete aggregate and roadstone by Blue Ridge Stone Corp., near Lawyer and Rustburg, and Rockydale Stone Service Corp., near Lynchburg; a limited quantity was also produced as agstone. "Virginia Greenstone," a miscellaneous stone variety, was quarried and processed by Virginia Greenstone Co., Inc., near Lynchburg. Output included rough and dressed dimension building stone, dimensioned and dressed refractory stone (bakery oven-hearth stones), and a small quantity of marketable mill scrap. Lynlite Materials Co., a lightweight aggregate producer active in 1965, was idle throughout 1966. Leesville Stone Corp. quarried quartzite near Leesville for use as dimension stone.

Carroll.—Sandstone for use as construction aggregate, was quarried and crushed by H. D. Crowder and Sons, near Shorts Creek.

Pyrrhotite was mined intermittently and in limited quantity near Galax, for use in the Pulaski plant of Allied Chemical Corp., General Chemical Division. Production from this operation was not reported and it is not included in the statistical tables.

Chesapeake (City).—Portland cement was produced by Lone Star Cement Corp. in Chesapeake. Calcareous marl and clay, captively produced near Chuckatuck in Nansemond County, were among the raw materials used in the wet process plant. Non-air-entrained portland cement was the only product; a limited quantity of masonry cement was also shipped. Three 7- by 219-foot kilns and one 10- by 340-foot kiln were in operation.

Radcliff Materials, Inc., Norfolk, dredged buried marine shell deposits (reef shell) in the Hampton Roads and Tangier Sound areas. The shells were marketed for road aggregate, base for oyster seeding grounds, poultry grit, and for cement manufacture. Hydrated lime chiefly for agricultural purposes was produced by Reliance Fertilizer and Lime Corp. A mixture of half dolomitic limestone and half oystershell was calcined in four coal-fired pot kilns.

Charles W. Priddy & Co., Inc., and F. S. Royster Guano Co., both near Chesapeake, and Smith-Douglass (A division of the Borden Chemical Co.), near Norfolk, ground imported gypsum for use as a land dressing.

Chesterfield.—Output of sand and gravel increased moderately, but unit value was lower than in 1965; the county continued to rank third in production among the sand-and-gravel-producing areas.

Southern Materials Co., Inc., recovered sand and gravel by dredging along the James River. The material was processed for construction use at the company's Kingsland Reach plant near Chester. Sand and gravel was produced by Friend and Co., Inc., and transferred by conveyor system to the company's plant across the Appomattox River in Prince George County.

Output of granite (including production for the independent city of Richmond) increased. Southern Materials Co., Inc., at its Dale quarry, near Chester and Tidewater Crushed Stone & Asphalt Co., Inc., near Richmond, quarried and crushed granite chiefly for use as concrete aggregate and roadstone; a limited quantity of riprap was also produced.

Output and value of clay increased moderately compared with 1965 levels. Clay was mined by Daniels Brick & Tile Co., Inc., for the manufacture of vitrified sewer pipe and flue linings at its Richmond plant. General Shale Products Corp., Southside Division, and Redford Brick Co., Inc., also mined clay in the county for use in building brick manufacture at their Richmond plants. Southern Pottery at Richmond produced flowerpots from purchased clay.

Clarke.—Limestone for use as concrete aggregate, roadstone, and agstone was quarried and crushed by Stuart M. Perry, Inc., near Berryville. J. C. Digges & Sons produced calcareous marl near Old Chapel for agricultural use.

Culpeper.—Sandstone, chiefly for concrete aggregate and roadstone, was quarried and crushed by Culpeper Stone Co., Inc., at its stationary plant near Stevensburg. Diabase was quarried for use as a monumental and architectural stone by Buena Black Granite Corp. and Virginia Granite Corp. at plants near Buena. Production and value of both crushed and dimension stone increased.

Dickenson.—Accounting for slightly over one-quarter of the coal mined in the State, Dickenson County was the second ranking of the eight coal-producing counties. Output increased 6 percent over that of 1965. Included among the 116 active mines—19 less than in 1965—were 92 underground mines (112 in 1965), 16 strip mines (13 in 1965), and 8 auger mines (10 in 1965). Of the county output 83 percent was from underground production, compared with 90 percent in 1965. Leading in coal production were Betty B. Corp., Clinchfield Coal Co., Contracting Enterprises, Inc., and Open Fork Coal Co. Principal producing coal seams were Upper and Lower Banner, Clintwood, Dorchester, Splashdam, and Tiller.

Clinchfield Coal Co., Division of the Pittston Co., produced natural gas from numerous wells in the county and 447 million cubic feet (592 million cubic feet in 1965) were delivered to Kentucky-West Virginia Gas Co. pipelines.

Clay for use in the manufacture of clay dummies (shot hole tampers) was produced near Georges Fork by Combs Dummie Co.

Dinwiddie.—Crushed granite was produced for concrete aggregate and roadstone by Southern Materials Co., Inc., at its Jack quarry near Petersburg. Production increased in 1966.

Daniels Brick & Tile Co., Inc., mined schist near Ford for use in manufacturing vitrified sewer pipe and flue linings at its plant in Richmond.

Fairfax.—Fairfax County, ranking second in output among the sand-and-gravel-producing areas (first in 1965), continued, however, to lead in value. Production totaled 3.4 million tons valued at $4.2 million, a decrease of 15 percent in output and 18 percent in value compared with production and value in 1965. The more than proportional decrease in value was due to a lower average value per ton in 1966, reflecting a lower output of the higher priced processed material. Of the output 71 percent was processed, compared with 78 percent in 1965. Reflecting a declining trend, production and value constituted 20 and 25 percent, respectively, of the State total, compared with 26 and 28 percent in 1965, and 32 and 35 percent in 1964. Most of the tonnage produced was used for building and road construction. Producers reporting output in 1966 were Clem Road Gravel Co., George F. Dodd Gravel Corp., Lynch Construction Corp. (formerly Edsall Corp.), Hilltop Sand and Gravel Co., Inc., L. S. Sorber and Co., Virginia Sand and Gravel Co., Inc., and Newton Asphalt Co., Inc. The output of the latter two companies was processed at plants in Alexandria.

Vulcan Materials Co., Mideast Division, produced crushed granite near Occoquan and Fairfax Quarries, Inc., produced crashed diabase near Bull Run; the crushed stone output was used chiefly as concrete aggregate and roadstone. The quarry groups of both companies were awarded Certificates of Achievement in Safety for operating throughout 1966 without a lost-time work injury.

Franklin.—Soapstone was mined and ground chiefly for use in insecticides and foundry facings by Blue Ridge Talc Co., Inc., at its mine and plant near Henry. The company also processed out-of-State hematite to produce a variety of finished natural and manufactured iron oxide pigments.

Frederick.—The leader in value of limestone produced in 1965, and second in output ranking, Frederick County was surpassed by five counties in value and six counties in output among the limestone-producing areas in 1966. Output of limestone—the leading stone type produced in the county—was 1.6 million tons, valued at $2.5 million, compared with the 2.5 million-ton output, valued at $3.5 million, produced in 1965. Largely responsible for the decline was a sharp drop in output of crushed limestone from concrete aggregate and roadstone due to lower demand for construction aggregates. Producers of limestone included W. S. Frey Co., Inc., near Clearbrook; M. J. Grove Lime Co., Division of the Flintkote Co., near Middletown and Stephens City; and Stuart M. Perry, Inc., near Winchester. The entire limestone output was crushed and used, in decreasing order of tonnage produced, for metallurgical fluxstone, concrete aggregate and roadstone, lime manufacture, glass making, agstone, stone sand, and cement manufacture.

Hydrated lime and quicklime were produced at the Stephens City plant of M. J. Grove Lime Co., Division of The Flintkote Co. The products were marketed for chemical and other industrial uses, for construction uses (soil stabilization and mason's lime), and for agricultural purposes.

Sand (industrial silica), mainly for use in glass manufacture, was produced by Virginia Glass Sand Corp. at its stationary plant and quarry near Gore; a limited quantity of building sand was also produced, Shenandoah Silica Co., Inc., operated a processing plant near Gore utilizing material quarried by Virginia Glass Sand Corp., the output was marketed for ceramic purposes.

Shale mined near Winchester was used by Shenandoah Brick & Tile Corp. in brick making at its Winchester plant.

Giles.—Giles County continued to lead in lime production; output and value increased, compared with 1965 levels. Foote Mineral Co. and National Gypsum Co. quarried and crushed limestone near Kimballton chiefly for use in the production of quicklime and hydrated lime at the companies' plants, also near Kimballton.

The products were marketed chiefly for chemical and other industrial uses; limited quantities of mason's lime and agricultural lime were also sold. A limited output of limestone was produced for metallurgical and other uses. Out-of-State magnetite was processed for use in coal preparation at a grinding plant operated by Foote Mineral Co., Kimballton. Virginian Limestone Corp. and Ripplemead Limestone Co., Inc., both near Ripplemead, quarried and crushed limestone for use as construction aggregate, railroad ballast, agstone, and coal mine dust. The latter company was awarded a Certificate of Achievement in Safety for quarry operation without a lost-time work injury throughout 1966. Output and value of limestone—the only stone type produced in the county—were comparable to those of 1965. While only ranking eighth in output among the stone-producing areas in the State, Giles County led in value in 1966 (second ranking in 1965). The county's traditionally high value ranking is attributable chiefly to the higher average value of crushed limestone per ton used for industrial (as in lime manufacture) rather than construction applications.

Goochland.—Granite for concrete aggregate and roadstone was quarried and crushed by Boscobel Granite Corp. near Manakin, Vulcan Materials Co., Mideast Division, and Rockville Stone Co., a subsidiary of Boscobel Granite Corp., both near Hylas. The latter company also produced crushed quartzite for use as construction aggregate.

Grayson.—Miscellaneous stone (amphibolite) was quarried and crushed for use as construction aggregate by Grayson Stone Corp., near Galax. A limited quantity of crushed basalt for road use was produced by Paul E. Delp near Comers Rock.

Construction sand was produced by W. A. and Irving Patton and Riverside Sand at operations near Galax and Fries, respectively.

Hanover.—Crushed granite for construction aggregate was produced near Verdon by The General Crushed Stone Co. Aplite (for use in glassmaking) and titanium minerals (ilmenite and rutile) were produced by M & T Chemicals, Inc., at its mine and processing plant near Montpelier.

Henrico.—Sand and gravel, mostly processed for construction use, was produced by Carter Sand & Gravel Co., Inc., and Commonwealth Sand and Gravel Corp., both near Richmond; Sadler Materials Corp. near Varina; and West Sand & Gravel Co., Inc., near Highland Springs. Dredge No. 12, owned by Southern Materials Co., Inc., continued operations along the James River, but the output was processed at the company's Kingsland Reach plant near Chester and production data for this operation is included with those reported for Chesterfield County. A Certificate of Achievement in Safety for working throughout the year without a lost-time work injury was awarded the West Sand & Gravel Co., Inc.

Henry.—Crushed granite for use as construction aggregate was produced by Martinsville Stone Corp., near Martinsville; Snyder Stone Co., near Figsboro and Wilson Quarries, near Horse Pasture.

Isle of Wight.—Hydrated lime for agricultural purposes was produced by Battery Park Fish & Oyster Co., near Battery Park. Oystershell, obtained as a coproduct of oyster-cannery operations, was calcined and hydrated. Processed construction sand was produced by Southern Materials Co., Inc., at Benns Church Sand plant, near Benns Church. A limited tonnage of sand for masonry use was produced by Zuni Sand Co., Inc., from a pit near Zuni.

Lee.—Production of coal was substantially less in Lee County, one of the three coal-producing counties with lower production in 1966. The number of active mines

decreased by more than one-fifth to 53 in 1966, of which 49 were underground, 3 were strip mines, and 1 was an auger mine. Over three-quarters of the coal output was produced by underground mining. Black Mountain Coal Co., Laurel Branch Coal Co., Stallard Coal Co., and Wright Coal Co. were among the leading producers. Output was largely from Darby, Taggart, and Mason seams.

Kentucky-Virginia Stone Co., Inc., near Gibson Station, and Woodway Stone Co., near Woodway, quarried and crushed limestone for uses including agstone, construction aggregate, coal mine safety dust, filter bed media, and railroad ballast.

Lee County (Ben Hur and Rose Hill fields) was the only oil-producing area in the State. Output was 1,073 barrels, compared with 3,617 barrels in 1965. Six wells were productive at yearend in 1966, the same number as in 1965.

Loudoun.—Production and value of diabase (basalt), the only stone type produced in the county, decreased 8 and 7 percent, respectively. The declines were attributed to a lessened demand for construction aggregates in 1966. However, the county continued to rank fourth in output value among the stone-producing counties in the State. Virtually the entire output was crushed for use as construction aggregate; a small quantity of riprap and a limited tonnage of stone sand were also produced. Producers reporting production in 1966 were Arlington Stone Co., near Leesburg; Bull Run Stone Co., Inc., near Manassas; Chantilly Crushed Stone, Inc., near Arcola; Loudoun Quarries, Inc., near Herndon; and Virginia Trap Rock, Inc., near Leesburg.

Louisa.—Limestone crushed for concrete aggregate and roadstone, was quarried by Superior Stone Co., Division of Martin Marietta Corp., at its quarry near Gordonsville. A. H. Smith Stone Co. produced crushed granite for aggregate use from a quarry near Mineral.

Lynchburg (City).—Smiley Sand Co. dredged construction sand from the James River near Lynchburg. Production data for this operation is included with those reported for Amherst County. Ferromanganese was manufactured from imported ore by E. J. Lavino & Co., Division of International Minerals & Chemical Corp. at a plant in Lynchburg. Slag, purchased from this company, was crushed and marketed for highway and roofing use by Lynchburg Materials Inc. The Minerals and Refractory Division of Howmet Corp. operated a processing plant for imported manganese ore.

Mecklenburg.—Output and value of granite decreased substantially owing largely to the inactivity of Southern Materials Co., Inc., quarrying operations near Bracey, in 1966. Crushed granite for construction aggregate was produced by Vulcan Materials Co., Mideast Division, at the company's Buggs Island quarry near Boydton; the quarry was not active over the entire year, however. Both companies maintained stockpile sales.

Montgomery.—Montgomery Limestone Corp. produced crushed limestone at its Shawsville and Ellett quarries chiefly for use as concrete aggregate and roadstone; a limited quantity of agstone was also produced. Ironto Sand Co. quarried and crushed sandstone near Ironto for use as construction aggregate. Old Virginia Brick Co., Inc., mined shale near Elliston for use in brick making at its brick plant near Salem. A limited quantity of semi-anthracite coal was mined from the Brushy Mountain seam.

Nansemond.—Calcareous marl, mined near Chuckatuck, and clay, dredged from the Nansemond River near Chuckatuck, were captively used in the manufacture of portland cement by Lone Star Cement Corp. at its Norfolk plant in the city of Chesapeake. Clay mined near Suffolk was used in brick making by Webster Brick Co., Inc.

Nelson.—Dimension soapstone was produced by Alberene Stone Division of The Georgia Marble Co. at Schuyler. The material was quarried near Alberene and also near Schuyler; the output from the quarries was processed at Schuyler. Laboratory and architectural stone and flagging were the principal products.

Aplite, chiefly for use in glass manufacture as a source of alkalies, alumina, and silica, was mined and processed by International Minerals & Chemical Corp., Industrial Minerals Division, near Piney River. Shipments of ground aplite were made to glassmakers in Midwestern, southern, and eastern States. Dominion Stone Plant, Inc., also near Piney River, produced crushed aplite mainly for use as construction aggregate. The Piney River mine of International Minerals & Chemical Corp., Indus-

trial Minerals Division, was awarded a Certificate of Achievement in Safety for working throughout the year without a lost-time work injury.

Norfolk (City).—Radcliff Materials, Inc., dredged buried marine shell deposits in the Hampton Roads and Tangier Sound areas. The shells were marketed for road aggregate, base for oyster seeding grounds, poultry grit, and for use in cement manufacture. Production data for this operation is included with statistics for the independent city of Chesapeake. Imported gypsum was processed at a plant near Norfolk by United States Gypsum Co. for plaster and other gypsum products.

Orange.—Clay output and value increased substantially in 1966; the county ranked first in output value (second in 1965) among the clay-producing counties in the State. Triassic mudstone and shale for use in brick manufacture were mined by Webster Brick Co., Inc., near Somerset.

Page.—Commercial construction sand and gravel was produced and processed by Shenandoah Sand and Gravel, Inc., near Shenandoah. Crushed gravel for highway construction was produced near Luray by S. M. Satterfield.

Pittsylvania.—Crushed granite for use as construction aggregate was produced by Vulcan Materials Co., Mideast Division, at a quarry near Dry Fork. The company's Chatham quarry was awarded a Certificate of Achievement in Safety for working throughout 1966 without a lost-time work injury. The Danville quarry of Superior Stone Co., Division of Martin Marietta, was inactive during most of the year, but sales of crushed granite were made from stockpile.

Commercial sand was produced by dredging and processed for use mainly in paving applications. Principal producers included Kendall Sand Works and Marshall's Sand & Gravel Co., both near Danville.

Shale mined in North Carolina (near the North Carolina-Virginia border) was used in the manufacture of lightweight aggregate by Virginia Solite Corp. at its plant near Leaksville Junction.

Powhatan.—The Genito operation of Vulcan Materials Co., Mideast Division, was inactive during 1966, but shipments of crushed granite for construction aggregates were made from stockpile.

Prince Edward.—Kyanite, mined from the Baker Mountain deposit, was crushed, beneficiated, and additionally processed near Darlington Heights by Kyanite Mining Corp. Two processing plants for the beneficiated output from the Baker Mountain mine are operated by the company—a calcining, grinding, and bagging plant near the mine, and a grinding and bagging plant near Pamplin City. Chief uses were the ceramic and refractory industries. A subsidiary company (Dixon Sand Co.) marketed sand, prepared from quartz separated during the beneficiation of the kyanite ore, for industrial and construction uses.

Prince William.—Stone (diabase) was produced for construction aggregate by McCanless Construction Co., Inc., near Aldie, Silver Lake Shale Pit, near Haymarket, and Vulcan Materials Co., Mideast Division, near Gainesville and Manassas. The latter company's Manassas quarry was awarded a Cetificate of Achievement in Safety for working throughout 1966 without a lost-time work injury.

The Manassas quarry of Vulcan Materials Co., Mideast Division, is described in a recent trade journal.[8] Mudstone and shale for the manufacture of building brick was mined by Woodbridge Clay Products Co. near Manassas.

Pulaski.—Radford Stone Corp., at quarries near Radford and Newbern, and Acme Stone, Inc., at its Newbern quarry, produced crushed limestone principally for use in building and construction; other uses were agstone, railroad ballast, and stone sand. Robert P. Whitman produced crushed limestone near Pulaski for local use.

Hercules Powder Co., Inc., Imperial Color & Chemical Department, Hiwassee, mined crude iron oxide near Hiwassee to produce natural iron oxide pigments at its Hiwassee plant; imported iron oxide was also utilized. The company also produced manufactured or synthetic iron oxide pigments at its Hiwassee and Pulaski plants.

Roanoke.—Limestone for use as construction aggregate and agstone was quarried and crushed by Rockydale Quarries Corp., near Roanoke, and Salem Stone Corp., near Dixie Caverns. Shale mined near Salem and Elliston in Montgomery County was used in the manufacture of building brick

[8] Bergstrom, John H. Quality Control Keynotes Manassas Plant. Rock Products, v. 69, No. 5, May, 1966, pp. 112–114.

by Old Virginia Brick Co., Inc., at its Salem plant.

Rockbridge.—Crushed limestone, principally as concrete aggregate and roadstone, was produced by C. W. Barger & Son, Inc., near Lexington. Lone Jack Limestone Co., Inc., produced crushed limestone and quartzite near Glasgow for construction aggregate and railroad ballast. Crushed limestone for use in Interstate Highway construction was produced by Acme Stone, Inc., and Ararat Rock Products Inc., at portable plants near Lexington and Buffalo Creek, respectively.

Sand, marketed primarily for use in glass manufacture, was produced from sandstone quarried near Goshen by Locher Silica Corp.

Clay was recovered near Glasgow by Locher Brick Co., Inc., for use in making brick.

Rockingham.—Stone production and value again increased substantially, and in 1966 the county ranked fourth in output among the stone-producing areas in the State. Fred K. Betts III Quarry, Inc., near Harrisonburg; Elkton Limestone Co., near Elkton; The Frazier Quarry, Inc., near Harrisonburg; C. S. Mundy Quarries, Inc., near Singers Glen; and Vulcan Materials Co., Mideast Division, near Mount Crawford, quarried and crushed limestone primarily for use in building and road construction. The latter company's Mount Crawford quarry was awarded a Certificate of Achievement in Safety for working throughout the year without a lost-time work injury. Other uses for the limestone were as agstone, in cement and lime manufacture, and railroad ballast. Dimension limestone, chiefly irregularly shaped building stone, was produced by Nielson Construction Co., Inc., Harrisonburg. Jamison Black Marble Co. crushed marble near Harrisonburg primarily for use as terrazzo.

Timberville Lime Co. marketed, for agricultural use, pulverized dolomite that had been accumulated during zinc-ore processing at Timberville until the early 1960's when the mine was closed.

Sand and gravel, mainly for construction use, was produced and processed by Grottoes Sand & Gravel Co., Inc., at its stationary plant near Grottoes.

Russell.—Although 2 fewer mines were active than the 42 in 1965, output of coal was 10 percent greater. Virtually all the tonnage was accounted for by underground production. Principal producers were B & M Coal Co., Clinchfield Coal Co., Division of the Pittston Co., and Flat Rock Coal Co. Coal seams chiefly mined were Upper and Lower Banner, Red Ash, Tiller, and Widow Kennedy seams.

Production of limestone decreased substantially, due principally to lessened demand for construction aggregate. Clinch River Quarries, near St. Paul, and R. G. Pope Construction, Inc., near Dickensonville, quarried and crushed limestone for concrete aggregate and roadstone. White Excavating Co. quarried and crushed limestone near Castlewood. James River Hydrate and Supply Co., Inc., near Gardner, produced crushed limestone for aggregate, mine safety dust, and miscellaneous uses. This company's operations are described in a recent publication.[9]

Shale used in the manufacture of lightweight aggregate by the Clinchfield Coal Co., Division of the Pittston Co., was obtained from the coal preparation plant of the Moss No. 2 mine of Clinchfield Coal Co., near Cleveland, and processed at a plant near South Clinchfield.

Scott.—Output and value of limestone decreased slightly. Natural Tunnel Stone Co., Inc., and Tri-State Lime Inc., produced crushed limestone near Glenita and Bruno, respectively. The output was marketed as concrete aggregate, roadstone, railroad ballast, and agstone. Foote Mineral Co. captively mined and crushed limestone at Sunbright for use in manufacturing lithium hydroxide at its spodumene-processing plant also at Sunbright. Penn-Dixie Cement Corp. mined and crushed limestone near Speers Ferry for captive use at its Kingsport, Tenn., cement plant. Hilton Sand Co. produced sand from friable sandstone for building and highway use. A small output of coal was produced in the county by underground operations.

Shenandoah.—The county's output and value of crushed limestone, the only stone variety produced, rose 8 and 2 percent, respectively; the county continued to lead in stone production and moved from third to second in rank valuewise among the stone-producing areas in Virginia. An increased demand for use as construction aggregate and in lime making were chiefly responsible for output and value gains. Limestone

[9] Trauffer, Walter E. James River's New Plant in Western Virginia. Pit and Quarry, November 1966, pp. 122–126.

was quarried and crushed chiefly for construction aggregate by Salem Stone Corp., with portable operations near Mount Jackson and Woodstock; Interstate Stone Corp. at its portable plant near New Market; C. S. Mundy Quarries, Inc., at its stationary plant near Forestville; and Toms Brook Lime and Stone Co., Inc., at a stationary plant near Toms Brook; a limited quantity of agstone was also produced. Chemstone Corp., a subsidiary of Minerals and Chemicals Philipp Corp., produced crushed limestone at its Dominion quarries near Strasburg, primarily for use in the company's limemaking operations, and as fluxstone in blast-and open-hearth furnaces. Other uses were in road construction and miscellaneous applications. Stockpiled waste stone at the Chemstone site was crushed for asphalt and crushed stone use by Virginia Asphalt Paving Co., Inc. Shenandoah Valley Lime & Stone Corp. produced crushed limestone at its stationary plant near Strasburg for concrete aggregate, roadstone, and fluxstone. Kipps Magnesium Limestone quarry produced crushed limestone near Forestville for agstone.

Quicklime and hydrated lime were produced from captive limestone quarried and processed near Strasburg by Chemstone Corp., subsidiary of Minerals and Chemicals Philipp Corp. The products were marketed chiefly as flux for steelmaking and for use in paper manufacture. Water purification and softening and sewage-and-trade-wastes treatment were other uses. Principal marketing areas were Maryland, Ohio, Pennsylvania, and Virginia.

Smyth.—Lime, for use in the company's chemical operations, was produced by Olin-Mathieson Chemical Corp., Saltville, from limestone quarried nearby; a limited quantity of the crushed stone was marketed as construction aggregate. Virtually the entire output of lime was captively consumed in the production of soda ash, together with salt brine from the company's nearby salt wells. Chlorine and caustic were other principal products manufactured from the captive brine.

Limestone for concrete aggregate and roadstone was quarried and crushed near Marion by Holston River Quarry, Inc.

Gypsum was recovered by United States Gypsum Co. from its Locust Cove mine near Chatham Hill; the crude material was trucked to the company's processing plants at Plasterco in Washington County.

Aggregate material for use as construction sand was produced from sandstone by Sayers Sand Co. and C. R. Snider & Sons Sand Co., both near Marion.

General Shale Products Corp., Appalachian Shale Division, mined shale for use in the manufacture of brick at a plant near Groseclose.

Spotsylvania.—Construction and general-purpose sand and gravel was mined in the Fredericksburg area by Massaponax Sand & Gravel Corp., and processed at its stationary plant near Fredericksburg.

Crushed granite chiefly for construction aggregate was processed near Fredericksburg by Fredericksburg Stone Co., Inc.; a limited quantity was marketed for railroad ballast.

Tazewell.—Crushed limestone, largely for concrete aggregate and roadstone, was produced by Pounding Mill Quarry Corp. at quarries near Bluefield and Pounding Mill. Other uses included agstone, fluxstone, mine dust, railroad ballast, and stone sand. Mine dust was produced by Limestone Dust Corp. at its grinding plant near Bluefield from purchased limestone.

Coal output decreased by almost two fifths. Of the 15 active mines (16 in 1965), 10 were underground mines, 3 were auger mines, and 2 were strip mines. Leading producers were Alfredton Coal Co., Anderson & Anderson Contractors, Inc., Quinton White Coal Co.; and Rebecca Coal Co. The Jawbone, Upper and Lower Seaboard, Pocahontas No. 5, and Widow Kennedy seams were chiefly mined.

Tazewell County led in the production of natural gas, producing 2,732 million cubic feet (2,443 million cubic feet in 1965) or 64 percent of the total output. Deliveries were to the pipeline of the Atlantic Seaboard line.

Limestone quarried by Blue Grass Lime Co., near Maxwell, and Peery Lime Co., near North Tazewell, was calcined and hydrated; a limited quantity of the crushed limestone was also marketed for local use by the latter company. The hydrated lime was marketed as mason's lime, agricultural lime, and for use in water purification and softening. Markets were chiefly in Virginia and neighboring States.

Shale for use in brick manufacture was mined near Richlands by General Shale

Products Corp. Clay used in the manufacture of clay dummies, was produced near Tazewell by Tazewell Clay Products Co.

Virginia Beach (City).—Reflecting heightened construction activity in the area in 1966, production of sand and gravel almost doubled and the city ranked first in output (second in 1965) and second in value (fourth in 1965). The output, over three quarters of which was processed, was predominately sand and was used principally for building, road construction, and fill; a limited quantity was marketed for industrial use. Leading in the recovery of sand and gravel from pits near Virginia Beach were Baillio Sand Co., Inc., J. C. Jones Sand Co., Inc., Tidewater Sand Co., Inc., E. V. Williams Co., Inc., and E. C. Womack, Inc.

Warren.—Riverton Lime & Cement Co., Inc., quarried and crushed limestone near Riverton for use in the manufacture of masonry cement; a sizable tonnage was also produced for construction aggregate, agstone, and railroad ballast. A limited quantity of crushed quartzite was produced by J. B. Earle, Front Royal, for use as construction aggregate.

Washington.—Output and value of limestone, the only stone type produced in the county, declined slightly. The stone was quarried and crushed chiefly for construction aggregate; a limited quantity of agstone was also produced. Producers reporting production in 1966 were Acme Stone Co., Inc., near Abingdon; Meadowview Lime & Stone Co., near Meadowview; Vulcan Materials Co., Midsouth Division, near Bristol; and Washington County Stone Co., near Glade Spring. A Certificate of Achievement in Safety was awarded to the Bristol quarry of Vulcan Materials Co., Midsouth Division, for working throughout the year without a lost-time work injury.

The United States Gypsum Co. mined and processed gypsum at Plasterco. Gypsum, mined at the company's Locust Cove mine near Chatham Hill, Smyth County, was also processed at Plasterco. Materials Marketed included plasterboard and other gypsum products for distribution chiefly to construction industries.

Westmoreland.—The Coles Point operation of Construction Materials, Inc., active in 1965, was idle in 1966, but stockpile sales continued during the year.

Wise.—Output of coal in Wise County, the third ranking of the eight coal-producing counties, continued an increasing trend. Although 4 less mines were active than the 200 mines in 1965, production rose 1 percent. The county produced slightly over one-fifth of coal mined in Virginia and led in the production of strip-mined coal. Of the 196 mines active in 1966, 155 were underground mines, 24 were strip mines, and 17 were auger mines. Of the county output 72 percent was from underground mines (68 percent in 1965); strip mines accounted for 21 percent (26 percent in 1965). Leading coal producers included Coal Processing Corp., Stallard-Womack Mining Corp., Sunrise Coal Co., Inc., and Westmoreland Coal Co., Stonega Division. Important producing seams were the Blair, Clintwood, Imboden, Kelly, Taggart, and Upper Banner. Coke producers (beehive) in 1966 were Christie Coal and Coke Co., Inc., and Norton Coal Co., Inc., both with plants near Norton; Westmoreland Coal Co., Stonega Division, and Wise Coal and Coke Co., with plants near Roaring Fork and Dorchester, respectively.

Southwest Quarries, Inc., near Big Stone Gap, and Lonesome Pine Stone Co., Inc., near East Stone Gap, produced crushed limestone for construction aggregate, railroad ballast, and agricultural liming material. Building sand and coal preparation sand were produced by Skyline Sand Co. from sandstone near Pound.

Wythe.—The New Jersey Zinc Co. treated zinc and lead ores from both the Austinville and Ivanhoe mines at its mill at Austinville; ore from the Ivanhoe mine was conveyed to the mill through an underground tunnel. Zinc concentrate was treated at the Palmerton, Pa., smelter of The New Jersey Zinc Co. Lead concentrate was shipped to Schuylkill Products Co., Baton Rouge, La.

Total stone production and value was less than in 1965. Crushed limestone for construction aggregate was produced by H. D. Crowder & Sons Quarry, near Poplar Camp, and Pendleton Construction Corp. near Wytheville. Limestone recovered from lead and zinc ore concentration at The New Jersey Zinc Co. operations at Austinville was marketed chiefly as agstone, although some material was also produced for construction aggregate and fertilizer filler. Crushed sandstone for construction aggregate was produced by Newman Brothers Quarry, Inc., near Patterson. The Wythe sand plant of Pendleton Construction Corp., near Wytheville, was idle in

1966. Silica Products Co. produced construction sand (crushed sandstone) at its stationary plant near Fort Chiswell.

York.—Construction sand was dredged and processed by Southern Materials Co., Inc., at its Grafton plant. The Yorktown (Goodwin Neck) oil refinery operation of the American Oil Co. is described under Petroleum and Natural Gas in the commodity section of this chapter.

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 Ronald P. Collins [1] and William N. Hale [2]

Mineral production in Washington was valued at $89 million in 1966, a 3-percent increase in value over that of 1965. The average annual rate of growth of the State's mineral output over the last 10 years was slightly over 3.5 percent. In 1956 a trend started to emerge that gradually shifted the dominant commodity values from lead, zinc, and coal to the construction commodities—sand, gravel, stone, and cement. In 1966, the latter group made up 80 percent ($72 million) of total mineral production.

Planned expansions at existent aluminum reduction plants by the four producers in the State were to add over 320,000 tons to the annual rated capacity within the State by 1970. During the year, several firms announced plans for constructing new metal producing facilities in the State: Reynolds Metals Co., an aluminum cable plant at its Longview property; Kawecki Chemical Co., a high-strength aluminum alloy plant at Wenatchee; and Sandvik Special Metals Corp., a zirconium alloy-tube-manufacturing plant in the Finley area.

Tacoma was the site selected for a $4 million pilot plant to test the feasibility of producing high-quality fuels from low-quality coal samples gathered throughout the United States.

Kaiser Cement & Gypsum Corp. began an expansion program costing $3.5 million for bulk storage facilities in Seattle. Anacortes was the site chosen by Lone Star Cement Co. for a cement plant that was still in the design state.

Offshore petroleum exploration drilling on Federal lands beyond the State 3-mile limit was initiated with a joint operation between Shell Oil Co. and Pan American Petroleum Corp.

The economic expansion of 1965 carried through to 1966 and was marked by a steep rise in key indicators. Washington led all States in the rate of income expansion; personal income expanded at a rate (13 percent) that exceeded the national average by over 5 percent. The State's diversified manufacturing sector registered substantial gains in shipbuilding, machinery, primary metals, and fabricated metals manufacturing. Favorable weather conditions, high production levels, and rising prices were instrumental in the increased value of cash receipts from farm marketings; the total value was estimated at nearly 17 percent over 1965, grossing $743 million.

The Boeing Co. embarked on the largest capital expenditure program in its history. Investments in plant, property, and equipment of $500 million were allocated for 1966 and 1967; $200 million had been allocated during the previous 5 years.

Diversification and expansion of nucleonics related facilities continued at Hanford, near Richland. Construction was completed on the $3 million Donald W. Douglas Space Propulsion Laboratory. Battelle Northwest continued work on its $20 million technical research laboratory. The Atomic Energy Commission (AEC) announced that an $87.5 million Fast-Flux Test Facility was to be constructed during the next 6 years to develop nuclear fuels

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[2] Mineral specialist, Bureau of Mines, Albany, Oreg.

Table 1.—Mineral production in Washington [1]

Mineral	1965 Quantity	1965 Value (thousands)	1966 Quantity	1966 Value (thousands)
Barite—short tons	(2)	$1	-------	-------
Carbon dioxide—thousand cubic feet	11,848	3	W	W
Cement:				
Portland—thousand 376-pound barrels	6,258	22,351	6,820	$24,340
Masonry—thousand 280-pound barrels	62	201	60	187
Clays [3]—thousand short tons	162	211	185	249
Coal (bituminous)—short tons	55	497	59	514
Copper (recoverable content of ores, etc.)—do	30	21	34	25
Gem stones	NA	75	NA	75
Lead (recoverable content of ores, etc.)—short tons	6,328	1,974	5,859	1,771
Peat—do	29,729	131	25,599	136
Sand and gravel—thousand short tons	31,301	27,234	29,002	26,806
Stone—do	12,461	17,446	13,250	20,273
Talc and soapstone—short tons	2,861	17	3,880	22
Uranium ore—do	73,495	1,871	W	W
Zinc (recoverable content of ores, etc.)—do	22,230	6,491	24,772	7,184
Value of items that cannot be disclosed: Diatomite, fire clay, gold, gypsum (1966), lime, magnesite, mercury (1965), olivine, pumice, silver, tungsten (1965), vanadium (1966), and values indicated by symbol, W	XX	r 7,648	XX	7,510
Total	XX	86,172	XX	89,092

XX Not applicable. NA Not available. r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed."
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Less than ½ unit.
[3] Excludes fire clay; included with "Value of items that cannot be disclosed."

and provide engineering and scientific data for development of nuclear-fuel power reactors. Washington Public Power Supply System's $122 million nuclear-powered steam plant at the Hanford Works attained full generating capability of 800,000 kilowatts of electric energy.

Employment.—During the year, 98,000 nonagricultural workers were added to the labor force, an aggregate employment gain greater than the total increment added in the 5-year period prior to 1965. The percentage increase in industrial employment (8.8 percent) was over three times greater than the national average for the same period. The greatest single factor was the resurgence of the aerospace industry, which added 28,300 new workers in a year. Aerospace dominated the State's employment picture but growth in other diversified manufacturing industries contributed much to the record employment figures. The rapidly expanding aluminum industry caused employment advances in the primary metal and fabricating sectors. Employment in the construction sector climbed to the highest level since World War II because of a heavy schedule of commercial and industrial expansion, highway and hydroelectric power projects. As a result, earnings of construction workers surged upward nearly one-fourth. All supporting industries responded with above average gains in earnings. Especially noteworthy was the gain of more than one-fifth in the earnings of factory workers.

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]
1961	$65,508
1962	67,076
1963	70,011
1964	78,772
1965	83,669
1966	p 85,589

p Preliminary.
[1] Data for 1961–65 revised.

Legislation and Government Programs.—The Seattle Oceanographic Study Committee submitted a proposal to the State legislature and a bill was introduced to establish a permanent State commission and a State institute to assist, encourage,

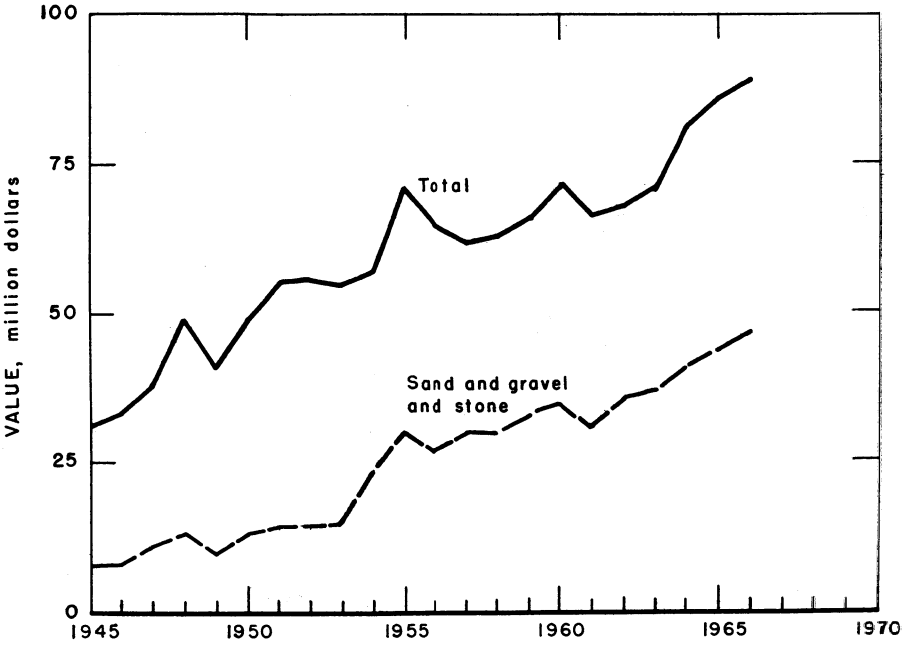

Figure 1.—Value of sand and gravel and stone, and total value of mineral production in Washington.

Table 3.—Indicators of Washington business activity

		1965	1966 p	Change, percent
Personal income:				
Total	million dollars	$8,641.0	$9,776.0	+13.1
Per capita	dollars	$2,906.0	$3,280.0	+12.9
Construction activity:				
Building permits	million dollars	$440.2	$607.7	+38.1
Heavy engineering awards	do	$408.7	$247.9	−39.3
State highway commission:				
Value of contracts awarded	do	$102.9	$101.4	−1.5
Value of contract work performed	do	$103.3	$119.6	+15.8
Cement shipments to and within Washington.	thousand 376-pound barrels	5,893.8	8,041.3	+36.4
Cash receipts from farm marketings	million dollars	$636.8	$743.0	+16.7
Factory payrolls	do	$3,998.2	$4,721.1	+18.1
Annual average labor force and employment:				
Total labor force	thousands	1,166.3	1,252.9	+7.4
Unemployment	do	58.5	47.6	−18.6
Employment:				
Construction	do	46.4	54.9	+18.3
Aerospace	do	57.0	85.3	+49.6
Lumber and wood products	do	46.9	46.9	------
Food processing	do	26.2	28.4	+8.4
All manufacturing	do	227.0	265.3	+16.9
All industries	do	1,106.6	1,204.1	+8.8

p Preliminary.

Sources: Survey of Current Business, Construction Review, Pacific Builder & Engineer, Washington State Highway Commission, The Farm Income Situation, Washington Employment Security Department, and Bureau of Mines.

Table 4.—Annual employment and total wages in the mineral industries

Industry	1965		1966	
	Employment	Wages (thousands)	Employment	Wages (thousands)
Mining:				
Metal mining	587	$4,135	537	$3,788
Bituminous coal, crude petroleum, and natural gas	127	899	92	619
Nonmetallic mining and quarrying	1,098	8,421	1,162	9,676
Total	1,812	13,455	1,791	14,083
Stone, clay, and glass products:				
Cement, hydraulic	542	3,950	554	4,263
Structural clay products	276	1,666	278	1,596
Concrete, gypsum, and plaster products	3,710	27,278	3,862	29,739
Other	929	6,303	949	6,782
Total	5,457	39,197	5,643	42,380
Smelting, refining, and casting:				
Blast furnaces, steel works, rolling and finishing mills	1,896	14,309	1,901	14,370
Iron and steel foundries	1,092	7,847	1,189	9,196
Smelting, refining, and casting of nonferrous metals, except aluminum	1,108	7,609	1,186	8,273
Smelting, rolling, drawing, and casting of aluminum	7,544	59,388	8,577	69,374
Miscellaneous	73	553	527	4,712
Total	11,713	89,706	13,380	105,925
Industrial chemicals [1]	6,781	59,914	5,334	49,535
Petroleum refining and related industries	1,230	9,923	1,199	10,009
Grand total	26,993	212,195	27,347	221,932

[1] The Hanford atomic plant is the largest in this classification.

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.—Employment 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
1965:								
Coal	83	219	18	145	---	12	82.57	2,959
Metal	427	300	128	1,028	1	74	72.97	7,552
Nonmetal	129	169	22	175	---	2	11.41	319
Sand and gravel	1,712	187	321	2,580	---	54	20.93	449
Stone	1,220	206	251	2,018	---	30	14.87	246
Peat	35	116	4	32	---	1	30.79	123
Total	3,606	206	744	5,978	1	173	29.11	1,657
1966: [p]								
Coal	80	211	18	138	---	11	79.71	2,870
Metal	370	281	104	831	1	52	63.78	15,197
Nonmetal	140	149	21	175	---	2	11.43	63
Sand and gravel	1,530	195	299	2,284	---	52	22.77	647
Stone	1,180	197	232	1,866	---	36	19.29	589
Peat	28	136	4	31	---	---	---	---
Total	3,328	204	678	5,325	1	153	28.92	2,932

[p] Preliminary.

and develop a coordinated State program in oceanography and oceanographic engineering. The AEC began to develop the conceptual design of the Fast-Flux Test Facility at the Hanford project near Richland. The additional employment requirements, estimated at between 200 to 300 engineers and scientists, were expected to offset the loss to be experienced from the shutdown by AEC of one plutonium reactor in 1967. The U.S. Geological Survey and the Federal Bureau of Mines continued a project begun in 1965 to evaluate the minerals potential of the North Cascades Primitive Area. One contract with the Office of Minerals Exploration (OME), U.S. Department of the Interior, remained in effect that had been initiated in 1965 at the Chelan County property (Gold King mine) of L–D Mines, Inc.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasives.—Most of the crude silicon carbide manufactured by Carborundum Co. at Vancouver was shipped to abrasive-grain sizing and treatment plants in the Eastern United States for further processing into material suitable for bonded and other abrasive products.

Barite.—No barite was produced. A report described aspects of the potential commercial development of eastern Washington barite deposits.[3]

Cement.—Shipments of portland cement by four firms from six plants totaled 6.9 million barrels valued at $24.3 million.

Cement was distributed to consumers in the State and surrounding region from the six plants, and from seven distribution terminals. About 86 percent of the portland and masonry cement shipments terminated within the State; the remainder was sent to other Pacific Northwest States and Alaska. Of the total portland cement shipped, 79 percent was transported by truck, 19 percent by rail, and 2 percent by boat. The ratio of bulk to paper bag shipments was about 9:1.

About 74 percent of the portland cement produced was distributed to firms manufacturing commercial concrete products, such as ready-mixed concrete companies (58 percent), concrete product manufacturers (11 percent), and building material dealers (5 percent). The remaining 26 percent was sold to highway (11 percent) and other contractors (11 percent), and to miscellaneous customers and Federal, State, and local government agencies (4 percent).

Kaiser Cement & Gypsum Corp. began construction on a $3.5 million cement storage complex at a Duwamish Waterway site acquired in 1965 from the Seattle Port Commission. The cement storage silos were the first phase of a multimillion-dollar cement manufacturing facility at Seattle to replace the company's Bellingham plant which was sold to Pittsburgh Plate Glass Co. in September. Columbia Cement Co., a subsidiary of the glass company, operated the Bellingham plant. Included in the purchase by Pittsburgh Plate Glass Co. was a limestone quarry at Maple Falls, and a cement distribution terminal at Harbor Island Seattle.

The Ideal Cement Co. wet-process plant nearing completion at Seattle featured a computerized-central-control room from where the kiln operation and plant functions, from the grinding of raw materials to storing of finished cement, could be monitored by closed-circuit television. Upon completion of the Seattle plant, the firm's Grotto and Irvin plants were to be converted to distribution terminals.

Lone Star Cement Co. announced plans to construct a 4-million-barrel-annual-capacity cement plant at Anacortes. Preliminary estimates by the company indicated a construction cost of $32 to $40 million. The company considered the feasibility of transporting limestone slurry through a 45-mile pipeline from Concrete to the proposed site.

Clay.—The quantity of clays sold or used by Washington producers declined 2 percent from the 1965 total largely because of less clays used for refractory purposes.

Fire clay was mined at four operations in King and Spokane Counties by International Pipe & Ceramics Corp. and at one operation in Douglas County by L–D Mines, Inc. Miscellaneous clay for use in making heavy clay products came from 13

[3] Masson, Donald F., and John A. Jaekel. Beneficiation of Washington Barite. Washington State Univ. College of Eng. Res. Section, Circ. 26, 1966, 7 pp.

pits in nine counties. Clay used in manufacturing cement came from pits in King, Spokane, and Whatcom Counties.

Diatomite.—The tonnage of diatomite production increased 17 percent over the 1965 total.

Kenite Corp. mined diatomite at a pit southeast of Quincy in Grant County. Crude material was trucked 18 miles to a company calcining plant at Quincy.

Gypsum.—Gypsite (a mixture of gypsum, quartz, and clay) mined from the Poison Lake deposit was processed from stockpiles by Argo Minerals, Inc. at Tonasket and sold for agricultural purposes. Crude gypsum was imported from Baja California, Mexico, by Kaiser Gypsum Co., Inc., Seattle, and processed for use in building products. Gypsum from Canada was marketed by Greenacres Gypsum Co., Spokane, for agricultural purposes.

Lime.—Output of lime declined 6 percent from the 1965 total. Pacific Lime, Inc., Tacoma, manufactured primary open-market lime for use in water and sewage treatment; for construction and agricultural purposes; and for use by the paper, steel, calcium carbide, ore concentrating, petroleum, and tanning industries. Limestone for the operation was received by barge from company quarries at Texada Island, British Columbia, Canada. Limestone was calcined to lime for use in sugar refining at Utah-Idaho Sugar Co. refineries in Grant and Yakima Counties. Calcium-bearing sludge was converted to lime at eight pulping operations for their own use in manufacturing pulp and paper products.

Magnesian Minerals.—Increased demand for refractory magnesia by the steel industry resulted in a 15-percent advance in tonnage of crude magnesite mined at the Stevens County Finch, Keystone, and Red Marble quarries by Northwest Magnesite Co.

Olivine production, declining 4 percent from the 1965 total, was from the Skagit County quarries of Northwest Olivine Co. and Scheel Stone Co., and from the Whatcom County quarry of Olivine Corp. Crude material was processed at plants of Northwest Olivine Corp., Hamilton, and Olivine Corp., Bellingham. Precessed tonnages were marketed mainly for use as foundry sand to Pacific Coast States and Canadian consumers.

Pumice.—Output of pumice and pumiceous materials declined 3 percent from the 1965 total. Ewer Lumber Co. continued to produce pumice for use as concrete aggregate from a deposit near Chelan Lake, Chelan County.

Sand and Gravel.—Sand and gravel production declined 7 percent from the 1965 total owing to smaller requirements by the State highway department and U.S. Army Corps of Engineers.

Sand and gravel was produced in 37 of the 39 counties. Commercial firms operated 107 plants—78 stationary and 29 portable; whereas output from Government-and-contractor operations was from 67 plants—22 stationary and 45 portable. Output was valued at over $5 million in King County, more than $4 million in Pierce County, over $2 million in Snohomish County, and more than $1 million each in Columbia, Spokane, Whitman, and Yakima Counties.

Distribution of output by use was roadbuilding and maintenance, 47 percent; construction, 28 percent; fill, 16 percent; railroad ballast, 6 percent; and miscellaneous, 3 percent. Included under miscellaneous were small but important quantities of special industrial silica sands used for glass manufacturing, grinding, polishing, sandblasting, and foundry applications.

Silica sands near Wenatchee were described in a report.[4]

Stone.—Stone was quarried in 36 counties. Benton, King, Skagit, Spokane, Stevens, and Walla Walla Counties each had production valued at over $1 million.

Basalt output of 11.4 million tons, from operations in 33 counties, was 86 percent of the stone total. The basalt was used for building purposes, concrete aggregate, roadstone, riprap, and ballast.

Limestone production of 1.4 million tons valued at $2.5 million came from quarrying operations in Okanogan, Pend Oreille, San Juan, Skagit, Snohomish, Stevens, and Whatcom Counties. A large part of the limestone produced was used by the cement industry; some was used for agricultural purposes and by the pulp and paper and metallurgical industries. Limestone

[4] Rivisto, Michael A., Industrial Consultants. Economic Feasibility of Silica Sand Processing and Related Manufacturing Operations in Chelan County, Wash. Study sponsored by U.S. Department of Commerce, Economic Development Administration, 1966.

Table 6.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Building	5,699	$6,235	6,801	$7,859
Road material	6,047	6,015	6,341	6,541
Fill	2,724	1,899	3,046	1,734
Railroad ballast	190	142	1,892	1,151
Other [1]	739	1,030	766	894
Total	15,399	15,321	18,846	18,179
Government-and-contractor operations:				
Building	2	6	1,280	1,684
Road material	7,260	6,768	7,195	5,740
Fill	8,404	4,772	1,516	1,083
Other [1]	236	367	165	120
Total	15,902	11,913	10,156	8,627
All operations:				
Building	5,701	6,241	8,081	9,543
Road material	13,307	12,783	13,536	12,281
Fill	11,128	6,671	4,562	2,817
Railroad ballast	190	142	1,892	1,151
Other [1]	975	1,397	931	1,014
Grand total	31,301	27,234	29,002	26,806

[1] Includes special sands for construction and industrial uses and sand and gravel for micellaneous unspecified purposes.

Table 7.—Stone sold or used by producers, by uses

(Thousand short tons and thousand dollars)

Use	1965		1966	
	Quantity	Value	Quantity	Value
Dimension stone (building)	9	$269	23	$291
Concrete and roadstone	8,208	10,488	9,406	13,084
Riprap	2,326	2,359	1,132	1,854
Other [1]	1,917	4,330	2,688	5,045
Total [2]	12,461	17,446	13,250	20,273

[1] Used at cement, paper, metallurgical, and chemical plants, sugar refineries, for railroad ballast, and for miscellaneous unspecified purposes.

[2] Owing to rounding, individual items may not add to totals shown.

also was imported for use in manufacturing cement, lime, and paper. The limestone occurrences of western Washington were the subject of a report.[5]

Sandstone, quartz, and quartzite output for use as industrial silica totaled 122,512 tons valued at $592,344. The silica-bearing material came from Chelan, Ferry, Pend Oreille, Pierce, Skagit, Spokane, and Stevens Counties. It was used in manufacturing abrasives, cement, ferrosilicon, glass, roofing granules, sodium silicate, terrazzo, and for foundry applications. Dimension sandstone was produced in Chelan, Ferry, Kittitas, Pierce, and Skagit Counties.

Granite from Chelan, Douglas, Ferry, King, Skagit, Snohomish, and Whitman Counties was used for poultry grit, riprap, and roadstone.

Sized marble from operations in Ferry, King, and Stevens Counties was marketed for use as furnace flux, paint filler, roofing granules, stucco, and for agricultural purposes. Dimension marble came from Ferry and Stevens Counties.

Talc and Soapstone.—Soapstone was mined at three operations near Marble-

[5] Danner, Wilbert R. Limestone Resources of Western Washington. State of Washington, Division of Mines and Geology, Bull. 52, 1966, 474 pp.

mount, Skagit County. Two producers sold crude material for grinding at plants of Northwest Talc & Magnesium Co., Clear Lake, and Miller Products Co. and Stauffer Chemical Co., both in Portland, Oreg. The ground and sized material was used in manufacturing insecticides and paint. The third operator sold output for sculpturing purposes.

Vermiculite.—Crude vermiculite from a Montana mining operation was exfoliated at the Spokane plant of Vermiculite Northwest, Inc. The expanded product was marketed for use in insulation, plaster and concrete aggregates, and for agricultural purposes.

METALS

Aluminum.—Production of primary aluminum climbed from 534,680 tons valued at $263 million in 1965 to 598,260 tons valued at $294 million. The total production figure for the State's five primary aluminum plants was less than the technically rated capacity as shown in table 8, because the first of three 76,000-ton potlines scheduled for the Intalco Aluminum Corp. plant, Bellingham, was completed at mid-year, and a second was completed just before yearend. However, Aluminum Company of America (Alcoa), Kaiser Aluminum & Chemical Corp., and Reynolds Metals Co. continued to produce for the third straight year at a level above their combined rated capacity. The first shipment of primary aluminum from the initial potline at the new Intalco plant, was delivered in mid-year to Hunter Engineering, a division of American Metal Climax (Amax), at Riverside, Calif. The second potline, and a third, expected to be on line by 1968, will give the plant a total annual capacity of 228,000 tons. Reynolds Metals Co. announced a $325 million, 4-year expansion program that will increase primary aluminum capacity by 160,000 tons at its two Pacific Northwest plants. The additions will increase the rated annual capacities of the Longview, Wash. and Troutdale, Oreg., plants to 190,000 and 140,000 tons, respectively. Reynolds also announced that a cable plant was to be added at Longview to convert aluminum into high-voltage transmission cable for use in the rapidly expanding west coast power system. Reynolds' employment at Longview was anticipated to grow from 500 to 1,150 by 1970. Annual capacity of Kaiser Aluminum & Chemical Corp.'s primary aluminum plant at Tacoma was to be doubled to 81,000 tons. Alcoa announced plans for a fifth potline at its Wenatchee plant. The additional unit and supporting facilities, includung a carbon-baking furnace and ingot-casting equipment, were estimated to cost over $10 million. When the potline is energized in early 1968, the rated capacity will be 175,000 tons of primary aluminum. Kawecki Chemical Co. of Boyertown, Pa., announced start of a $2.5 million aluminum alloy plant at Wenatchet. Titanium aluminum for grain refining and boron aluminum for electrical wire and cable products were to be manufactured.

Copper.—Copper output was up 4 tons from the 1965 level to 34 tons. Most of the metal was recovered as a byproduct of lead-zinc mining in Pend Oreille County (Pend Oreille mine) and zinc mining in Stevens County (Van Stone and Calhoun mines). Because of increased demands for copper, American Smelting and Refining Company (Asarco) initiated a $25 million long-term program to increase refined copper output of its Tacoma plant. The additional capacity was to be used to process concentrates barged from the Granduc mine in British Columbia, Canada, jointly developed by Asarco and Newmont Mining Co., as well as additional custom domestic tonnage.

Gold.—Gold output decreased 6 percent. from that of 1965. As in prior years, the Ferry County mines (Knob Hill and Gold Dollar) of Knob Hill Mines, Inc., and Day Mines, Inc., and the Chelan County mine (Gold King) of L–D Mines, Inc., were the principal producers in the State. The Gold King mine operated at full mill capacity during 1966, but at yearend, the reserves of commercial-grade ore had dwindled, and termination was expected in early 1967. Gold Placers, Inc., a gold-dredging operation located northwest of Ellensburg, announced plans to expand production on 14 claims along a creek bed in the Swauk mining district of Kittitas County.

Iron Ore.—Washington Mineral Profits Corp. was completing construction of a plant to extract iron ore, silica, and garnet sand from the black sands of Baker Bay (Pacific County) at the mouth of the Columbia River.

Table 8.—Primary aluminum plant capacity and production data

Year	Rated primary capacity, short tons	Primary production			Average U.S. ingot price per pound, cents
		Short tons	Percent of national total	Value (thousands)	
1957–61 (average)	483,000	353,626	19	$179,848	[1] 26.6
1962	483,000	371,757	18	178,226	23.9
1963	483,000	439,144	19	202,327	22.6
1964	483,000	489,919	19	232,893	13.7
1965	524,000	534,680	19	262,702	24.5
1966	676,000	598,260	20	294,115	24.5

[1] Price of pig now applied to ingot. The use of the term "pig" was discontinued in August 1960.

Lead-Zinc.—Lead output declined 7 percent from that of 1965, and the value was down 10 percent because of a 2-cent per-pound drop in price during the year. Zinc output increased 11 percent and was valued at a little more than $7 million. All of the lead-zinc production was from Pend Oreille (Pend Oreille mine) and Stevens Counties (Calhoun and Van Stone mines). According to the annual report, the Pend Oreille mine owned by Pend Oreille Mines & Metals Co. yielded 594,654 tons of ore which contained nearly 4,000 tons of lead and 12,000 tons of zinc. The mill was operated without interruption during the year, but at less than 68 percent of rated capacity due to continued shortage of skilled labor. The Calhoun mine and mill of the American Zinc Co., located at Colville in Stevens County, started operations in early October. The Van Stone mine owned by Asarco showed a 4-percent gain in the output of lead-zinc ore treated as compared with the 1965 figures.

Silver.—Output of silver came largely as a byproduct from two gold producers. The Knob Hill-Gold Dollar properties in Ferry County and the Gold King mine in Chelan County supplied 90 percent of the total output. Silver was recovered at an average rate of 3.7 ounces per ounce of recoverable gold. Lead-zinc operations furnished 10 percent of silver output, with an average of 1.5 ounces of silver per ton of concentrate produced.

Steel.—Northwest Steel Rolling Mills, Inc., Seattle, announced plans to build a new production facility on a 32-acre tract in Kent. The steel rolling mill was to have a capacity of about 80,000 tons annually, compared with the 55,000-ton capacity of the firm's present Seattle facility. Construction was slated to begin early in 1967 on the plant which was to be equipped with the latest in air pollution control equipment.

Titanium.—The Boeing Co., Seattle, was constructing a titanium processing facility to support its supersonic transport program. Hot-forming, hot-sizing, and chemical processing were to be performed. The hot-forming area included a 70-foot-long stress-relief furnace, five preheat furnaces for dies and spacer blocks, and 10 hot-sizing presses capable of operating at 1,500° F while exerting vertical and horizontal pressure on dies.

Tungsten.—W. R. Grace & Co., a widely diversified Connecticut firm, took an option to purchase the Silver Hill tin-tungsten mine, located 4 miles south of Spokane, for $400,000. A 150-ton, gravity-type concentrator was constructed at the site in 1960, and small shipments of tungsten and tin concentrates were made in 1961 and 1962, but the property since has been idle.

Uranium.—Newmont Exploration, Ltd., prompted by the growing uranium demand for nuclear power reactors, undertook new exploration on the Spokane Indian Reservation, southwestern Stevens County, for Dawn Mining Co. at its Midnite uranium mine.

Dawn Mining Co., 51 percent owned by Newmont Mining Corp. and 49 percent by Midnite Mines, Inc., was the Northwest's largest uranium producer since starting production in 1958. Mining operations were halted in 1964, and milling of stockpiled ore was completed in mid-1965, but shipments of uranium oxide to AEC had been continued under a sales contract due to expire December 31, 1966.

Zirconium.—Sandvik Special Metals Corp. announced that construction was to begin on a zirconium alloy-tube-manufacturing plant in the Tri-Cities area of Washington State. The new plant was designed to manufacture tubing required for nuclear, powerplants. The firm is jointly owned by the Sandvik Steel Works of Sweden and United Nuclear Corp., a leading U.S. nuclear fuel producer. Its affiliate, Douglas United Nuclear, Inc., operates AEC's plutonium production reactors and related fabrication facilities at Hanford.

MINERAL FUELS

Carbon Dioxide.—Carbon dioxide, recovered from mineral waters in Klickitat County by Gas-Ice Corp., was converted to dry ice by the company. Another plant was operated by the same company at Finley, Benton County, for making carbon dioxide from an ammonia-plant waste product.

Coal.—Coal output from five mines in three western counties totaled 58,637 tons, an increase of 7 percent above the 1965 tonnage. About 16 percent of the raw coal washed by mechanical cleaning equipment was refuse from the underground mining operations in King and Thurston Counties. Coal was marketed directly from a strip-mining operation in Lewis County without processing. The average value of coal sold in the open market was $8.77 per ton.

Construction began at Tacoma by Pittsburgh and Midway Coal Mining Co. on a plant to test the feasibility of producing high-quality, low-ash, low-sulfur fuel from low-quality coals.

Peat.—Production of peat was 25,599 tons of which 11,566 tons was unprepared, 11,783 tons was shredded, and 2,250 tons was shredded and kiln dried before marketing. The average unit value of peat was $5.33 per ton. King County led in peat production, followed by Snohomish, Kitsap, Thurston, Skagit, and Mason Counties.

Petroleum and Natural Gas.—Two exploratory dry holes for oil and gas were drilled, one each in Jefferson and Lewis Counties. Oil and gas exploratory leases on 4,520 acres of State-owned land in Grays Harbor, Clallam, and Whatcom Counties were offered in May at public auction by the State Department of Natural Resources. The first exploratory drilling of offshore Continental Shelf lands outside the State 3-mile limit included a joint operating venture between Shell Oil Co. and Pan American Petroleum Corp. The well, spudded from the Santa Fe Drilling Co. drilling platform Blue Water II, was 14 miles west of Cape Shoalwater; water depth from the drilling platform totaled about 240 feet.

Washington Water Power Co. continued testing an underground natural gas storage site near Chehalis. Eight wells were drilled in Lewis County to allow injection of gas to the reservoir.

Table 9.—Test holes drilled for oil and gas in 1966

Company	Well	Total depth (feet)	County
Belco Petroleum Corp	Milwaukee-Land 1-1	6,832	Jefferson
Robert E. Wise and Stephen C. West	Hawkins No. 1	3,720	Lewis

Source: Washington Division of Mines and Geology.

REVIEW BY COUNTIES

Selected counties with significant metal and nonmetal developments are discussed in the following review. Mineral production was reported from all 39 counties in the State. With certain important exceptions, output was principally from nonmetallic deposits.

Chelan.—Ewer Lumber Co. produced pumice from a pit near the southeastern part of Chelan Lake. The screened material was sold to Pacific Northwest and Canadian consumers for use in manufacturing building blocks. L-D Mines, Inc., quarried sandstone from a deposit near Wenatchee and sold crushed silica-bearing material to cement plants. Dimension stone also was produced by the firm.

According to the annual report to stock-

holder by Day Mines, Inc., development work at the Gold King mine comprised 4,467 feet of drifts and crosscuts, 906 feet of raises, and 2,969 feet of test bore holes. Production was 92,496 tons of ore milled, averaging 0.23 ounce of gold and 0.5 ounce of silver per ton.

The Alcoa plant at Wenatchee saw the beginning of its biggest expansion program (a fifth potline and carbon-baking facilities) and the establishment of an alltime high production record. Alcoa began operating the plant in 1952. According to a company publication, wages and salaries (including employee fringe benefits) rose nearly $1 million from 1965 to $8.7 million. For the second consecutive year power costs declined, $5.9 million in 1966 compared with $6.2 million in 1965.

Clark.—Hidden Brick Co., Vancouver, produced clay for use in making building brick and draintile.

The Vancouver plant of Alcoa operated throughout the year at rated capacity.

Cowlitz.—The stratigraphic sequence, details of the geology, and geologic environment of the ferruginous bauxite area in the Kelso-Cathlamet area of Cowlitz and

Table 10.—Value of mineral production in Washington, by counties

(Thousand dollars)

County	1965	1966	Minerals produced in 1966 in order of value
Adams	$405	$284	Sand and gravel, stone.
Asotin	8	W	Sand and gravel.
Benton	1,112	1,832	Stone, sand and gravel.
Chelan	W	W	Gold, stone, sand and gravel, silver, pumice, copper.
Clallam	87	291	Sand and gravel, stone.
Clark	2,262	1,320	Stone, sand and gravel, clays.
Columbia	2,057	1,825	Sand and gravel, stone.
Cowlitz	397	408	Stone, sand and gravel, clays.
Douglas	112	321	Do.
Ferry	W	W	Gold, silver, stone, copper.
Franklin	502	783	Sand and gravel, stone.
Garfield	192	333	Stone, sand and gravel.
Grant	2,132	1,983	Diatomite, lime, stone, sand and gravel.
Grays Harbor	796	695	Sand and gravel, stone.
Island	34	89	Sand and gravel.
Jefferson	551	W	Stone, sand and gravel.
King	14,154	16,745	Cement, sand and gravel, stone, coal, clays, peat.
Kitsap	296	276	Sand and gravel, peat.
Kittitas	142	655	Stone, sand and gravel.
Klickitat	795	924	Sand and gravel, stone, carbon dioxide.
Lewis	483	510	Sand and gravel, stone, coal, clays.
Lincoln	244	182	Stone, sand and gravel.
Mason	173	2	Sand and gravel, peat, stone.
Okanogan	322	240	Stone, sand and gravel, gypsum, gold, silver, copper.
Pacific	175	349	Stone, sand and gravel.
Pend Oreille	8,241	7,880	Zinc, cement, lead, stone, sand and gravel, silver, copper.
Pierce	5,179	5,601	Sand and gravel, lime, stone, clays.
San Juan	531	W	Sand and gravel, stone.
Skagit	6,550	6,940	Cement, stone, olivine, sand and gravel, peat, soapstone.
Skamania	186	W	Stone, sand and gravel, copper, silver.
Snohomish	2,672	2,963	Sand and gravel, stone, peat, clays.
Spokane	4,630	5,703	Cement, stone, sand and gravel, clays, uranium, vanadium.
Stevens	6,744	6,685	Zinc, stone, magnesite, lead, sand and gravel, silver, clays, copper, gold.
Thurston	302	352	Sand and gravel, stone, coal, peat.
Wahkiakum	2	145	Stone.
Walla Walla	2,530	1,982	Stone, sand and gravel.
Whatcom	W	W	Cement, stone, sand and gravel, clays, olivine.
Whitman	1,895	2,081	Sand and gravel, stone.
Yakima	1,610	2,434	Sand and gravel, stone, lime.
Undistributed [1]	17,669	16,279	
Total	86,172	89,092	

W Withheld to avoid disclosing individual company confidential data.

[1] Includes value of mineral production that cannot be assigned to specific counties and values indicated by symbol W.

Wahkiakum Counties were mapped and defined.[6]

Reynolds Metals Co. aluminum reduction plant at Longview was operated at capacity. Longview was chosen by Reynolds as the site for a new transmission cable manufacturing plant. Underway at the reduction plant was a major construction program to increase capacity to 190,000 tons annually.

Douglas.—Keokuk Electro-Metals Co. continued to operate its ferrosilicon and silicon metal plant at Wenatchee.

Ferry.—Day Mines, Inc., Gold Dollar mine at Republic was extended to the new 13th level, but initially the grade of ore proved to be submarginal, and the ore body was badly faulted. The Gold Dollar ore body was mined from the workings of the adjoining Knob Hill mine.

Grant.—Kenite Corp. trucked crude diatomite from a pit southeast of Quincy to a company plant at Quincy where it was ground, calcined, sized, and packaged for shipment.

King.—The county, in terms of value of mineral commodities, continued to be the principal nonmetal-producing area in the State. Cement production increased at both the Ideal Cement Co. Grotto plant, and at the Lone Star Cement Co. Seattle plant. Construction work continued and neared completion on the Ideal Cement Co. 2.5-million-barrel-annual-capacity cement plant at Seattle. The plant, located on a 25-acre site on the Duwamish Waterway, features a 14- by 151½- by 500-foot kiln, two finish grinding mills (each 12 by 32 feet), each powered by 2,500-horsepower motors, and a raw grinding mill (11 by 36 feet) powered by a 2,000-horsepower motor. Limestone for the Seattle plant was to be furnished by the firm's Rock Products Division at Texada Island, British Columbia, Canada. The firm's storage capacity in the Seattle area would be increased to 373,000 barrels upon completion of the Seattle plant.

International Pipe & Ceramics Corp. produced clay from the Palmer, Renton, and Pit 55 pits for use in making building brick and draintile. The firm manufactured firebrick from material dug at the Blum and Harris pits. Builders Brick Co. mined clay at the Elk and Newcastle pits for use in making building brick and draintile. Ideal Cement Co. dug clay at the Grotto pit for use at its cement plant.

Palmer Coking Coal Co., Inc., continued supplying coal from the Rogers No. 2, Rogers No. 3, and Franklin No. 12 mines. Peat came from six bogs, and the county again ranked first in the State as a peat-producing area.

The county position was second in terms of output of sand and gravel; production totaled 5.2 million tons valued at $5.2 million. Most of the output was by commercial firms for building purposes and road construction.

Lewis.—Production of silicon metal began at the Centralia plant of Imperial Metals and Abrasives, Inc. The metal was for use as an additive in the foundry and

[6] Livingston, Vaughn E., Jr. Geology and Mineral Resources of the Kelso-Cathlamet Area, Cowlitz and Wahkiakum Counties, Washington. State of Washington, Division of Mines and Geology, Bull. 54, 1966, 110 pp.

Table 11.—Mine production of gold, silver, copper, lead, and zinc in the Metaline district, Pend Oreille County, in terms of recoverable metals

Year	Mines producing, lode and placer	Material sold or treated [1] (thousand short tons)	Gold, lode and placer (troy ounces)	Silver, lode and placer (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)	Total value (thousands)
1957–61 (average)	4	925	1	34,972	34	9,398	18,936	$6,707
1962	3	830	-----	29,233	35	5,901	21,430	6,068
1963	4	810	-----	30,274	35	5,373	22,270	6,343
1964	3	809	-----	28,766	31	4,755	19,597	6,634
1965	1	641	-----	23,689	22	4,411	13,201	5,277
1966	1	595	-----	21,478	19	3,923	11,909	4,681
1906–66	-----	16,592	307	664,062	492	181,985	412,717	137,767

[1] Does not include gravel washed.

aluminum industries. A 4,000-kilowatt furnace was used; an additional furnace rated at 10,000 kilowatts was being constructed, and a third furnace rated at 10,000 kilowatts was planned for future use.

Mason.—The stratigraphic sequence of Tertiary marine strata was mapped in western Mason and eastern Grays Harbor Counties.[7]

Pend Oreille.—The Metaline Falls operation of Lehigh Portland Cement Co. was the principal nonmetal producer. Cement shipments by the company were 6 percent less than the 1965 total.

Total lead-zinc production from the Pend Oreille mine declined 10 percent from that of 1965. Since construction of the Boundary hydroelectric project began in 1962, a persistent shortage of skilled labor had curtailed production to an average 70 percent of rated milling capacity. The decreased tonnage, according to the annual report of Pend Oreille Mines & Metals Co., as well as the reduced lead price, resulted in receipts from concentrates declining to $2.9 million from $3.3 million in 1965. Operating costs per ton were $3.886 and total costs $4.258 compared with $3.906 and $4.243, respectively, in 1965.

Pierce.—Pacific Lime, Inc., sold lime from its Tacoma plant to Pacific Northwest and Canadian customers for chemical and construction purposes. Builders Brick Co. dug clay from the Clay City pit for use in making brick. The county, with 35,000 tons more sand and gravel produced than the total for King County, ranked first in sand and gravel output; it totaled 5.2 million tons valued at $4 million. The largest commercial sand and gravel firms operating in the State included the Steilacoom operations of Pioneer Sand & Gravel Co. and Glacier Sand & Gravel Co.

Skagit.—The Lone Star Cement Corp. plant at Concrete was the major mineral industry activity in terms of value. Output increased 16 percent, and shipments were 13 percent greater than the 1965 total. Limestone was hauled by aerial tram about 1 mile in ¾-cubic-yard buckets from the Lang quarry to the plant at Concrete.

Olivine mined at the Twin Sisters quarry was trucked 20 miles to the Northwest Olivine Co. grinding plant at Hamilton. Olivine also was mined at the Sisters Mountain quarry by Scheel Stone Co.

Soapstone was mined at deposits near Marblemount by Herman Smith, Skagit Talc Products, and Scheel Stone Co.

Snohomish.—The county ranked second as a peat-producing area. Output was from three bogs, one near Lynnwood and two near Bothell. Lowell Brick Co. dug clay at a pit near Lowell for use in making building brick. Limestone for agricultural purposes came from operations at the Haystack quarry by Miller Lime Co. and from operations at the Bryant quarry by Western Lime Co.

Spokane.—The Irvin plant of Ideal Cement Co. continued to be the principal nonmetallic industry activity in terms of mineral production value. Output at the plant increased 14 percent, and shipments were 2 percent greater than the 1965 total. Clay for the operation came from the company-owned Spokane County clay pit, and limestone came from the firm's Stevens County Limerock quarry.

International Pipe & Ceramics Corp. dug clay from the Mica and Sommer pits for manufacturing clay products and fire clay refractories at the firm's Mica plant.

Quarry Tile Co. completed a plant at Spokane for manufacturing clay products. Clays used in the operation were brought by rail to the plant from nearby pits, stockpiled inside the plant, ground, dried, blended, and then pressed into shapes that were fired in a tunnel kiln. The clay products were shipped to customers in the Pacific Northwest, California, Virginia, Louisiana, and Georgia.

Stevens.—Magnesite from the Finch, Red Marble, and Keystone quarries of Northwest Magnesite Co. was the most important nonmetallic mineral produced in the county. Limestone, marble, and silica-bearing materials also were quarried.

According to the annual report of Asarco, the Van Stone mine at Colville yielded concentrates containing an average 820 tons of zinc per month. The Calhoun mine and mill of American Zinc Co., located 40 miles northwest of Colville, became operative in October. Exploration at the Midnite uranium mine was begun by Newmont Exploration, Ltd., on the Spokane Indian Reserva-

[7] Rau, Weldon W. Stratigraphy and Foraminifera of the Satsop River Area, Southern Olympic Peninsula, Washington. State of Washington, Division of Mines and Geology, Bull. 53, 1966, 66 pp.

tion claims belonging to Dawn Mining Co. Old rotary-drill holes were being deepened and new ones drilled. Surface trenching also was accomplished. The exploration was undertaken to increase the known ore reserves, reported at about 550,000 tons.

Whatcom.—The county continued to rank second in value of nonmetal mineral commodities. The Columbia Cement Co. (a subsidiary of Pittsburgh Plate Glass Co.) plant at Bellingham, formerly operated by Kaiser Cement & Gypsum Corp., was the leading nonmetallic operation in the county in terms of value, and continued as the largest source of cement in the State. Limestone for the operation came from a company quarry near Maple Falls.

Power was supplied in May to the first of three scheduled 76,000-ton potlines at the primary aluminum reduction plant of Intalco Aluminum Corp., located north of Bellingham at Ferndale. The second potline came on line at yearend, and a third was planned to be operating by 1968.

The Mineral Industry of West Virginia

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

By Meherwan C. Irani [1]

The continued growth of the national economy during 1966 favorably affected the basic industries like coal, oil, steel, and nonferrous metals and the minerals industry of West Virginia. The value of mineral production in the State increased by $32.2 million, a gain of 4 percent. Coal production accounted for 85 percent of the value of the State's mineral output and increased by $27.8 million in value. During 1966, 45 large new mines were constructed, the greatest expansion of coal production capacity since the 1940's.

[1] Metallurgist, Bureau of Mines, Pittsburgh, Pa.

Table 1.—Mineral production in West Virginia [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays [2] thousand short tons	289	$328	300	$334
Coal (bituminous) do.	149,191	726,096	149,681	753,851
Lime do.	W	W	240	3,492
Natural gas million cubic feet	207,416	48,743	211,610	49,940
Petroleum (crude) thousand 42-gallon barrels	3,530	13,591	3,674	14,623
Salt thousand short tons	1,153	5,539	1,147	5,446
Sand and gravel do.	5,253	11,480	5,448	11,569
Stone [3] do.	8,482	14,587	9,738	16,354
Value of items that cannot be disclosed: Calcium-magnesium chloride, cement (portland and masonry), fire clay, gem stones, natural gas liquids, stone (dimension sandstone) and values indicated by symbol W	XX	39,240	XX	36,191
Total	XX	859,604	XX	891,800

W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed."
XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes fire clay; included with "Value of items that cannot be disclosed."
[3] Excludes certain stone; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in constant 1957–59 dollars

(Millions)

Year	Value [1]	Year	Value [1]
1957	$953	1962	$770
1958	756	1963	839
1959	760	1964	891
1960	753	1965	934
1961	731	1966	951

[1] Data for 1957–65 revised.

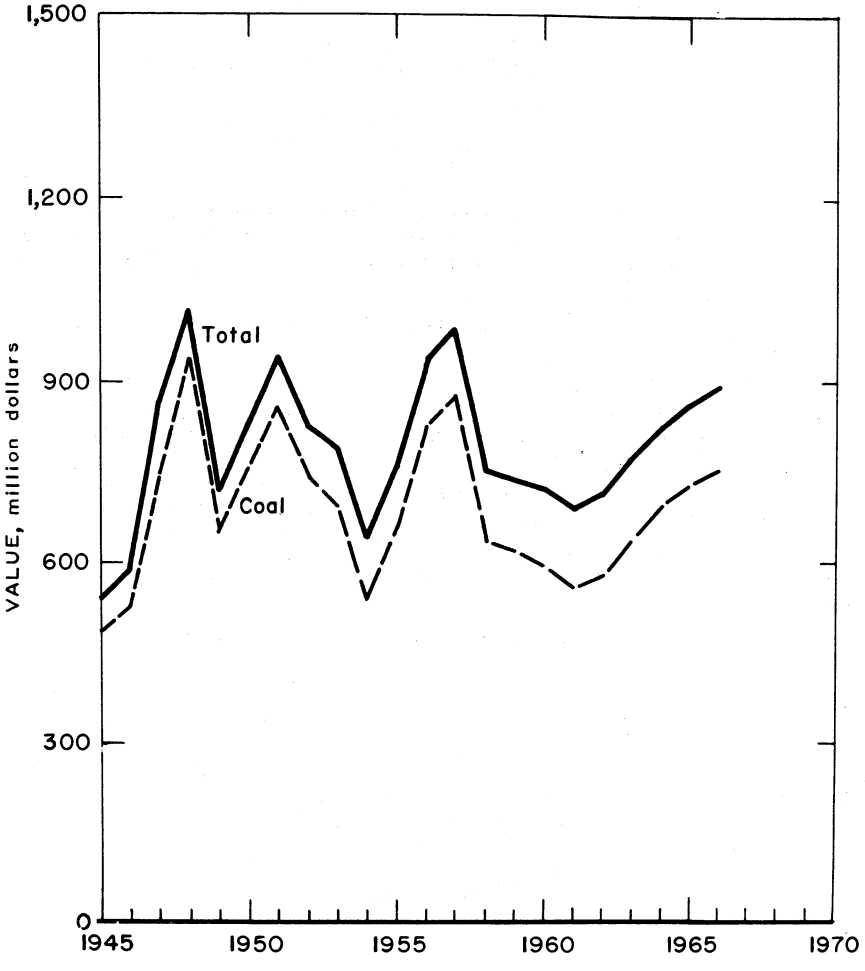

Figure 1.—Value of coal and total value of mineral production in West Virginia.

Table 3.—Employment 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
1965:								
Coal	44,495	215	9,580	75,999	95	4,678	62.80	11,619
Nonmetal	967	310	300	2,400	---	17	7.08	433
Sand and gravel	240	234	56	473	---	10	21.16	838
Stone	1,164	256	298	2,495	1	39	16.03	3,717
Total	46,866	218	10,234	81,367	96	4,744	59.48	10,984
1966: [p]								
Coal	43,500	213	9,269	73,420	80	4,335	60.13	10,494
Nonmetal	1,000	307	308	2,465	---	17	6.90	486
Sand and gravel	270	256	70	600	2	14	26.67	20,382
Stone	1,420	261	371	2,940	---	59	20.07	1,113
Total	46,190	217	10,018	79,425	82	4,425	56.75	9,911

[p] Preliminary.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—West Virginia maintained its position as the leading coal-producing State in the Nation. Although total production of 149.7 million tons was only slightly higher than in 1965, the value increased by 4 percent to $754 million from $726 million in 1965.

The production of coal sold on the open market increased by 1 percent to 130.3 million tons while the value increased 5 percent to $637 million. Coal produced by captive mines was 19.3 million tons, a decrease of 2 percent, valued at $116.8 million, about the same as in 1965. The average value per ton of coal rose to $5.04 from $4.87 in 1965. There were 1,597 active mines with production in excess of 1,000 tons, a decrease of 63. Of the total production, 89 percent was produced at 1,318 underground operations, a decrease of 65; 8 percent at 179 strip mines, a decrease of 12; and 3 percent at 100 auger mines, an increase of 14.

Equipment used at underground mines included 1,345 cutting machines, 128 less than in 1965; 1,756 hand-held and post-mounted drills, a decrease of 214; 231 mobile drills, an increase of 22; 888 rotary drills, an increase of 88; and 325 percussion drills, a decrease of 11.

Strip coal mining equipment included 270 power shovels, 30 draglines, nine carry-all scrapers, 311 bulldozers, 56 horizontal and 89 vertical drills. Transportation of coal from strip pit to tipple, an average distance of 7 miles, was done by 536 trucks, each having an average capacity of 19 tons. Equipment at auger mines included 110 augers, eight power shovels, 105 bulldozers, and four horizontal and six vertical drills. Coal transportation from auger operation to tipple, an average distance of 5 miles, was done by 224 trucks, each with an average capacity of 20 tons.

Of the total underground production, mechanically loaded coal increased to 96 percent, 2 percent more than in 1965. Of the total mechanically loaded, 47 percent was by 812 mobile loading machines, 32 more than in 1965. Of the total loading machines, 674 loaded into shuttle cars, 96 into mine cars and 42 onto chain conveyors. Continuous mining machines produced 66.7 million tons, equal to 52 percent of the coal mechancially loaded. Of the 585 continuous mining machines in use, 79 more than in 1965, 416 loaded into shuttle cars and 169 onto conveyors. An additional 149 mobile loaders were used in conjunction with continuous miners to obtain greater production by preventing delays that occur at times in shuttle car transportation. The remainder of the mechanically loaded tonnage was hand loaded into 122 face conveyors, 38 less than in 1965.

In 1966, 161 cleaning plants, three more than in 1965, cleaned 79 percent of total production compared with 79.5 percent in 1965. Of the total, 31 percent was cleaned by jigs, 62 percent by wet washing other than jigs, and 7 percent by pneumatic methods. Of the total output, 36 percent was crushed, 22 percent was dried in 54 thermal drying plants, and 11 percent was treated for dust control. Of the total treated for dust control, 91 percent was with oil, 3 percent with calcium chloride and oil, and the balance with calcium chloride and with other materials.

Of the total production, 96 percent was transported by rail and water and the remainder by truck and other methods.

Under a contract with the U.S. Department of the Interior, Office of Coal Research, a pilot plant to manufacture gasoline from coal, was constructed at Cresap, by Consolidation Coal Co., a subsidiary of Continental Oil Co. According to company officials, the plant is the result of 15 years of successful benchwork and process development research conducted at the company research laboratory near Library, Pa. Economic studies indicated that gasoline from coal could be produced on a very large scale by the process for between 11 and 13 cents per gallon. The primary objective of the pilot plant, designed to process 1 ton per hour of coal feeds and produce about 60 barrels per day of hydrocarbon liquids, is to prove, on a larger scale, the earlier laboratory research. Initially, the plant will operate on Pittsburgh No. 8 seam coal from the nearby Ireland mine of Consolidation Coal Co. The Office of Coal Research hopes that this plant will provide the data needed for design of a commercial plant by the early 1970's and operation of

a commercial plant by industry prior to 1975.

At the Morgantown Coal Research Center of the Bureau of Mines, research was accelerated on more efficient power-generating systems using coal. New economical processes for sulfur removal from steam coals and from stack gases and the use of fly ash for reclamation of surface-mine spoils, as a soil conditioner, and as a source of trace nutrients in agriculture were investigated. Research was conducted to develop use of radioisotopes for rapid inexpensive analysis of coal and on processes for economical recovery of valuable products from low temperature tar. Development work continued on perfecting electrostatic precipitators for removal of dust from coal gases at higher than normal temperatures and pressures. Fundamental research on coal carbonization and gasification was continued. Such basic research is useful for development of economic processes for converting coal into chemicals, pipeline gas, and other products.

The West Virginia Coal Research Bureau at Morgantown conducted research on use of fly ash for manufacturing bricks and other construction materials and under a contract with the Department of the Interior, Office of Coal Research, constructed a pilot plant to make these materials. The project's objective is to develop a commercial market for fly ash, so that coal-burning powerplants may have inducement to install equipment for more efficient collection of fly ash. According to the Office of Coal Research, preliminary estimates show that use of fly ash for bricks could result in byproduct credits that would reduce powerplant fuel costs by 2 cents per million Btu.

Table 4.—Coal (bituminous) production

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1957–61 (average)	125,603	$657,508
1962	118,499	578,293
1963	132,568	634,794
1964	141,409	693,572
1965	149,191	726,096
1966	149,681	753,851

Table 5.—Coal (bituminous) production by counties

(Thousand short tons and thousand dollars)

County	1965		1966	
	Quantity	Value	Quantity	Value
Barbour	3,366	$14,328	3,350	$14,212
Boone	8,597	38,330	9,068	42,956
Brooke	1,020	3,353	871	3,095
Clay	65	258	W	W
Fayette	6,237	27,771	5,586	25,415
Grant	1,729	6,396	2,035	7,070
Greenbrier	972	4,679	839	3,659
Hancock	4	9	5	13
Harrison	8,158	34,053	6,940	30,113
Kanawha	10,938	46,087	11,577	50,299
Lewis	342	1,196	546	1,976
Lincoln	18	43	10	24
Logan	16,343	74,313	17,293	83,672
McDowell	17,102	107,761	17,057	110,983
Marion	14,093	72,030	13,826	71,064
Mason	423	1,447	389	1,599
Mercer	W	W	1,344	8,721
Mineral	W	W	141	559
Mingo	5,640	29,313	5,411	29,789
Monongalia	8,977	42,756	W	W
Nicholas	8,031	38,090	8,465	42,967
Pocahontas	91	322	W	W
Preston	3,857	13,954	3,692	12,943
Raleigh	9,657	51,933	9,112	52,257
Randolph	1,027	3,704	856	3,382
Taylor	317	1,115	241	876
Tucker	460	1,317	599	1,772
Upshur	591	2,252	614	2,286
Webster	667	3,097	670	3,384
Wyoming	14,099	75,991	15,274	86,139
Other counties [1]	6,370	30,198	13,870	62,626
Total	149,191	726,096	149,681	753,851

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

[1] Includes data for Braxton (1965), Gilmer, Marshall, Ohio, and Wayne Counties, and counties indicated by symbol W.

According to preliminary data, 80 fatal accidents occurred in coal mining in 1966, 69 occurred underground and 11 on the surface. Of the surface fatalities, six were at surface facilities serving underground mines, four at strip mines, and one at auger operations.

Causes of fatal accidents underground were falls of roof or face, 41; haulage, 14; gas or dust explosion, seven; electricity, one; machinery, five; and other, one.

One major disaster (five or more fatalities) occurred in 1966. A gas explosion in the New River Co. Siltex Mine killed seven men.

Coke and Coal Chemicals.—Coke production at three oven-coke plants having 668 ovens was 3.6 million tons, about the same as in 1965. Total value of the oven-coke f.o.b. plant was $61.6 million, an increase of $2.2 million; average value per ton was $17.30, an increase of $0.42 from that of 1965.

At the oven-coke plants, 5.2 million tons of coal was carbonized with a coke yield of 68.75 percent. A total of 205,731 tons of coke breeze, 3.97 percent per ton of coal carbonized, valued at $1.23 million was recovered. Coal chemicals produced at oven coke plants included coke-oven tar (49.4 million gallons), coke-oven gas (58.1 billion cubic feet), ammonium sulfate (46,225 tons), and large quantities of crude light oil from which benzene, toluene, xylene, and solvent naphtha were recovered.

Natural Gas Liquids.—Production of natural gas liquids in 1966 was 304 million gallons. Reserves of all natural gas liquids at the end of 1966 were 81 million barrels (42 gallons each), an increase of 8 percent.[2] There were 34 natural gas processing plants in operation during the year, consisting of 29 compression facilities, two absorption plants, two combination facilities, and one cycling operation. An average of 537 million cubic feet per day of gas was processed, and average daily production was 47,460 gallons of propane, 53,740 gallons of normal butane, 554,985 gallons of combined gasoline and liquefied petroleum (LP) gas, 28.140 gallons of debutanized natural gasoline, and 46,800 gallons of other products.[3]

Plants were operated by Consolidated Gas Supply Corp. in Wetzel County; Owens, Libbey-Owens Gas Department and Union Oil Co. of California in Kanawha County; Union Carbide Corp. in Wetzel and Kanawha Counties; United Fuel Gas Co. in Kanawha and Wayne Counties. Pennzoil Co. operated 26 small compression plants in various counties.

Petroleum and Natural Gas.—Crude oil production in 1966 was 3.7 million barrels, about the same as in 1965. The well-head price was $4.00 per barrel in Cabin Creek and Kelly Creek fields.[4] Natural gas production [5] of 211,600 million cubic feet was slightly higher than that in 1965. The estimated number of producing wells in the State at the end of 1966 was 21,000 gas wells and 13,500 oil wells.

There was a slight increase in oil and gas drilling activity in the State in 1966 as compared with the previous year. During the year, according to the State of West Virginia Geologic and Economic Survey, the State issued 1,315 permits to drill or deepen wells. Drilling was reported in 40 of the State's 55 counties. Total footage drilled was 3,071,074 feet, a slight decrease from that of 1965. There were 2,803,827 feet of development drilling and 267,247 feet of exploratory tests. The average depth of the wells drilled was 2,568. A total of 1,207 wells were drilled in 1966, 41 more than 1965. Of these, 214 were oil wells, 620 gas wells, 176 combination wells, 50 miscellaneous wells (storage, injection, etc.), and 147 dry holes. There were 80 exploratory tests, of which 51 were successful. Of the 51 successful wells, 43 were gas wells.

Important new field discoveries were made in Hardy, Harrison, Mineral, and Preston Counties. In Hardy County just south of Hampshire County line, in eastern West Virginia, the largest recorded gas well in the State, producing at the rate of 90 million cubic feet per day, was completed. As in previous years, the Big Injun Sand was the main oil- and gas-producing formation in the State. In 1966, over 570 successful wells were drilled to this sand, mostly in the north-central counties of Calhoun, Doddridge, Gilmer, Lewis, Ritchie, and

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[2] American Gas Association. Report of the Committee on Natural Gas Reserves. Apr. 3, 1967, table 2.
[3] Oil and Gas Journal. V. 65, No. 12, Mar. 20, 1967, p. 204.
[4] Oil and Gas Journal. V. 65, No. 23, June 5, 1967, p. 196.
[5] West Virginia Geological and Economic Survey.

Roane. Drilling for Big Injun oil in the Walton Field, Roane County, was very active (about 160 wells). Of the seven successful new field wildcats completed in 1966, four in Hardy, Jackson, Mineral and Kanawha Counties were considered to be significant.

Natural gas in storage at the end of 1966 was 334.9 billion cubic feet, a 19.7-billion-cubic-foot decrease from that of 1965.

Two plants, located near Falling Rock and St. Marys, had refining capacity of 7,000 barrels per day of crude oil and a cracking and reforming capacity of 3,950 barrels of crude oil per day, and produced gasoline, lubricating oil, and waxes.

Proved reserves of crude oil at yearend were 56.6 million barrels, an increase of 1.4 million barrels over that of 1965.[6] Reserves of natural gas at the end of 1966 were 2,622 billion cubic feet, an increase of 128 billion cubic feet over that of the previous year.[7]

NONMETALS

Cement.—Shipments of portland cement declined 2 percent and masonry cement 5 percent from the 1965 levels. The average price per barrel declined slightly. The sole producer, Capitol Cement Co., Division of Martin Marietta Corp. at Martinsburg, Berkeley County, continued its modernization program during 1966. For its raw material requirements, the company operated an underground high-calcium limestone mine and open pit mines for cement rock and shale. All kilns were coal fired. Most of the cement was used for ready-mix concrete, concrete products, and building and highway construction. Shipments were to Maryland, District of Columbia, Virginia, Western Pennsylvania, North Carolina, Delaware, and West Virginia. The delivery of the cement was about evenly divided between truck and railroad haulage.

Clays.—Combined production of fire clay and miscellaneous clay was 8,400 tons more than in 1965. Miscellaneous clay output rose 10,900 tons, offsetting a decline in fire clay output. The former were chiefly used in the manufacture of building brick and cement manufacture, whereas the fire clay was used mostly for producing firebrick and block (including ladle brick). A total of 11 mines were in operation, seven of which were open-pit and four underground. Clay was produced in seven counties, the highest production of miscellaneous clay was from Berkeley County and greatest output of fire clay was from Hancock County.

Gem Stones.—Mineral specimens were collected by hobbyists at scattered locations in the State. Aragonite, cave onyx, and stilbite are among the specimens collected in recent years.

Lime.—Production of lime increased over that of 1965. Chief uses were for refractory lime, steel production, and pulp and paper manufacture. Three companies operated plants—one each in Berkeley County, Jefferson County, and Pendleton County.

Sand and Gravel.—Production of sand and gravel increased 4 percent but total value remained about the same as in 1965. The average price per ton decreased by 7 cents to $2.12. Of the total output, 61 percent was sand and 39 percent was gravel. About 62 percent of the output was shipped by barge and the balance was shipped by railroad and truck.

Production was reported from operations in 11 counties. Of the leading producing counties, Hancock was first, followed in descending order by Morgan, Pleasants, Wood, Ohio, and Brooke.

[6] American Petroleum Institute. Crude Reserves Report. Apr. 3, 1967.

[7] American Gas Association. Report of Committee on Natural Gas Reserves. Apr. 3, 1967, table 1.

Table 6.—Clays sold or used by producers

Year	Fire clay		Miscellaneous clay		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1957–61 (average)	320,175	$2,130,033	262,530	$264,873	582,705	$2,394,906
1962	242,913	W	203,954	W	446,867	2,085,597
1963	236,695	W	177,624	W	414,319	2,044,390
1964	W	W	261,498	308,522	W	W
1965	W	W	289,395	327,576	W	W
1966	W	W	300,321	334,231	W	W

W Withheld to avoid disclosing individual company confidential data.

Table 7.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	1,505	$1,947	1,704	$2,200
Paving	444	772	418	705
Fill	31	41	44	55
Gravel:				
Building	1,209	1,515	1,400	1,764
Paving	858	1,452	671	1,065
Fill	21	26	W	W
Undistributed [1]	1,185	5,727	1,211	5,780
Total sand and gravel	5,253	11,480	5,448	11,569

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes glass, molding, blast, engine, fire or furnace, grinding and polishing (1966), filtration, ground and other industrial sands; railroad and other gravel, and items indicated by symbol W.

Natural Salines.—Natural well brines near South Charleston yielded calcium-magnesium chloride as a byproduct. Production, significantly more than in 1965, was used for coal preparation, dust control in coal mines, and chemical manufacturing.

Salt.—Production of salt from brines was about the same as in 1965. Most of it was used by the producers for manufacture of chlorine and caustic soda by electrolysis. Production was reported from Kanawha, Marshall, Pleasants, and Tyler Counties, and in all except Kanawha was from deep well solution mining. Kanawha County output was obtained from naturally occurring brines.

Slag (Iron-Blast-Furnace).—Weirton Steel Co., Division of National Steel Corp., produced air-cooled crushed blast furnace slag for aggregate use.

Stone.—Total crushed stone production (limestone and sandstone) increased by 15 percent over that of 1965. Crushed limestone production increased 12 percent to 8.7 million tons. Major uses for the limestone were as flux in iron and steel production, for concrete aggregate, railroad ballast, and lime and cement manufacture.

Production of crushed sandstone, which was mostly used for concrete aggregate and highway construction, increased to 1,015,276 tons valued at $2 million from 680,535 tons valued at $1.3 million in 1965. Berkeley, Jefferson, Monongalia, and Greenbrier Counties were the leading producers of limestone. Leading sandstone producing counties were Harrison, Raleigh, Wyoming, Kanawha, Wayne, and Tucker.

Table 8.—Stone sold or used by producers, by uses

Use	1965		1966	
	Short tons	Value	Short tons	Value
Crushed and broken stone:				
Concrete and roadstone	3,120,037	$4,817,789	3,988,880	$6,642,228
Railroad ballast	636,051	797,883	640,885	839,182
Agriculture	125,444	299,506	124,955	295,519
Other uses [1]	4,600,153	8,672,094	4,983,593	8,577,140
Total	8,481,685	14,587,272	9,738,313	16,354,069

[1] Includes limestone for glass, asphalt filler, coal dust, filter beds (1966), stone sand, cement, lime, riprap, flux, refractory material, and miscellaneous uses, and sandstone for stone sand (1966), glass, engine, and refractory use.

METALS

Aluminum.—The aluminum reduction plant of Kaiser Aluminum & Chemical Corp., at Ravenswood in Jackson County, operated at full capacity during 1966. Alumina for the plant was processed from Jamaican bauxite at the company's Louisiana alumina plant and transported to Ravenswood by barge. The ingots of electrolytic aluminum were rolled into sheets and plates and shipped to aluminum fabricating plants in various States.

Ferroalloys.—Union Carbide Corp.'s large ferroalloys plant at Alloy, Fayette County, operated 18 submerged arc electric furnaces ranging in size from 2,000 to 25,000 kilovolt-amperes (KVA). Plant products included silico-manganese, ferromanganese, silicon metals, ferrochrome, ferrovanadium, exothermic alloys of manganese and chromium and specialty alloys of zirconium, strontium, calcium-silicon, and calcium-manganese-silicon. Most mineral raw materials for the plant were obtained from other States or imported, except for the quartzite consumed; 5 percent of which was obtained from West Virginia mines, the rest from North Carolina. Electrode carbon paste was obtained from the carbon and graphite manufacturing plant of the corporation near Clarksburg, W. Va. During 1966, the company modernized one of its furnaces and started construction on a new 25,000-KVA furnace. Plant power demand varied between 150,000 and 235,000 KVA, with the main power supply coming from the firm's 100,000-KVA hydroelectric station located 8 miles from the plant on New River. The excess power requirement was generated at the company's 135,000-KVA capacity, coal-fired steam plant at Alloy, which contained four generators of from 25,000 to 50,000 KVA. Company owned mines in the vicinity supplied 50 percent of the coal requirements; the remainder was purchased.

Iron and Steel.—The H. K. Porter Co. plant in Huntington made steel in electric furnaces from purchased scrap, principally No. 1 heavy melting, No. 2 heavy melting, and bundled auto scrap. Two electric arc furnaces of 15 feet shell diameter, rated at 11,500 KVA were operated. During 1966, the average heat was 53.5 tons and average tap to tap time was 3 hours and 45 minutes.

Besides scrap, raw materials used were lime and Mexican fluorspar for flux and lump iron ore from the Mesabi range for decarburizing the steel. Alloying materials used were ferrosilicon, ferrochrome, and ferrovanadium, 30 percent of which the firm reportedly purchased from sources in West Virginia.

The plant made 40 percent killed steel and 60 percent semikilled steel. The ingots were rolled into specialty products such as subpurlins for building industry, mine roofing bolts, rails, and products for heavy implement manufacture, and concrete reinforcing bars.

Almost all incoming and outgoing shipment was by truck.

Plant slag, due to its high lime and fluoride content, was not suitable for aggregate or agricultural purposes and was dumped.

The company accelerated its pollution control program during 1966 when construction started on a dust collector for one of the plants existing 20,000-KVA furnaces, and installation of a venturi-type wet dust collector began on the new 25,000-KVA furnace.

Vanadium Corporation of America produced ferroalloys in its plant at Graham in Mason County.

Nickel.—The International Nickel Co., Inc., rolled various alloys of nickel at its rolling mill at Huntington. The company imported nickel from its Canadian operations, but many of the other basic materials were obtained in West Virginia or adjoining States.

Zinc.—Mathiessen & Hegeler Zinc Co. operated a zinc smelter in Harrison County. Mineral raw materials used at the operation were zinc concentrates imported chiefly from Canada, galvanizer's dross purchased from various sources, bituminous coal from West Virginia, clay from Ohio, and anthracite from Pennsylvania. The plant, equipped with 20 vertical retort zinc furnaces, has an annual capacity of 50,000 tons of slab zinc and 6,000 tons of zinc dust.

Of the zinc products produced 80 percent was slabs; 14 percent, zinc dust; and 6 percent, ball anodes for use as electrolytic protection against galvanic corrosion.

REVIEW BY COUNTIES

Barbour.—Total coal production was about the same as in 1965. Output from underground mines reportedly increased 7 percent, and was over half the total. Strip mine production decreased slightly. Auger production decreased 30 percent although there were three active mines compared with one in 1965. Equipment used at strip mines included 22 power shovels, four draglines, one carryall scraper, 30 bulldozers, and 59 trucks with an average capacity of 17 tons. Grafton Coal Co. was the leading strip mine producer. Of the underground production, 95 percent was mechanically loaded, compared with 92 percent in 1965. Of the mechanically loaded coal, 46 percent was by mobile loading machines, and 54 percent by continuous miners. There were 13 continuous miners and 21 mobile loading machines. Badger Coal Co., Inc., and Bethlehem Mines Corp. were the leading underground producers.

Table 9.—Value of mineral production in West Virginia, by counties [1]

County	1965	1966	Mineral production in 1966 in order of value
Barbour	$14,328,035	W	Coal, stone.
Berkeley	18,951,730	W	Cement, stone, lime, clays.
Boone	38,329,519	W	Coal, stone.
Braxton	W	W	Stone.
Brooke	W	W	Coal, sand and gravel.
Cabell	W	W	Sand and gravel, clays.
Clay	257,764	W	Coal.
Doddridge	8,212	---	
Fayette	27,771,017	$25,414,729	Coal.
Gilmer	W	W	Do.
Grant	W	W	Coal, stone.
Greenbrier	6,755,949	5,847,755	Do.
Hancock	W	W	Clays, sand and gravel, coal.
Hardy	40,886	34,747	Stone.
Harrison	W	30,650,278	Coal, stone.
Jefferson	4,986,004	5,414,152	Stone, lime.
Kanawha	46,892,306	51,229,572	Coal, salt, stone, clays, calcium-magnesium chloride.
Lewis	W	2,126,622	Coal, stone, clays.
Lincoln	W	28,805	Coal, stone.
Logan	74,313,414	83,672,064	Coal.
McDowell	107,807,209	110,982,513	Do.
Marion	72,030,408	71,064,113	Do.
Marshall	14,137,037	15,441,107	Coal, salt.
Mason	1,490,919	W	Coal, sand and gravel.
Mercer	8,217,633	W	Coal, stone, clays.
Mineral	725,336	W	Coal, stone.
Mingo	29,312,840	29,789,116	Coal.
Monongalia	W	W	Coal, stone.
Morgan	W	W	Sand and gravel.
Nicholas	38,133,070	42,975,862	Coal, stone.
Ohio	W	W	Coal, sand and gravel.
Pendleton	964,951	W	Lime, stone.
Pleasants	W	W	Sand and gravel, salt.
Pocahontas	514,070	431,268	Coal, stone.
Preston	W	W	Do.
Raleigh	W	W	Coal, stone, sand and gravel.
Randolph	W	W	Coal, stone.
Roane	---	7,163	Stone.
Taylor	W	W	Coal, clays.
Tucker	W	W	Coal, stone.
Tyler	W	W	Salt.
Upshur	W	2,285,924	Coal.
Wayne	W	310,258	Coal, stone.
Webster	3,096,846	3,383,707	Coal.
Wetzel	W	W	Sand and gravel.
Wirt	---	3,734	Stone.
Wood	W	W	Sand and gravel.
Wyoming	76,039,395	86,464,044	Coal, stone, sand and gravel.
Undistributed	274,499,315	324,242,376	
Total	859,604,000	891,800,000	

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

[1] Calhoun, Hampshire, Jackson, Monroe, Putnam, Ritchie and Summers Counties are not listed because no production was reported.

[2] Includes gem stones, natural gas, natural gas liquids, petroleum, and some salt and stone that cannot be assigned to specific counties, and values indicated by symbol W.

Two cleaning plants prepared 32 percent of county coal; 93 percent was crushed and 4 percent was treated.

General Paving Corp. quarried sandstone shale for concrete aggregate and paving.

Berkeley.—Manufacture of cement continued to be the leading mineral industry. Capitol Cement Co., Division of Martin Marietta Corp., produced both portland and masonry cement. Limestone and shale needed for the cement production came from company owned mines. Production of cement was about the same as in 1965.

The county continued to be the leading limestone producer, most of which was used for manufacture of cement. Other uses were for blast-and-hearth flux, concrete aggregate, roadstone, lime manufacture, and railroad ballast. Producers were Capitol Cement Co. and Appalachian Stone, both divisions of Martin Marietta Corp., Inwood Quarry, Inc., and Blair Limestone Division, Jones & Laughlin Steel Corp.

Lime was produced by Blair Limestone Division of Jones & Laughlin Steel Corp. mainly as use for flux.

Production of clay was about the same as in 1965 and the county maintained its position as the leading clay producer. Clay for building brick was produced by The United Clay Products Co. and the Continental Clay Products Co.

Boone.—Output of coal increased 5 percent, and the county rose from eighth to seventh place in total production of coal in the State. It maintained its position as the leading producer of auger-mined coal and rose from fourth to third place in strip production. Of the total coal output, 72 percent was from 60 underground mines. Of the underground production, 95 percent was mechanically loaded by 45 mobile loaders, and 14 continuous miners. Equipment at the auger mines included 10 augers, two power shovels, 11 bulldozers, and 24 trucks with an average capacity of 31 tons. At strip mines 13 power shovels, 15 bulldozers, and 41 trucks with an average capacity of 42 tons were used. Of the total production, 65 percent of the coal was cleaned in six cleaning plants. Four of the plants dried 28 percent of the clean coal by thermal drying. Of the total coal output, 40 percent was crushed.

Ranger Fuel Corp. lead in both auger and strip production. The leading underground producers were Westmoreland Coal Co. (two mines), Eastern Associated Coal Corp. (three mines), and Armco Steel Corp. (one mine). Eastern Associated Coal Corp. opened the Harris underground mine in January. The Valley Camp Coal Co. purchased the underground mine of Ferndale Mining Co. in August, which was designated as No. 20 mine. The Blue Pennant underground mine was opened by Kessler Coals, Inc., in October. Ranger Fuel Corp. opened one new underground mine in June, two new strip mines in May and July, and one new auger mine in July.

R. B. Hill quarried a small quantity of sandstone for paving and concrete aggregate.

Braxton.—One small active underground coal mine produced less than 1,000 tons.

Sandstone was quarried for State Road Commission by Meadow Stone & Paving, Inc., from Rock Camp Quarry and Laurel Fork Quarry. The material was used for paving and concrete aggregate.

Brooke.—Coal production decreased 15 percent from that of the previous year. Of the total output, 72 percent was from underground mines. Of the underground production 98 percent was mechanically loaded with four mobile loading machines and two continuous mining machines. The leading underground producer continued as in past years to be Windsor Power House Coal Co., who used the coal in its own powerplant. K & P Construction Co. was the leading strip producer. Weirton Ice and Coal Supply Co. operated a cleaning plant for preparing coal from West Virginia and Ohio mines. Windsor Power House Coal Co. cleaned its coal at the company plant.

Production of sand and gravel increased slightly over that in 1965. Building and industrial sand and bank-run gravel was produced by The Brilliant Materials Co. near Follansbee. Duquesne Sand Co., the largest producer of sand and gravel in the county, produced building and paving sand and building gravel.

Cabell.—Sand and gravel production decreased by 53 percent as compared with 1965 figures. Ohio River Dredging Co., Inc., terminated its dredging operation in the county. Tri-State Materials Corporation

continued dredging of building and paving sand and gravel.

Production of red shale by Barboursville Clay Manufacturing Co., Barboursville, for manufacture of building brick increased by 10 percent over that of 1965.

Clay.—Production of coal, from five mines, decreased. Of the total underground production, 81 percent was hand-loaded onto face conveyors. None of the coal was processed.

Fayette.—Although output decreased 10 percent, and the number of active mines decreased by 29, the county continued to rank 11 in the State in coal production. Of the total, 82 percent was produced in 96 underground mines, 13 percent from 10 strip mines, and 5 percent from six auger mines. Of the underground production, 90 percent was mechanically loaded. Of this total, 58 percent was loaded by 62 mobile loading machines, 41 percent by 26 continuous mining machines, and 1 percent by 10 hand-loaded face conveyors.

Of the total production, 55 percent was cleaned at nine preparation plants, 33 percent was crushed, 3 percent was oil treated. Of the cleaned coal, 26 percent was thermally dried in two of the preparation plants. The leading underground producers were Allied Chemical Corp., The New River Co. (two mines), Riverton Coal Co. (three mines), and Beards Fork Coal Mining Corp. (three mines, two of which were new in 1966). Whitesville A & S Coal Co. was the largest strip producer and C. C. Conley & Sons was the leading auger producer. New mines employing over 20 men were opened by Clifftop Smokeless Coal Co., Gauley Eagle Coal Co. and Riverton Coal Co.

Union Carbide Corp. operated a large ferroalloy plant at Alloy. The plant employed 1,100 hourly and 300 salaried employees.

Gilmer.—Total coal production decreased 19 percent. Rochester & Pittsburgh Coal Co., the leading underground producer, cleaned its entire output with jigs and thermally dried 40 percent of the production. Of the total output, 48 percent was crushed and 3 percent treated with oil.

Basil R. Heavner's sandstone quarry was idle during the year.

Grant.—Coal production increased 18 percent. About 99 percent of the underground coal was mechanically loaded by one mobile loading machine and 17 continuous mining machines. North Branch Coal Co. and Alpine Coal Co. were leading underground producers; Buffalo Coal Co., Inc., was the leading strip producer. Two cleaning plants, one with thermal drying facilities, were operated. Of the total output, 92 percent was crushed but none was treated.

Production of limestone declined 40 percent. Material was used for agricultural stone, concrete aggregate, and roadstone. Producers were Bean's Lime & Stone, Inc., Petersburg, Keplinger Lime Co., Inc., Maysville, and Garbart Trucking Co., Aurora.

Petersburg Blocks, Inc., mined a small quantity of sandstone for manufacture of stone sand.

Greenbrier.—Coal production decreased 14 percent, with almost all of the county output from underground operations. Mechanically loaded coal increased to 74 percent of underground production from 60 percent in 1965. The coal-loading equipment consisted of nine mobile loading machines, nine continuous miners, and four hand-loaded face conveyors. The largest underground mines were operated by Leckie Smokeless Coal Co. and Gauley Coal & Coke Co. There were no cleaning or drying facilities in operation. About 17 percent of the county output was crushed, and less than 1 percent was treated.

Limestone production increased 5 percent over that of 1965, and the county was the fourth largest producer of limestone. The material was used for railroad ballast, concrete aggregate, roadstone, rock dust for coal mines, stone sand, and agricultural stone. Producers were The H. Frazier Co., Inc., and Acme Limestone Co., both of Fort Spring, Savannah Lane Quarries, Frankford, and Central Asphalt Paving Co., Richlands.

Hancock.—The Globe Brick Co. mined fire clay for manufacture of refractory bricks for ladle use at steel plants, and high-alumina clay for manufacture of refractory bricks. Crescent Brick Co., Inc., New Cumberland, mined fire clay for manufacture of refractory bricks and blocks. Output of sand and gravel increased by 44 percent, and the county maintained its position as the leading sand

and gravel producer in the State. Dravo Corp. used two dredges on the Ohio River to produce building sand and gravel. Iron City Sand & Gravel Corp. produced sand and gravel for building, paving, and fill purposes at a stationary plant near Arroyo.

Hardy.—Production of crushed limestone decreased 16 percent. State Soil Conservation Service, Potomac Valley Soil Conservation District, produced limestone for concrete aggregate and agricultural purposes.

Harrison.—Coal production decreased 15 percent and the county dropped from ninth to 10th place in the State. The county fell from second to fourth place in strip output. Of the total output, 30 underground mines produced 82 percent; 18 strip mines, 17 percent; and five auger mines, 1 percent. Of the underground output, 99 percent was produced mechanically with 87 percent by 27 continuous miners and the balance by 22 loading machines. The equipment used at strip mines included 23 power shovels, three draglines, one carryall scraper, 24 bulldozers, and 48 trucks with an average capacity of 15 tons. About 64 percent of the county output was cleaned at six preparation plants; five had thermal drying facilities and dried 54 percent of the cleaned coal. Of the total, 42 percent was crushed and 5 percent was treated with oil. The largest strip producers were Wesgin Mining Co., Inc., Mountaineer Coal Co., and Fresa Construction Co. The largest underground producers were Clinchfield Coal Co. (three mines) and Mountaineer Coal Co. (two mines).

The production of crushed limestone by Paul Harrold at a quarry near Wolf Summit for concrete aggregate and roadstone increased substantially over that of 1965. Producers of sandstone materials used for aggregate paving and roadstone were North View Stone Co., Deshard, Salerno Bros., Inc., Shinnston, and the State Road Commission.

Zinc was smelted at a vertical retort plant at Meadowbrook. The sales for 1966 was about $15 million and total wages were $1.8 million.

Jefferson.—Limestone production increased 12 percent and the county maintained second place among the limestone-producing counties. Output was used primarily for blast furnace flux and manufacture of dead-burned dolomite; lesser amounts went for refractory use, aggregate, railroad ballast, and agricultural purposes. Producers were Standard Lime & Refractories Co., Division of Martin Marietta Corp., Millville; United States Steel Corp., Millville; and Blair Limestone Division, Jones & Laughlin Steel Corp., Millville. Standard Lime & Refractories Co. also produced quicklime for refractory purposes in steel plants.

Kanawha.—The county maintained its position as the fifth largest producer of coal in the State. Total production, 87 percent from 81 underground mines, 6 percent from five strip mines, and 7 percent from 10 auger mines increased 6 percent. Of the underground production, 97 percent was mechanically loaded by 80 mobile loading machines, 20 continuous mining machines, and one hand-loaded face conveyer. The county continued to rank second in the State in auger production. Equipment used at the auger mines included 11 augers, two power shovels, nine bulldozers, and 46 trucks with an average capacity of 17 tons. The leading auger producers were Union Carbide Corp. and Kelley's Creek Fuel Co. The leading underground producers with 88 percent of the output were The Carbon Fuel Co. (five mines), Union Carbide Corp. (four mines), The Valley Camp Coal Co. (eight mines), Cannelton Coal Co. (three mines), Oglebay Norton Co. (seven mines), and Imperial Colliery Co. (five mines). Of the total county output, 10 preparation plants cleaned 81 percent of the coal mined. One plant had thermal drying. About 41 percent of the output was crushed and 10 percent treated with oil.

New underground mines employing over 20 men were opened by Imperial Colliery Co., Oglebay Norton Co., and Union Carbide Corp.

Inorganic Chemical Division, FMC Corp. produced salt in brine for use by the company in manufacturing chlorine and caustic soda at its South Charleston plant. Production was slightly less than in 1965. The company also recovered calcium-magnesium chloride.

Dimension and crushed sandstone was produced by Tony Pacifico Stone Quarry, Inc., near Charleston. Crushed sandstone for aggregate uses was produced by Mazella Quarries, Inc., South Charleston. The State

Road Commission quarried sandstone from Rocky Fork Quarry for paving and concrete aggregate. Fire clay was produced by both Charleston Clay Products Co. and West Virginia Brick Co. of Charleston for manufacturing building brick and paving tile. Output was about the same as in 1965.

Lewis.—Coal production increased 60 percent. Of the total output, 98 percent was strip production and the balance underground. None of the underground production was loaded mechanically, cleaned, or treated, but 81 percent was crushed.

Crushed sandstone was quarried by State Road Commission at Keeley Quarry and by Weston Stone Co. and Basil R. Heavner.

Miscellaneous clay was produced by Gum Bros. for use by Weston-Jane Lew Brick & Tile Co. in the manufacture of building brick.

Lincoln.—Three companies dredged coal from Guyandot River. A small quantity of sandstone was mined by the State Road Commission from Alkol Quarry for paving and concrete aggregate.

Logan.—The county rose to first place in coal production and maintained its position as the third largest producer of auger-mined coal. Total production increased 6 percent. Underground coal production which was 94 percent of the total output increased 4 percent, strip mining increased 37 percent, and auger mining increased 30 percent. All of the underground production was mechanically loaded, 85 percent by 112 mobile loading machines and 15 percent by 22 continuous mining machines. Three additional mobile loading machines were used in conjunction with continuous miners. A total of 21 cleaning plants in the county prepared 90 percent of county production; four of these plants thermally dried 15 percent of the cleaned coal. Of the total coal output, 27 percent was crushed and 16 percent was treated. The leading underground producers with 63 percent of the underground output were Island Creek Coal Co. (nine mines), Amherst Coal Co. (six mines), Omar Mining Co. (four mines), and Boone County Coal Corp. (two mines). The leading producer by auger mining was Raleigh Eagle Coal Co.

Amherst Coal Co. opened the new MacGregor No. 5 underground mine, Crystal Block Coal & Coke Co. closed the No. 11 underground mine and opened the No 12 underground mine, and Princess Coals, Inc., opened the Jane Ann No. 11 underground mine during 1965.

Marion.—The county continued to rank fourth in coal production, although output decreased 2 percent. Almost all the coal was mined from 11 underground mines. There were two strip mines in operation during 1966. Virtually all of the underground production was mechanically loaded, of which 95 percent was loaded with 73 continuous miners. The balance was loaded by eight mobile loading machines. An additional 57 mobile loading machines were used in conjunction with the continuous miners. Almost all of the coal produced was cleaned in eight preparation plants, six of which had facilities for thermal drying. About 37 percent of the coal was crushed but less than 1 percent was treated. Leading producers were Mountaineer Coal Co. (four mines), Bethlehem Mines Corp. (two mines), and Eastern Associated Corp.

Marshall.—Coal production from three producers, Hanna Coal Co., The Valley Camp Coal Co., and State of West Virginia, all underground operators, increased 11 percent over that of 1965. Of the mechanically loaded coal, 96 percent was loaded with 17 continuous mining machines. The balance was loaded by one mobile loading machine. An additional 13 mobile loading machines were used with the continuous miners. Hanna Coal Co. and The Valley Camp Coal Co. continued operating their cleaning plants and cleaned 88 percent of the county output. About 26 percent of the total coal production was crushed, but none was treated.

Salt production increased slightly over that of 1965, and the county continued to be the leading producer in the State. Brine operations were conducted by Pittsburgh Plate Glass Co., New Martinsville, and Solvay Process Division, Allied Chemical Corp., Moundsville. Output was used for the manufacture of chlorine and caustic soda.

Mason.—Coal production decreased 8 percent. Almost all of the underground coal was mechanically loaded by five mobile loading machines and 11 hand-loaded face conveyors. Lieving Coal Co. continued to be the leading underground producer. About 61 percent of the total production

was crushed and 2 percent was treated.

Sand and gravel for building and paving was produced by Mason Aggregates, Inc., West Columbia, and Letart Sand & Gravel Co., Inc., Letart.

McDowell.—The county dropped to second place in the State among the coal-producing counties. The output remained about the same with 94 percent produced from 251 underground mines and the balance was from 9 strip and 11 auger operations. Of the underground production 92 percent was loaded mechanically, 79 percent with 97 continuous mining machines, and 20 percent with 61 mobile loading machines. The balance was loaded with six hand-loaded face conveyors and eight duckbills. Nine additional mobile loading machines were used with the continuous miners. The county continued to rank fifth in the State in strip production. Equipment used at the strip mines included 15 power shovels, 20 bulldozers, and 33 trucks with an average capacity of 26 tons.

Cleaning operations continued at 22 plants which prepared 97 percent of the county output. Seven of the preparation plants thermally dried 36 percent of the cleaned coal. Of the total output, 43 percent was crushed and 45 percent was treated with oil. The leading underground producers accounting for 78 percent of the underground production were United States Steel Corp. (seven mines), Eastern Associated Coal Corp. (one mine), Bishop Coal Co. (two mines), Olga Coal Co. (one mine), Pocahontas Fuel Co. (four mines), and Island Creek Coal Co. (two mines). United States Steel Corp. was the leading strip producer.

Bishop Coal Co. reactivated the No. 33 mine which had been abandoned by Pocahontas Fuel Co. in 1952. Pocahontas Empire Coal Corp. opened a new mine at Squire, W Va., in July employing 62 men.

Mercer.—Coal production increased. Of the total underground production, 95 percent was mechanically loaded with 13 mobile loading machines, four continuous miners, three more than in 1965, and six hand-loaded face conveyors. Of the total coal output, 92 percent was cleaned at four preparation plants. Less than 1 percent of the coal was crushed and 12 percent was treated. The leading producer of both underground and strip coal was Pocahontas Fuel Co.

Crushed sandstone was produced by Oakvale Stone Co. at a portable plant near Athens for concrete aggregate and roadstone. Shale production by Virginian Brick & Tile Co., Princeton, for manufacture of building brick and other heavy clay products was less than in 1965.

Mineral.—Coal production increased. Of the total underground coal mined, 73 percent was mechanically loaded. Of the total output, 85 percent was crushed, and 88 percent was cleaned, but less than 1 percent was treated.

Limestone production was significantly less than in 1965. Output was used mostly for concrete aggregate and road construction. Producers were Allegany Quarries Inc., Keyser (formerly Earl L. Spencer, Keyser), and Aurora Stone Co., Inc., Short Gap.

Mingo.—Coal production decreased by 4 percent. Of the total, 71 underground mines accounted for 94 percent of the total output. Of the total underground production, 97 percent was mechanically loaded, 87 percent by 61 mobile loading machines and 13 percent by five continuous miners. Of the total output, 82 percent was cleaned in six preparation plants; four of which had thermal drying facilities that dried 22 percent of the cleaned coal. About 30 percent of the total was crushed and 13 percent treated with oil. The leading underground producers were Island Creek Coal Co. and National Coal Mining Co.

Monongalia.—Coal production decreased and the county dropped from seventh to ninth place in the State in the output of coal. Most of the production was from 38 underground mines; a relatively small amount was produced by 11 strip mines and 5 auger mines. Of the underground production, 99 percent was mechanically loaded by 40 continuous miners, and by 10 mobile loading machines. Additional equipment consisted of 34 mobile loading machines used with the continuous miners. Three cleaning plants, one of which had facilities for thermal drying, continued in operation and prepared 63 percent of the coal produced in the county. About 16 percent of the total output was crushed and 3 percent was treated. Christopher Coal Co. continued as the leading producer with four operating underground mines. Eastern Associated Coal Corp. started development

work for a new Federal No. 2 underground mine.

Production of crushed limestone was significantly higher than in 1965 and the county continued to rank third in output. Producers were Greer Limestone Co. and Green Bag Cement Co., Division of Marquette Cement Manufacturing Co., which operated Deckers Creek Mine. The former company used the limestone mainly for concrete aggregate, stone sand, railroad ballast, and riprap; the latter company used most of its limestone production for manufacture of cement. Some limestone was also used for agricultural purposes, railroad ballast, and riprap.

Sandstone was mined by Greer Limestone Co. for engine sand and sand for glass and concrete products.

Morgan.—The county continued to rank second in sand and gravel production and first in value. Production by Pennsylvania Glass Sand Corp., Hancock, was about the same as in 1965. Most of the output was used for glass, abrasives, pottery, engine, and blast sand.

Nicholas.—Coal production increased 5 percent and the county rose from 10th to eighth place in coal output. Of the total coal production, 96 percent was from 89 underground mines. Of the 97 percent underground coal mechanically loaded, 42 percent was loaded with 61 mobile loading machines, 53 percent with 60 continuous mining machines, and 5 percent with 34 hand-loaded face conveyors. Of the total output, 83 percent was cleaned in nine cleaning plants, six of which had thermal drying facilities that dried 50 percent of the cleaned coal. About 35 percent of the output was crushed and 3 percent was treated. The leading underground producers were Gauley Coal and Coke Co. (five mines), Sewell Coal Co. (two mines), Summersville Coal Co. (three mines), Imperial Smokeless Coal Co. (three mines), and Johnstown Coal & Coke Co. (one mine). Summersville Coal Co. was also the leading strip producer.

Nettie Sand Co. produced crushed sandstone for use as concrete aggregate.

Ohio.—Coal production, all from three underground mines of The Valley Camp Coal Co. increased 17 percent. All output was mechanically loaded with 10 mobile loading machines and three continuous mining machines. The company cleaned 83 percent of the production and dried 16 percent of the cleaned coal. Of the total output, 25 percent was crushed and 41 percent was treated.

The production of sand and gravel declined by 25 percent and the county dropped to fifth rank from fourth in 1965. The material was dredged from the Ohio River near Wheeling by Delta Concrete Co.

Pendleton.—Limestone production increased 17 percent. It was used for concrete aggregate, agricultural purposes, rock dust in coal mines, and glass and lime manufacture. Producers were North Fork Lime Producers Cooperative, Inc., and Germany Valley Limestone Co., Division of Greer Limestone Co., both at Riverton; and Ruddle Lime, Franklin.

Quicklime was produced by Germany Valley Limestone Co., Division of Greer Limestone Co., for use in paper and pulp manufacture, tanning, and manufacture of refractories.

Pleasants.—Salt brine was produced from Pleasants and Tyler Counties by Inorganic Chemical Division, FMC Corp. by deep well solution mining of underground salt deposits. The brine was shipped by barge to South Charleston for manufacture of chlorine and caustic soda.

Sand and gravel was dredged by Ohio River Sand & Gravel, Division of McDonough Co., on the river at Middle Bros. Island. Most of the production was used for building and paving.

Pocahontas.—Coal production all from three underground mines, decreased. All the coal was loaded with two continuous miners and one mobile loading machine. None was crushed or treated.

Limestone production, slightly less than in 1965, was used for concrete aggregate and road construction. Producers were Terra Alta Limestone Co. and R. H. Burns & Co., which was a new producer.

Preston.—Coal production decreased 4 percent but output from 25 strip mines, which accounted for 40 percent of the total production, increased 12 percent. The county rose to first place from its 1965 position as the third largest strip producer. Equipment used at strip mines included 40 power shovels, 15 draglines, 41 bulldozers, and 76 trucks with an average capacity of

19 tons. The leading strip producer was Kingwood Mining Co.

Of the underground production, 65 percent was mechanically loaded with 19 mobile loading machines and 11 continuous miners. The leading underground producer was Chapel Coal Co. Of the total production, 50 percent was crushed and 39 percent was cleaned at four preparation plants, one of which had thermal drying facilities. None of the coal was treated. Sandy Creek Fuel Corp. changed its name to Reliable Coal Corp. in January, but retained the former name for its cleaning plant at Albright.

Preston Limestone Co., Inc., Terra Alta, produced crushed limestone for concrete aggregate, roadstone, and agricultural stone. Terra Alta Limestone Co., Laurel Mount, produced crushed limestone for concrete aggregate. A small quantity of dimension sandstone was produced by Rhine Creek Stone Co. at a quarry near Brookside.

Raleigh.—Coal output decreased 6 percent, but the county continued to rank sixth in the State in coal production. Of the total mines, 97 underground mines accounted for 87 percent of total production; 12 strip mines, 8 percent; and nine auger mines, 5 percent. Of the underground production, 95 percent was mechanically loaded. Of this total, 75 percent was loaded by 80 mobile loading machines, 24 percent with 30 continuous miners, and 1 percent with six hand-loaded face conveyors. The county maintained its position as the fourth largest producer by auger mining.

Of the total coal output, 78 percent was cleaned at 17 preparation plants, 33 percent crushed, 5 percent treated with oil.

The leading underground producers were Winding Gulf Coals, Inc. (eight mines), Slab Fork Coal Co. (two mines), and Armco Steel Corp. (two mines). The Dorothy No. 1 underground mine of Armco Steel Corp. mined out at the end of the year. The Cranberry mine of the New River Co. abandoned in 1958 was reopened by the company in July. Sterling Smokeless Coal Co. opened a new underground mine near Whitby and reactivated the Duncan mine which was abandoned by the Duncan Coal Co. in 1965. Winding Gulf Coals, Inc., closed its Tams No. 2 and No. 4 mines during the year.

Producers of crushed sandstone were Raleigh Stone Co. and Table Rock Sand Plant, both near Beckley. Output was used for concrete aggregate and roadstone.

Grandview Sand Co., a subsidiary of Beaver Block Co., produced a small quantity of sand for building purposes near Glen Morgan.

Randolph.—Coal production decreased 17 percent. Of the total output, 84 percent was from underground mines. Of the underground production, 85 percent was mechanically loaded with 13 continuous miners, four mobile loading machines, and 11 hand-loaded face conveyors. Of the total production, 77 percent was crushed, 24 percent was processed by two cleaning plants, and 12 percent was treated. A. C. & H. Coal Co. and Marson Coal Co. were the leading underground producers.

Limestone production was 8 percent lower than in 1965, and was used mainly for concrete aggregate and roadstone, with a small quantity for railroad ballast, riprap, and agriculture. Producers were Elkins Limestone Co. and Sam G. Polino & Co. with stationary plants near Elkins and Bowden, respectively. A small quantity was produced also by Basil R. Heavner.

Roane.—The State Road Commission quarried a small quantity of sandstone from Amma Quarry for paving and concrete aggregate.

Taylor.—Coal production decreased 24 percent. Of the total output, 13 small hand-loaded underground mines accounted for 42 percent and six strip mines for 58 percent. None of the coal was mechanically loaded, cleaned, dried, or treated; 79 percent was crushed. The leading strip mine producer was LaRosa Fuel Co., Inc.

A small quantity of shale was produced by Grafton Brick Co. near Thornton for manufacturing building brick.

Tucker.—Coal production increased 30 percent owing to increased strip mine production by Douglas Coal Co. The one underground mine used three hand-loaded face conveyors. None of the coal production was prepared, crushed, or treated.

Sandstone was produced by Fairfax Sand & Crushed Stone Co. near Thomas and by the State Road Commission at Valley Furnace Quarry. The material was used for concrete aggregate and roadstone. Feather

Construction Co. abandoned the Tucker "G" quarry near Davis at the end of 1965.

Tyler.—No sand and gravel production was reported during 1966.

Inorganic Chemical Division, FMC Corp., produced salt brines by deep well operations at Bens Run for chlorine manufacture at the company's plant at South Charleston. (See Pleasants County.)

Upshur.—Coal production increased 4 percent with 64 percent of the output from 15 underground mines. Of the underground production, 83 percent was mechanically loaded by four continuous miners using two mobile loading machines in conjunction with the miners. About 33 percent of the output was crushed, 53 percent was cleaned in two preparation plants, and less than 1 percent was treated with oil. The leading underground producer was Upshur Coals, Ltd. Pecks Run Coal Co., the leading producer in 1965, was acquired by Lafayette Coal Co.

Quertinmont sandstone quarry of Basil R. Heavner was idle.

Wayne.—Coal production decreased 17 percent. Of the total output, 57 percent was mechanically loaded by four mobile loading machines. Camp Creek Coal Corp. acquired the Fry Mining Co. and installed Jeffrey jigs for coal cleaning. About 2 percent was cleaned and 17 percent was crushed.

Sandstone was mined by State Road Commission from Glen Hayes quarry for concrete aggregate and road metal.

Webster.—Coal production was unchanged. Of the total output, 86 percent was from underground mines. Of the underground production, 96 percent was mechanically loaded by eight mobile loading machines, 13 continuous miners, and one hand-loaded face conveyor. Of the total output, 86 percent was cleaned in four coal preparation plants, one of which had facilities for thermal drying; 39 percent was crushed and 15 percent treated for dust control.

Wetzel.—Production of sand and gravel for building and paving by Ohio Valley Sand Co. from a dredge operation on the Ohio River was less than in 1965.

Wirt.—Sandstone for concrete aggregate and road metal was mined by State Road Commission from Creston Quarry.

Wood.—Production of sand and gravel was slightly higher than in 1965 and the county rose from fifth to fourth place in output. The output, which was used mostly for building and paving was produced by Kanawha Sand Co. and Pfaff & Smith Builders Supply Co.

Wyoming.—Coal production increased 8 percent and the county continued to rank as the third largest producer in the State. Of the total output, 94 percent was mined from 106 underground mines. Of the underground coal mined, 97 percent was mechanically loaded. Of this total, 61 percent was loaded by 106 mobile loading machines, 38 percent by 61 continuous miners using four mobile loading machines, and 1 percent by 19 hand-loaded face conveyors. Of the total output, 90 percent was cleaned at 15 plants, eight of which had thermal drying facilities which dried 45 percent of the cleaned coal. About 21 percent of the output was crushed and 11 percent treated with oil.

The leading underground producers accounting for 74 percent of the underground production were Eastern Associated Coal Corp. (five mines), Itmann Coal Co. (four mines), Island Creek Coal Co. (two mines), Allied Chemical Corp. (one mine), Pocahontas Fuel Co. (two mines), and Ranger Fuel Corp. (two mines). The leading strip mine coal producer was Ranger Fuel Corp. Eastern Associated Coal Corp. opened the new Keystone No. 2 underground mine at Herndon employing about 200 men.

There was a sharp increase in production of crushed sandstone for use as concrete aggregate and roadstone. State Road Commission was the principal producer.

Tolers Sand Co., Clear Fork, continued to produce a small quantity of sand for use as traction sand for mine locomotives.

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 Geological Survey of Wisconsin for collecting information on all minerals except fuels.

By Keith S. Olson [1]

Value of mineral output in Wisconsin was $76.0 million, an increase of 4 percent over that of 1965, and was the second highest on record, exceeded only by that of 1960. Nonmetals comprised nearly 90 percent of the total value, metals 10 percent, and mineral fuels (peat) less than 1 percent. Greater demand for road construction materials resulted in increased production of sand and gravel and stone. Value of metals decreased substantially due to the cessation of iron ore shipments and declines in value of lead and zinc production.

[1] Industry economist, Bureau of Mines, Minneapolis, Minn.

Table 1.—Mineral production in Wisconsin [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	119	$147	123	$148
Iron ore (usable)—thousand long tons, gross weight	141	W	---	---
Lead (recoverable content of ores, etc.)—short tons	1,645	513	1,694	512
Lime—thousand short tons	197	3,076	204	3,186
Peat—short tons	3,090	122	2,379	164
Sand and gravel—thousand short tons	38,751	27,707	41,523	30,713
Stone—do	15,344	21,924	16,150	23,735
Zinc (recoverable content of ores, etc.)—short tons	26,993	7,882	24,775	7,185
Value of items that cannot be disclosed: Abrasive stone (grinding pebbles), cement, gem stones, and value indicated by symbol W	XX	11,628	XX	10,367
Total	XX	72,999	XX	76,010

W Withheld to avoid disclosing individual company confidential data included with "Value of items that cannot be disclosed." XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in constant 1957–59 dollars

(Thousands)

Year	Value [1]	Year	Value [1]
1957	$69,995	1962	$66,470
1958	72,916	1963	65,246
1959	71,675	1964	67,600
1960	76,171	1965	70,870
1961	71,605	1966	[p] 73,359

[p] Preliminary.
[1] Data for 1957–64 revised.

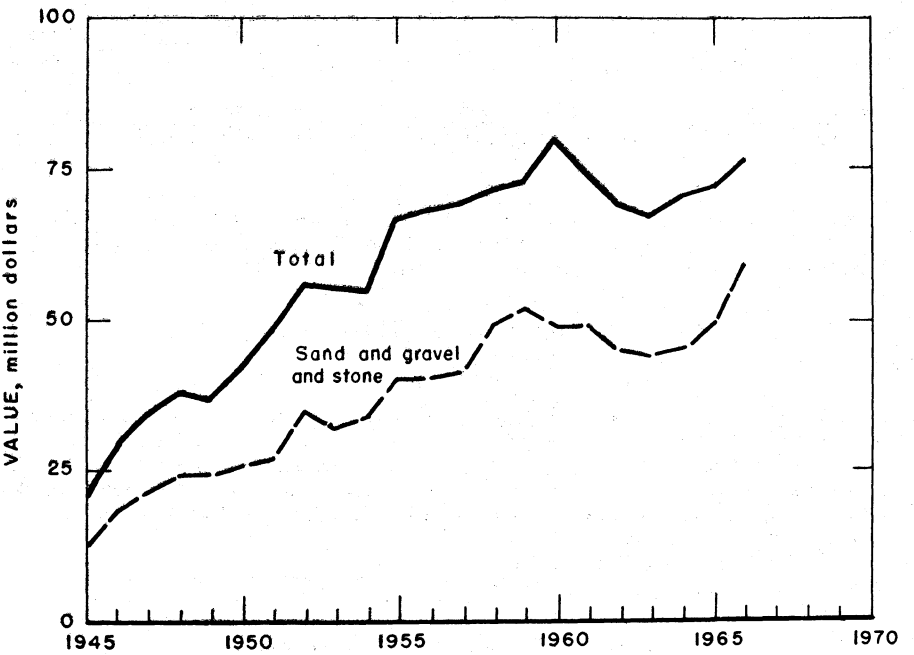

Figure 1.—Value of sand and gravel, stone, and total value of mineral production in Wisconsin.

Table 3.—Employment 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
1965:								
Metal	323	199	64	513	---	30	58.47	2,002
Nonmetal	20	110	2	18	---	---	---	---
Sand and gravel	2,271	197	448	3,788	---	68	17.95	848
Stone	2,682	202	541	4,414	2	107	24.69	3,421
Peat	14	79	1	9	---	1	113.37	5,668
Total	5,310	199	1,056	8,742	2	206	23.79	2,218
1966: [p]								
Metal	255	278	71	562	1	30	55.16	20,402
Nonmetal	85	134	12	96	---	4	41.67	1,521
Sand and gravel	2,215	201	444	3,755	1	79	21.30	2,058
Stone	2,115	210	445	3,690	2	113	31.17	5,376
Peat	15	77	1	9	---	---	---	---
Total	4,685	208	973	8,112	4	226	28.35	4,829

[p] Preliminary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Stone.—Baraboo Quartzite Co., Inc., produced grinding pebbles from a quartzite deposit in Sauk County for grinding silica flour and deburring purposes. Output increased both in quantity and value over that of 1965.

Cement.—Shipments of portland cement declined less than 1 percent both in quantity and value, whereas production increased 7 percent. Production consisted of types I and II (general use and moderate heat) and type III (high-early-strength) portland cement, and masonry cement. Approximately 34 percent of the portland cement production was air-entrained.

Average mill value per 376-pound barrel of portland cement was $3.41, a decrease of $0.01 from 1965. Portland and masonry cement shipments were primarily to Wisconsin consumers with lesser amounts shipped to Illinois, Michigan, Minnesota, and North Dakota.

About 68 percent of the total portland cement shipments were trucked and 32 percent were hauled by rail. Shipments of portland cement in bulk form comprised 88 percent of the total; the remainder was shipped in paper bags.

Increases over 1965 levels occurred in rail shipments and shipments of packaged cement. Approximately 71 percent of all portland cement shipments were to ready-mixed concrete companies, 13 percent to concrete product manufacturers, 10 percent to highway contractors, and 6 percent to building material dealers and other consumers. Approximately 6.6 million barrels of portland cement and 437,000 barrels of masonry cement were shipped into Wisconsin from plants located in other States, principally Illinois, Indiana, Iowa, Michigan, and Minnesota.

Marquette Cement Manufacturing Co. produced types I, II, and III portland cement and masonry cement at its Milwaukee plant. Manitowoc Portland Cement Co., a subsidiary of Medusa Portland Cement Co., produced types I and II portland cement at Manitowoc. Medusa Portland Cement Co. announced plans to begin converting its Manitowoc plant to the production of white cement in 1967 and to be completed by mid-1968. Portland cement markets served by the Manitowoc plant will be supplied by the parent company's plant under construction at Charlevoix, Mich.

Clays.—Miscellaneous clay or shale was produced in Dunn, Fond du Lac, Manitowoc, Pierce, Portage, and Racine Counties. The entire output was consumed by the producing companies. Products manufactured, in decreasing quantity of clay or shale used, were cement, building brick, vitrified sewer pipe, and other heavy clay products. Total production increased 4 percent in quantity and 1 percent in value.

Lime.—Increased output and value of both quicklime, which comprised about two-thirds of the total tonnage, and hydrated lime contributed to the more than 3 percent increase in production and value of total lime. About 75 percent of the total lime shipments were for chemical and other industrial uses. Principal uses for chemical and other industrial lime, in decreasing order of tonnage, were paper manufacture, water purification, metallurgy, disinfectant, sewage disposal, tanning, metal polishing, petroleum refining, food and food byproducts, plastics, brick, and miscellaneous uses. In addition, lime was sold for construction and agricultural purposes. More than half of the State total lime shipments was to 15 other States and Canada. Lime shipments into Wisconsin from other States totaled about 60,000 tons.

Commercial lime producers included Cutler-La Liberte-McDougall Corp., producing quicklime at Superior; Rockwell Lime Co., producing quicklime and hydrated lime at Rockwood; and The Western Lime & Cement Co., producing quicklime and hydrated lime at Green Bay and Eden and hydrated lime at Knowles. Mayville White Lime Works, at Mayville, produced quicklime for disinfectant purposes.

Perlite.—Midwest Perlite Co., at Appleton, and Zonolite Division, W. R. Grace & Co. (formerly Western Mineral Products Co.), at Milwaukee, expanded crude perlite mined outside the State. Expanded material was used for lightweight aggregate in concrete and building plaster, loose fill insulation, and soil conditioning. Decreases were recorded both in quantity and value of total shipments.

Sand and Gravel.—Output of sand and gravel, which comprised 40 percent of the State total mineral value, increased 7 percent in quantity and 11 percent in value. The largest increase, 1.7 million tons, was in material used for road construction. Commercial production comprised 69 percent of the total tonnage and 76 percent of the total value, compared with 66 and 74 percent, respectively, in 1965. Approximately 90 percent of the total output was processed; pit run material constituted the remainder. Of the total commercial production 92 percent was trucked and 8 percent transported by rail. Average value of the total sand and gravel produced was $0.74 per ton (sand $0.84 per ton and gravel $0.69 per ton), an increase of $0.02 per ton for total sand and gravel from that of 1965. Road construction material comprised 68 percent of the total quantity, building 19 percent, fill 10 percent, and industrial sand, railroad ballast, and miscellaneous uses the remainder. Wisconsin supplied over 4 percent of the national sand and gravel output, ranking fifth in quantity and eighth in value.

Industrial sands for use in molding, glass manufacture, filtration, sand blasting, engine, and oil (hydrafrac) were produced in Columbia, Dane, Eau Claire, Green Lake, Pierce, and Rock Counties.

Sand and gravel was produced in every county in the State. Counties producing more than 1 million tons were Dane, Rock, Washington, and Waukesha, which combined, produced 30 percent of the State total. The 10 leading producers of sand and gravel were Janesville Sand & Gravel Co.; T. Johnson & Sons; Edward Kraemer & Sons, Inc.; C. C. Linck, Inc.; Manley Sand Division (Martin Marietta Corp.); Arthur Overgaard, Inc.; State Sand & Gravel Co.; Valley Sand & Gravel Co.; Vulcan Materials Co. (Midwest Division); and Wissota Sand & Gravel Co.

Stone.—Stone ranked second in value among mineral commodities produced in the State, constituting 31 percent of the total value. Production, consisting of basalt, granite, limestone, marl, quartzite, and sandstone, increased 5 percent in quantity and 8 percent in value over that of 1965. Crushed and broken stone represented 99 percent in quantity and 83 percent in value of the total stone output. Of all crushed and broken stone produced 99 percent was by commercial operators, of which 92 percent was transported by truck and the remainder by rail. Total crushed and broken stone production increased 5 percent in quantity and 7 percent in value, chiefly because of greater demand for material used in concrete aggregate and roadstone.

Crushed and broken limestone production was reported from 37 counties. Output increased to 13.7 million tons valued at $15.4 million—representing 86 percent in quantity and 79 percent in value of all crushed stone production. About 90 percent of the total crushed limestone production was used for concrete aggregate and roadstone, 8 percent for agricultural purposes. Output for the former use increased in both quantity and value, whereas that for the latter decreased in quantity but increased in value. The remainder was used for lime manufacture, railroad ballast, riprap, asphalt filler, flux, filter beds, and miscellaneous uses. Average value of crushed and broken limestone produced in 1966 was $1.12 per ton, compared with $1.06 in 1965.

About 836,000 tons of crushed and broken granite was produced in Marathon and Wood Counties for road use. Crushed and broken sandstone and quartzite were produced in Marathon and Sauk Counties. Use patterns, in descending order of quantity, were railroad ballast, roofing granules, roadstone, silica brick, abrasives, terrazzo, filter material, and other purposes. Crushed and broken basalt was produced in Marinette and Polk Counties. Output was used for roofing granules, railroad ballast, and concrete aggregate and roadstone. Marl was produced for agricultural purposes in Burnett and Portage Counties. Wisconsin Aggregate Co.'s crushed marble operation was inactive in 1966.

Production of dimension stone, in decreasing order of value, was limestone, granite, and sandstone. Value of dimension limestone increased 20 percent, and dimension granite 7 percent, whereas dimension sandstone decreased 16 percent in value.

Dimension limestone was produced by 30 companies, in five counties. Of the total output, in terms of value, 88 percent was from Fond du Lac and Waukesha Counties. Limestone accounted for 89 percent in volume and 50 percent in value of all dimension stone sales in the State. House stone veneer comprised 73 percent of the

Table 4.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Building	3,495	$2,842	3,925	$3,279
Paving	2,424	2,031	2,889	2,080
Blast	15	44	W	W
Fill	1,325	623	1,355	637
Molding	879	2,251	1,076	2,953
Oil (hydrafrac)	3	15	W	W
Other [1]	169	229	193	247
Total	8,310	8,035	9,438	9,196
Gravel:				
Building	3,507	2,986	3,880	3,436
Paving	11,824	8,588	13,265	9,859
Railroad ballast	196	111	W	W
Fill	1,690	721	1,659	747
Other	142	111	224	120
Total	17,359	12,517	19,028	14,162
Total sand and gravel	25,669	20,552	28,466	23,358
Government-and-contractor operations:				
Sand:				
Building			15	6
Paving	3,459	1,777	2,519	1,257
Fill	491	152	622	203
Other	182	72	162	71
Total	4,132	2,001	3,318	1,537
Gravel:				
Paving	8,678	5,069	9,409	5,710
Fill	267	83	330	108
Other	5	2	---	---
Total	8,950	5,154	9,739	5,818
Total sand and gravel	13,082	7,155	13,057	7,355
All operations:				
Sand	12,442	10,036	12,756	10,733
Gravel	26,309	17,671	28,767	19,980
Total	38,751	27,707	41,523	30,713

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes foundry (1965), engine, filtration, glass, railroad ballast, and other construction sand.

total dimension limestone production, excluding rubble and irregular-shaped stone. Other uses of dimension limestone, in descending order of value, were rubble, sawed stone, rough construction, flagging, cut stone, and rough architectural stone.

Dimension granite, valued at $2 million, was produced by eight companies in Ashland, Marathon, Marinette, Marquette, and Waushara Counties. Rough and dressed monumental stone represented 89 percent, in value, of all dimension granite sales, excluding irregular-shaped stone. The remainder was sold for architectural and rough construction purposes. Dressed monumental granite continued to have the highest average unit stone value at $26.38 per cubic foot, an increase of $1.38 from that of 1965.

Eight companies in Marathon, Sauk, and Wood Counties produced dimension sandstone for rough construction, cut stone, flagging, and rubble. The 1966 output was valued at $49,000.

Vermiculite.—Zonolite Division, W. R. Grace & Co. (formerly Western Mineral Products Co.) produced exfoliated vermiculite at its Milwaukee plant from crude material mined outside the State. Output was used for loose fill insulation and lightweight aggregate in concrete and building plaster.

Table 5.—Limestone sold or used by producers, by uses

Use	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Dimension:				
Rough construction—thousand short tons	8	$77	[1] 49	[1] $416
Rubble—do	26	201	([1])	([1])
Rough architectural—thousand cubic feet	22	21	14	15
Sawed—do	45	149	56	168
House stone veneer—do	467	1,058	526	1,285
Cut—do	52	131	37	84
Flagging—do	87	88	89	97
Total—approximate thousand short tons [2]	88	[3] 1,724	106	2,065
Crushed and broken:				
Riprap—thousand short tons	67	62	46	55
Concrete aggregate and roadstone—do	11,623	11,798	12,356	13,429
Agriculture—do	1,116	1,485	1,062	1,531
Other [4]—do	136	321	254	412
Total—do	12,942	[3] 13,667	13,718	[3] 15,426
Grand total—do	13,030	15,391	13,824	[3] 17,492

[1] Rough construction and rubble combined to avoid disclosing individual company confidential data.
[2] Average weight of 160 pounds per cubic foot used to convert cubic feet to short tons.
[3] Data do not add to total shown because of rounding.
[4] Includes limestone for asphalt, filter beds, flux, lime, railroad ballast, and other uses.

METALS

Iron Ore.—Iron mining interest in Wisconsin has turned principally to various taconite prospects. On the western Gogebic Range, exploration drilling was conducted by The Hanna Mining Co. in Ashland County and by Inland Steel Co. (Jackson County Iron Co.) in Iron County. The latter company also held leases on taconite properties in the west central part of the State, near Black River Falls, Jackson County.

Iron ore, produced in Minnesota, was shipped by lake vessel from ore docks operated at Superior by the Great Northern Railway Co. and the Northern Pacific Railway Co. The 1966 iron ore shipping season from this port began April 11 and ended December 1. Construction continued on Great Northern Railway Co.'s 2.5-million-ton capacity storage area near its Allouez (Superior) docks. This facility was designed for winter storage of taconite pellets produced by the Butler Taconite Project and the National Steel Pellet plant, both operated by The Hanna Mining Co., on the Mesabi Range in Minnesota. A 2-mile-long conveyor system to the No. 1 dock and a bucket wheel reclaimer are among the types of equipment to be utilized at the new location. The company has provided for a future stage of expansion which can increase storage capacity to 5 million tons.

A report was published by the Federal Bureau of Mines regarding sampling and metallurgical evaluation of selected ores from the Wisconsin portion of the Gogebic Range.[2]

Lead and Zinc.—Output of zinc decreased 8 percent in quantity and 9 percent in value. Lead production increased 3 percent in quantity, but owing to a drop in the average price, total value remained virtually the same as in 1965.

Average yearly weighted prices used to calculate values of lead and zinc in table 1 were 15.115 cents per pound for lead and 14.5 cents per pound for zinc, compared with 15.6 cents for lead and 14.6 cents for zinc in 1965.

American Zinc Co. (formerly American Zinc, Lead & Smelting Co.) operated the Blackstone - Coulthard - Hancock - Winskell, Burnham, Champion, Temperly-Thompson, and Tennyson Nos. 1 and 2 mines. The Coulthard lease of the Blackstone group was last operated in 1957, and the Burnham was last operated by Grimes Mining Co. in 1965. Ores were treated at the company's mills near Tennyson and Shullsburg. Eagle-Picher Industries, Inc. (formerly The Eagle-Picher Co.), operated the Birkett-Bastian-Andrews, Booty-Thom-

[2] Heising, L. F., and D. W. Frommer. Lake Superior Iron Resources. Preliminary Samples and Metallurgical Evaluation of Selected Michigan-Wisconsin Iron Formations. BuMines Rept. of Inv. 6895, 1966, 31 pp.

Table 6.—Mine production of lead and zinc, in terms of recoverable metals

Year	Mines producing		Material treated		Lead		Zinc		Total value
	Lode	Tailings	Ore (short tons)	Tailings (short tons)	Short tons	Value	Short tons	Value	
1957–61 (average)	8	1	559,096	3,632	1,058	$262,928	15,525	$3,619,348	$3,882,276
1962	9	---	411,820	---	1,394	256,496	13,292	3,057,160	3,313,656
1963	8	---	445,742	---	1,116	241,056	15,114	3,476,220	3,717,276
1964	13	---	849,943	---	1,742	456,404	26,278	7,147,616	7,604,020
1965	16	---	967,083	---	1,645	513,240	26,993	7,881,956	8,395,196
1966	16	---	936,432	---	1,694	512,098	24,775	7,184,750	7,696,848

son, Kennedy, Shullsburg, Kickapoo-Thomson, and Stephens mines. Ores from these mines were treated at the company's mills at Shullsburg, Wis., and Galena, Ill. The company began production from the Stephens mine near Linden early in 1966, but discontinued operations after a short period of operation. The Coker No. 1 mine and mill near Rewey were operated intermittently by Mifflin Mining Co. during the first 5 months of 1966 and were idle the remainder of the year. Ivey Construction Co. operated the Graysville mine and treated the ore therefrom at its mill at Mineral Point. The New Jersey Zinc Co. began operating its Elmo mine in Grant County. Ore was stockpiled, awaiting completion of the company's mill, which was scheduled to begin production early in 1967.

American Zinc Co., Eagle-Picher Industries, Inc., The New Jersey Zinc Co., and Wisconsin Mining conducted exploration drilling in southwestern Wisconsin. C. C. Huston Exploration Co. continued its program of geochemical testing of spring water, surveying an area of about 100 square miles in Grant County by this method in 1966. Other activities by the company included 7,000 feet of churn drilling and 80 line miles of induced potential surveying.

Table 7.—Mine production of lead and zinc in 1966, by months, in terms of recoverable metals

(Short tons)

Month	Lead	Zinc
January	120	1,870
February	145	1,975
March	165	2,320
April	120	2,165
May	165	2,285
June	190	2,230
July	150	2,155
August	145	1,995
September	110	1,715
October	145	2,025
November	120	2,025
December	119	2,015
Total	1,694	24,775

MINERAL FUELS

Peat.—Sales of peat decreased 23 percent in quantity but increased 34 percent in value from that of 1965. Peat was produced by three companies in 1966, one producing only humus peat, one moss peat, and one both types. Approximately 74 percent of the total output was sold in packaged form, nearly all of which was sold for seed inoculant with a lesser amount for general soil improvement. Sales of peat in bulk form dropped to 26 percent of the State total, compared with 57 percent in 1965. Material was sold chiefly for general soil improvement.

REVIEW BY COUNTIES

Mineral production was reported from each of the 72 counties in the State. Value of mineral production increased in 53 counties and decreased in 19 counties, with output of over $1 million recorded in 17 counties. The five counties with the greatest value of mineral production, in descending order of value, were Waukesha, Manitowoc, Lafayette, Milwaukee, and Marathon. Sand and gravel was produced in every county, and stone in 44 counties; however, some producers did not indicate the county origin of their production. Minerals produced in each county are shown in table 8, although all counties are not discussed in the text.

Table 8.—Value of mineral production in Wisconsin, by counties

County	1965	1966	Minerals produced in 1966, in order of value
Adams	W	W	Sand and gravel.
Ashland	$243,343	$293,200	Sand and gravel, stone.
Barron	424,000	377,000	Sand and gravel.
Bayfield	118,000	W	Do.
Brown	891,866	935,808	Lime, stone, sand and gravel.
Buffalo	293,052	288,852	Stone, sand and gravel.
Burnett	66,195	114,238	Sand and gravel, stone.
Calumet	235,160	379,545	Do.
Chippewa	131,000	160,000	Sand and gravel.
Clark	W	W	Do.
Columbia	W	W	Sand and gravel, stone.
Crawford	167,155	321,060	Stone, sand and gravel.
Dane	2,301,642	2,668,393	Sand and gravel, stone.
Dodge	1,273,231	1,503,527	Lime, sand and gravel, stone.
Door	257,516	246,670	Sand and gravel, stone.
Douglas	W	W	Lime, sand and gravel.
Dunn	166,821	131,891	Sand and gravel, stone, clays.
Eau Claire	W	578,000	Sand and gravel.
Florence	36,000	W	Do.
Fond du Lac	1,493,855	1,703,271	Stone, sand and gravel, lime, clays.
Forest	56,000	96,000	Sand and gravel.
Grant	1,635,688	1,505,804	Zinc, stone, sand and gravel, lead.
Green	596,706	439,241	Stone, sand and gravel.
Green Lake	513,000	600,000	Sand and gravel.
Iowa	796,049	939,700	Zinc, stone, lead, sand and gravel.
Iron	W	W	Sand and gravel.
Jackson	173,000	215,000	Do.
Jefferson	506,017	264,021	Sand and gravel, stone.
Juneau	W	W	Stone, sand and gravel.
Kenosha	315,000	130,000	Sand and gravel.
Kewaunee	353,000	445,000	Do.
La Crosse	387,000	432,600	Stone, sand and gravel.
Lafayette	W	W	Zinc, lead, stone, sand and gravel.
Langlade	211,000	374,000	Sand and gravel.
Lincoln	230,500	266,600	Sand and gravel, peat.
Manitowoc	W	W	Cement, sand and gravel, stone, lime, clays.
Marathon	3,069,379	3,298,775	Stone, sand and gravel.
Marinette	W	W	Do.
Marquette	W	W	Do.
Menominee [1]	-----	W	Sand and gravel.
Milwaukee	W	6,536,195	Cement, stone, sand and gravel.
Monroe	366,500	343,000	Stone, sand and gravel.
Oconto	431,511	342,965	Sand and gravel, stone.
Oneida	214,000	274,000	Sand and gravel.
Outagamie	716,319	804,028	Stone, sand and gravel.
Ozaukee	428,000	401,000	Sand and gravel.
Pepin	29,241	W	Do.
Pierce	338,168	387,580	Stone, sand and gravel, clays.
Polk	677,882	830,901	Stone, sand and gravel.
Portage	457,215	517,650	Sand and gravel, clays, stone.
Price	84,000	86,000	Sand and gravel.
Racine	1,466,160	1,493,800	Stone, sand and gravel, clays.
Richland	50,000	169,684	Stone, sand and gravel.
Rock	1,822,035	2,717,069	Sand and gravel, stone.
Rusk	101,000	W	Sand and gravel.
St. Croix	454,287	682,015	Sand and gravel, stone.
Sauk	1,159,803	1,480,652	Stone, sand and gravel, abrasives.
Sawyer	72,000	W	Sand and gravel.
Shawano	308,353	337,986	Sand and gravel, stone.
Sheboygan	499,560	602,030	Do.
Taylor	378,000	436,000	Sand and gravel.
Trempealeau	W	154,236	Stone, sand and gravel.
Vernon	139,120	431,646	Do.
Vilas	64,000	135,000	Sand and gravel.
Walworth	577,000	616,000	Do.
Washburn	W	35,000	Do.
Washington	1,078,000	1,415,000	Do.
Waukesha	6,619,956	7,448,942	Sand and gravel, stone, peat.
Waupaca	W	329,740	Sand and gravel, stone.
Waushara	W	W	Do.
Winnebago	1,774,882	2,289,483	Stone, sand and gravel.
Wood	W	390,162	Sand and gravel, stone.
Undistributed [2]	35,750,833	25,614,040	
Total	72,999,000	76,010,000	

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

[1] Formerly part of Oconto and Shawano Counties.

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

Ashland.—Dimension granite was produced by Cold Spring Granite Co. at its Veined Ebony Black quarry near Mellen. Output was processed at the company's plants in Minnesota for architectural and monumental purposes. Primax Corp. also operated a granite quarry near Mellen, selling rough blocks for architectural uses.

About 229,000 tons of sand and gravel was produced for road construction and fill. Portable plants were operated by Barany Construction (Ashland Construction Co.), Edward Kraemer & Sons, Inc., and the county highway department.

The Hanna Mining Co. conducted exploration drilling for iron ore in the county. The Soo Line Railroad Co.'s iron ore dock at the port of Ashland was inactive in 1966.

Brown.—At Green Bay, the Western Lime & Cement Co. produced quicklime and hydrated lime from limestone mined in Michigan. Output was used for construction, chemical, and other industrial uses. Daanen & Janssen produced crushed limestone for roadstone with portable plants at quarries near Greenleaf, Duck Creek, and De Pere. Dimension limestone was produced by Scray Quarries near De Pere and sold for rough architectural use and house stone veneer. Approximately 402,000 tons of sand and gravel was produced by six companies near De Pere, Green Bay, New Denmark, and Suamico. Output was used for building, road construction, and fill.

Buffalo.—Crushed limestone was produced by Edward Kraemer & Sons, Inc., Mon-Arc Quarries, Inc., and Tiffany Construction, Inc. Output was from portable plants and was used primarily as roadstone, with a lesser amount used for agricultural limestone (aglime). The county highway department produced about 49,000 tons of sand and gravel for road construction, fill, and other purposes.

Clark.—Output of sand and gravel increased 35 percent in quantity, primarily because of greater demand for road construction materials. Opelt Brothers operated a stationary plant near Neillsville, producing material for building, road construction, and fill. Plautz Bros., Inc., operated portable plants near Willard. The county highway department produced about 204,000 tons of paving sand and gravel. Hatfield Sand & Gravel discontinued operating its stationary sand and gravel plant near Merrillan.

Columbia.—Sand and gravel production decreased 14 percent to approximately 985,000 tons, chiefly because of a substantial drop in output by the county highway department. Manley Sand Division (Martin Marietta Corp.) operated its fixed plant near Portage, producing sand chiefly for glass making and molding. Columbia Ready-Mix Co. operated a fixed plant near Pardeeville and produced material for building, road construction, and fill. James Sand & Gravel produced molding sand with a portable plant near Doylestown. Sand and/or gravel for road construction was produced by D. L. Gasser Construction, Inc., (formerly Wisconsin Dells Sand & Gravel) near Wisconsin Dells; Koepke Sand & Gravel Co. near Portage; Linck-Henes Construction Co., Inc., near Rio; C. C. Linck, Inc., near Columbus; and Rein, Schultz & Dahl, Inc., near Portage.

Crushed limestone used for road construction and/or aglime was produced by Dann & Wendt, Inc., Edward Kraemer & Sons, Inc., and the county highway department.

Crawford.—Value of mineral production nearly doubled from that of 1965, chiefly because of a greater demand for materials used in road construction. Producers of crushed limestone were Loren J. Slaght and Turner Stone Corp., who operated quarries near DeSoto, Eastman, Gays Mills, Mount Sterling, Prairie du Chien, Seneca, Steuben, and Wauzeka. Material was used almost exclusively for road construction, with a small quantity used as aglime. Lakeside Sand & Gravel and Prairie Sand & Gravel, Inc., operated dredges near Prairie du Chien, producing sand and gravel for building, road construction, and fill. The county highway department produced 2,000 tons of pit-run sand for ice-control purposes.

Dane.—Output of sand and gravel and cursched and broken limestone continued to increase, resulting in a 16-percent increase in value of county mineral production. Nearly 1.8 million tons of sand and gravel was produced for use in building, road construction, fill, molding, and other purposes by 15 companies and the county highway department. Major producers, in alphabetical order, included Capitol Sand & Gravel Co.; Hartland-Verona Gravel Co.;

Madison Sand & Gravel Co.; Rein, Schultz & Dahl, Inc.; Wingra Stone Co.; and Yahara Materials, Inc., (Henry A. Raemisch Co.). Molding sand was produced by General Silica Division (George M. Pendergast & Co., Inc.) at a fixed plant near Mt. Horeb.

Fifteen companies produced about 962,000 tons of crushed and broken limestone for concrete aggregate, roadstone, aglime, riprap, and other uses. Leading producers, listed alphabetically, were Hammersley Stone Co., Inc., near Fitchburg; Madison Stone Co., Inc., near Madison; and Wingra Stone Co., near Fitchburg.

Dodge.—Value of mineral production increased 18 percent from that of 1965, owing to increased output of sand and gravel and crushed limestone used for road construction. About 776,000 tons of sand and gravel was produced. Martin Kaddatz Gravel Co. near Watertown; Linck-Henes Construction Co., Inc., near Farmersville and Horicon; and C. C. Linck, Inc., at 11 pits throughout the county; operated portable plants, producing sand and gravel for road construction. The county highway department produced paving gravel and sand for ice-control purposes.

The Western Lime & Cement Co. produced hydrated lime, for construction purposes, at its Knowles plant. Mayville White Lime Works, near Mayville, produced quicklime for disinfectant uses. Both companies operated limestone quarries and produced crushed limestone for roadstone and lime manufacture. The latter company also produced limestone for aglime and filler. Linck-Henes Construction Co., Inc., near Theresa, and the county highway department produced crushed limestone for road construction. Total limestone production was about 354,000 tons.

Door.—About 264,000 tons of sand and gravel was produced for building, road construction, and fill. Fixed plants were operated by Hubert Charles, near Rosiere, and Vernon E. Olson Excavating Co., near Sturgeon Bay. Portable plants were operated by Koepke Sand & Gravel Co. near Baileys Harbor and by the county highway department. Dimension limestone was quarried by Adamski-Fisher Quarry, near Sturgeon Bay, and sold as sawed architectural stone and house stone veneer. The county highway department produced about 4,000 tons of crushed limestone for roadstone at the Suess quarry near Fish Creek.

Douglas.—The State's largest lime producer, Cutler-La Liberte-McDougall Corp., produced quicklime at its Superior plant, from limestone mined in Michigan. The company operated two rotary kilns, burning natural gas and bituminous coal for fuel. Output was used for paper manufacture, water purification and softening, metallurgical purposes, and other industrial purposes. Approximately 179,000 tons of sand and gravel was produced for road construction, fill, and other purposes. Portable plants were operated by Otto Wiesner, Inc., the county highway department, and the city of Superior.

Construction continued on the Great Northern Railway Co.'s 2.5-million-ton-capacity storage area near its Allouez docks. The storage area was scheduled to begin receiving pellets in early 1967.

Dunn.—Value of county mineral output declined because of lesser production of sand and gravel (156,000 tons) in 1966 by the county highway department than in the previous year. Sand and gravel output was used for road construction and ice-control purposes. Crushed limestone was produced by Edward Kraemer & Sons, Inc., and the Barron County Agricultural Department. Output was used for road construction and aglime. Menomonie Brick Co. produced clay for its own use in manufacturing building brick.

Eau Claire.—Fixed sand and gravel plants were operated near Eau Claire by Wissota Sand & Gravel Co. and Eau Claire Sand & Gravel Co. Both companies produced sand and gravel for building and road construction. In addition, the latter company produced material for sandblasting, railroad ballast, oilfield fracturing, filtration, and engine purposes. Edward Kraemer & Sons, Inc., produced sand and gravel for road construction.

Fond du Lac.—Value of mineral production increased 14 percent from that of 1965, principally because of greater demand for limestone and sand and gravel. The county ranged second in the State in production of dimension limestone. Producers of dimension limestone were El Dais Stone Co. and Oak Stone Co., near Oakfield; Eden Stone Co., Inc., near Eden; and Fond du Lac Stone Co., Inc., Panetti Stone, Inc., (formerly Hamilton Stone Co.), and Rade-

mann Stone Co., all near Fond du Lac. Types of dimension limestone produced, in descending order of value, were house stone veneer, irregular-shaped stone, sawed stone, rubble, flagging, cut stone, and rough architectural blocks. About 442,000 tons of crushed and broken limestone was produced by seven companies. Output was used for lime manufacture, roadstone, aglime, and metallurgical purposes. The Western Lime & Cement Co. operated its plant at Eden, producing quicklime and hydrated lime for construction, agricultural, chemical, and other industrial uses, with stone from the company's nearby quarry.

Approximately 454,000 tons of sand and gravel was produced for building, road construction, and fill. Lake View Sand & Gravel Co. operated its fixed plant near Fond du Lac. Portable plants were operated by C. C. Linck, Inc., near Byron, Oakfield, and Ripon, and by Cyril Simon near Taycheedah. About 9,000 tons of clay was produced by Oakfield Shale Brick & Tile Co. near Oakfield for its own use in the manufacture of building brick.

Grant.—American Zinc Co. (Tennyson Division) treated lead-zinc ores from the Burnham mine (last operated in 1965 by Grimes Mining Co.) and Tennyson Nos. 1 and 2 mines at its mill near Tennyson. The New Jersey Zinc Co. began operations at its lead-zinc mine near Elmo. Ores were stockpiled, pending completion of the company's nearby mill, slated for early 1967. Exploratory-drilling operations were conducted by American Zinc Co., The New Jersey Zinc Co., and C. C. Huston Exploration Co. Nearly 738,000 tons of crushed limestone was produced by ten companies, operating portable plants near Bagley, Bloomington, Boscobel, Cuba City, Fennimore, Lancaster, Muscoda, and Platteville. The material was used chiefly for roadstone and aglime. American Zinc Co. sold jig tailings from the Tennyson mill for roadstone.

About 120,000 tons of sand and gravel was produced primarily for building and road construction. Becker & Tuckwood and Dubuque Sand & Gravel Co. operated fixed plants near Lancaster and Kieler, respectively. The county highway department produced sand for ice-control purposes.

Green.—The 26-percent decrease in value of mineral production was attributed mainly to decreased requirements for sand and gravel by the county highway department. About 76,000 tons of sand and gravel was produced. Wm. J. Kennedy & Son produced paving gravel with a portable plant near Brodhead. Pit-run fill sand was produced near Monroe by John W. Dieckman and Rees Construction Co. Crushed limestone, for road construction and aglime, was produced by four companies with portable plants: Bergen Rock & Lime Co., near Brooklyn; Rees Construction Co. and Rufer-Graber Lime & Gravel (operation formerly owned by Ted Stauffacher), near Monroe; and P. W. Ryan Sons, Inc., near Albany, Blanchardville, Brooklyn, Monroe, Monticello, and New Glarus.

Green Lake.—Value of mineral production increased 17 percent from that of 1965, as a result of a greater output of sand and gravel (415,000 tons) for both industrial and construction purposes. Molding sand, comprising 55 percent of the total county mineral value, was produced at fixed plants near Berlin by Chier St. Marie Sand Co., C. A. Chier Sand Co., Inc., F. B. Dubberstein & Sons, Inc., and Wilbur W. Wick. Paul Polenska & Son operated a fixed plant near Manchester and produced sand and gravel for building and fill. Companies operating portable plants were Koepke Sand & Gravel Co. near Ripon, Kopplin & Kinas Co., Inc., near Green Lake, and C. C. Linck, Inc., near Markesan. Output was used for building and road construction. A portable plant of the county highway department produced paving gravel.

Iowa.—Value of mineral production increased 18 percent from that of 1965, mainly because of greater zinc output. Ivey Construction Co. operated its Graysville lead-zinc mine and its mill near Mineral Point. Eagle-Picher Industries, Inc., shipped zinc concentrates from the Kickapoo-Thomson, last operated by Ivey Construction Co. in 1964, and the Stephens mines, both near Linden. Development work at the Stephens mine began in 1965, but the mine was abandoned in 1966 after a few months of operation. The company's Linden mill was idle most of the year. Mifflin Mining Co. operated its Coker No. 1 mine and mill near Rewey for the first 5 months of the year. During that time, the company also shipped crude ore for custom milling to other mills in the area. Com-

panies conducting exploration drilling in the county included Eagle-Picher Industries, Ivey Construction Co., and Wisconsin Mining.

Approximately 458,000 tons of crushed limestone was produced chiefly for roadstone and aglime. Eagle-Picher Industries, Inc., sold jig tailings from its Linden mill for roadstone. Portable plants were operated by Davis & Richardson near Avoca; G. A. Watson near Arena, Barneveld, Lone Rock, and Spring Green; and by George Wendtlandt near Barneveld, Dodgeville, Edmund, Linden, Mineral Point, and Ridgeway. The county highway department produced crushed limestone for road construction. Watson Construction Co. produced paving sand near Barneveld.

Jefferson.—Approximately 403,000 tons of sand and gravel was produced, a decrease of 21 percent from the 1965 total. Commercial producers were Hausz Bros., Inc., near Lake Mills; C. C. Linck, Inc., near Concord; Rein, Schultz & Dahl, Inc., near Lake Mills and Marshall; Rude Sand & Gravel near Oakland; and Wolf Construction Co., Inc., near Sullivan. Output was used for building, road construction, and fill. In addition to its sand and gravel output, Hausz Bros., Inc., produced more than 27,000 tons of crushed limestone for road construction.

Juneau.—Crushed and broken limestone was produced by Arthur Overgaard Co., with a stationary plant, at its Lindina quarry for roadstone, aglime, and riprap. The county highway department produced 50,000 tons of sand and gravel for building, road construction, and fill.

La Crosse.—Crushed limestone, primarily for roadstone and aglime, was produced by Arthur Overgaard, Inc., with a portable plant near La Crosse. Also near La Crosse, sand and gravel for building and road construction was produced with a fixed plant by La Crosse Sand & Gravel, Inc., and with a dredge by Smith Sand & Gravel Co., Inc. The county highway department produced sand for road construction and ice-control purposes.

Lafayette.—The county dropped from first to third rank, statewide, in value of mineral production primarily because of lower output and prices of zinc. Production of lead also decreased in quantity and value from that of 1965. Lead-zinc mines operated by American Zinc Co. were the Champion and Temperly-Thompson near New Diggings, and Blackstone-Coulthard-Hancock-Winskell near Shullsburg. The last recorded production from the Coulthard lease of the Blackstone group was in 1957. Ore from these mines was beneficiated at the company's mill near Shullsburg. Eagle-Picher Industries, Inc., treated lead-zinc ores from the Shullsburg and Booty-Thomson mines at its Shullsburg mill. The company also hauled ores from the Birkett-Bastian-Andrews and Kennedy mines by truck to its mill near Galena, Illinois. American Zinc Co. and Eagle-Picher Industries, Inc., conducted exploration drilling in the county.

About 395,000 tons of crushed limestone was produced. American Zinc Co. and Eagle-Picher Industries, Inc., sold jig tailings from their mills near Shullsburg for roadstone and railroad ballast. Huggins & Son, Otto Jean Construction Co., G. A. Watson, George Wendtlandt, and Oscar Zwalanek operated portable plants, producing crushed limestone for concrete aggregate, roadstone, and aglime. Oscar Zwalanek also produced paving gravel near Gratiot.

Lincoln.—About 393,000 tons of sand and gravel was produced for building, road construction, and fill. Stationary plants were operated by Merrill Gravel & Construction Co. and Tomahawk Sand & Gravel Co., Inc., near Merrill and Tomahawk, respectively. Wilbert Storm produced pit-run gravel for road construction near Merrill. Superior Brand Peats produced moss and humus peat near Tomahawk. Output was sold in bulk and packaged form for general soil improvement.

Manitowoc.—This county advanced from third to second rank in value of mineral production with an increase of 7 percent in total value. Manitowoc Portland Cement Co. (a subsidiary of Medusa Portland Cement Co.) operated its Manitowoc plant, producing types I and II (general use and moderate heat) portland cement. The company operated four rotary kilns, utilizing bituminous coal and fuel oil as fuel. Raw materials used in the manufacturing process were limestone from Michigan and clay, piped in the form of a slurry, from the company's local pit. The parent company announced plans to convert this plant to the production of white cement. The first stage of construction, expected to begin in 1967 and to be completed by mid-1968, will involve conversion of the

present facilities to the production of white cement. Also planned was a second stage of construction which will involve additional equipment and increase annual capacity to 1 million barrels. At its plant near Rockwood, Rockwell Lime Co. (Division of Brisch Brick Co.) produced quicklime and hydrated lime, sold for construction, agricultural, chemical, and other industrial uses. The company produced crushed limestone with a stationary plant near Rockwood for lime manufacture, roadstone, and aglime. Valders Lime & Stone Co., near Valders, produced dimension limestone for use as rough and sawed architectural stone and rubble, as well as crushed and broken stone for road construction and riprap. The city of Manitowoc produced crushed limestone for road use.

About 861,000 tons of sand and gravel was produced for building, road construction, and fill. R & J Fricke Co. and Fred Radandt Sons operated fixed plants near Manitowoc and Shoto, respectively. Portable plants were operated by August Ehnert & Sons, Inc., near Kiel; Evenson Bros., near Valders; and Vic Zeman, Inc., near Maribel. The city of Manitowoc and the county highway department produced sand and gravel for paving use and fill.

Marathon.—Production of dimension granite was about 96,000 cubic feet, valued at $1.7 million representing an increase of 4 percent in quantity and 15 percent in value. County production represented 83 percent of the total value of State dimension granite output. Cold Spring Granite Co. produced dimension granite at its Bright Red quarry, near Wausau, for architectural and monumental purposes. The rough stone was transported to the company's plants in Minnesota for processing. Rough and dressed granite for monument use was produced near Wausau by Anderson Bros. & Johnson Co., Lake Wausau Granite Co., Prehn Granite Quarries, Inc., and Wisconsin Quarries, Inc., (subsidiary of Rock of Ages Corp.). About 683,000 tons of decomposed granite was produced for roadstone near Wausau and Mosinee by Harold Beilke, Ray Fitzgerald Granite Pit, Gottschalk Bros., Inc., Knauf Bros., Tony Schilling Granite Pit, and Carl Wimmer. Dimension sandstone was produced near Mosinee by Ellis Quarries, Inc., and Nemke's Stone Quarry and by Ernest F. Liebe near Wausau. Output was sold for rough construction, rubble, architectural use (cut stone), and flagging. Minnesota Mining & Manufacturing Co. operated its Greystone argillite quarry near Wausau, producing material for roofing granules, roadstone, terrazzo, and other uses. The company also operated the Rib Mountain quartzite quarry near Wausau, producing material for abrasives, filler use, terrazzo, and other purposes.

About 668,000 tons of sand and gravel was produced, an increase of 64 percent over that of 1965. The increase was attributed to a greater demand for road construction material. Output was used for building, road construction, and fill. Fixed plants were operated by Heiser Ready Mix Co., Lotz Sand & Gravel Co., and Riverside Gravel Co., all near Wausau, and by Sonnentag Concrete & Gravel near Marathon. Portable plants were operated by Gottschalk Bros., Inc., near Marathon; Knauf Bros., near Big Rib Falls; Rein, Schultz & Dahl, Inc., near Wausau; and Alton Zettler, near Athens. Frank Drewek and Edmund Gesicki, Sr. produced pit-run sand near Athens. Paving sand and gravel was produced by and for the county highway department.

Marinette.—The Ruberoid Co. operated its Kremlin quarry near Pembine, producing basalt (andesite) for use in manufacturing roofing granules. Anderson Bros. & Johnson Co. produced dimension granite, sold in both rough and dressed form for monument purposes, from its Silvery Grey quarry near Amberg.

Approximately 441,000 tons of sand and gravel was produced, representing a 5-percent increase over that of 1965. Soo Line Railroad Co. produced gravel for railroad ballast near Kremlin. Crivitz Gravel Co., Edward Kraemer & Sons, Inc., and Mason Sand & Trucking produced material for building, road construction, and fill. The county highway department produced paving sand and gravel.

Marquette.—Dressed granite was produced at Montello by the Montello Granite Co. for monument purposes. Edward Kraemer & Sons, Inc., and the county highway department produced paving gravel.

Milwaukee.—Marquette Cement Manufacturing Co. produced types I and II (general use and moderate heat) and type III (high-early-strength) portland cement

and masonry cement at its Milwaukee plant. One rotary kiln was used, utilizing bituminous coal for fuel. Franklin Stone Products, Inc., Edward Kraemer & Sons, Inc., and Vulcan Materials Co. (Midwest Division) produced crushed limestone for concrete aggregate and road construction. Production of sand and gravel decreased 39 percent to about 195,000 tons. The decrease was attributed to a lesser demand for paving gravel. Producers were Ray Anderson & Son Sand & Gravel, Inc., near Franklin, Fink Sand & Gravel near South Milwaukee, and Gravel, Inc., near Franklin. Material was used for building and road construction. Zonolite Division, W. R. Grace & Co. (formerly Western Mineral Products Co.) produced expanded perlite and exfoliated vermiculite at Milwaukee from material produced outside the State. Both products were used for lightweight aggregate in concrete and plaster. Exfoliated vermiculite was also used for loose fill insulation.

Monroe.—The county highway department produced 224,000 tons of sand and gravel for fill and road construction. Output represented a 31-percent decline from 1965. Limestone production increased 48 percent over that of 1965, and was used for road construction and aglime. Portable crushing plants were operated by Otto Meyer & Son near Tomah, Schendel Bros. near Norwalk, and Schulz Quarry Co. near Wilton.

Oconto.—About 550,000 tons of sand and gravel was produced. Gillett Cement Products, Inc., operated a stationary plant near Gillett, producing gravel for building and road construction. Portable plants, producing material mainly for road construction, were operated by Foster Construction Co., Inc., and M. R. K. Construction Co., Inc., near Little Suamico and Pulaski, respectively. The county highway department produced paving gravel. Foster Construction Co., Inc., produced limestone with portable plants at its Gillett quarry near Gillett and the Montevedio quarry near Abrams. Output from the former was sold for aglime, and from the latter for road construction.

Outagamie.—Output of crushed limestone, about 513,000 tons, represented an increase of 46 percent from that of 1965. The increase was attributed to greater demand for road construction materials. Black Creek Limestone Co. operated a fixed plant near Black Creek and produced crushed limestone for road construction and aglime. Roadstone was produced by Landwehr, Inc., and M. R. K. Construction Co., Inc., who operated portable plants near Freedom, Mackville, and Seymour. Sand and gravel production decreased from that of 1965. Carl W. Krause and Murphy Construction Co. operated fixed plants near Appleton and Black Creek, respectively, and Landwehr, Inc., operated a portable plant near Appleton. Material was used for building, road construction, and fill. Midwest Perlite Co. expanded crude perlite, mined outside the State, at its Appleton plant, for lightweight aggregate in concrete and building plaster, loose fill insulation, and soil conditioning. Thilmany Pulp & Paper Co. produced regenerated lime at its Kaukauna plant for use in paper and pulp manufacture, and water purification and softening.

Pierce.—Approximately 221,000 tons of sand and gravel was produced, representing a substantial gain over that of 1965. The increase was due primarily to a greater demand for paving material. Sand used for molding, sandblasting, and engine uses was produced by Bay City Sand Co. at its underground operation near Bay City. Maiden Rock Silica Sand Co. (acquired in 1965 by Delbert Gore) produced sand for molding and sandblasting from its underground operation near Maiden Rock. River Falls Sand & Gravel Co. operated its fixed plant near River Falls and produced sand and gravel for building. Edward Kraemer & Sons, Inc., operated a portable plant and produced paving gravel. Funk Bros. Transfer produced pit-run gravel near Esdaile. The county highway department produced sand and gravel for road construction, fill, and ice-control purposes. About 226,000 tons of crushed limestone was produced by Tiffany Consturction, Inc., near Elmwood and the county highway department for road construction and aglime. Red Wing Sewer Pipe Corp. produced clay near Elmwood. Output was used in the manufacture of vitrified sever pipe at its Red Wing, Minn. plant.

Polk.—Value of mineral production increased 23 percent from that of 1965, owing chiefly to a greater output of sand and gravel for road construction by the county highway department. Bohn Sand & Gravel operated a fixed plant near West Sweden,

producing sand and gravel for building, road construction, and fill. Atlas Gravel Co. and Jorgenson Construction Co., near Luck, and Ostermann Sand & Gravel, Inc., near Turtle Lake, operated portable plants and produced sand and gravel primarily for road construction. Bryan Dresser Trap Rock, Inc., produced crushed basalt (trap rock) for road construction and railroad ballast at its fixed plant near Dresser. About 46,000 tons of crushed limestone was produced by the county agricultural agency for roadstone and aglime.

Portage.—Value of mineral production increased 13 percent, primarily owing to greater demand for sand and gravel. About 607,000 tons of sand and gravel was produced. Material for building, road construction, fill, and railroad ballast was produced at fixed plants operated by F. F. Mengel Co., near Custer and Wimme Sand & Gravel, Inc., near Stevens Point. Fill sand was produced by Nick Charneski near Custer and Scipior Construction, Inc., near Stevens Point. The county highway department operated a portable plant and produced sand and gravel for road construction. Graff Brick Co. of Waupaca, Inc., produced clay near Stevens Point for use in brick manufacture. Caldwell's Dredging Co. produced marl for agricultural purposes near Almond.

Racine.—Vulcan Materials Co. (Midwest Division) produced crushed limestone for concrete aggregate and roadstone at its Ives quarry near Racine. Approximately 842,000 tons of sand and gravel was produced for building, road construction, and fill. Fixed plants were operated by Burlington Sand & Gravel Corp. and J. W. Peters & Sons, Inc., near Burlington, and Hillside Sand Co., Inc., near Caledonia. Edward Kraemer & Sons, Inc., Morrow & Reesman, Root River Sand & Gravel Co., Inc., and the county highway department operated portable plants. Union Grove Drain Tile Co. produced about 2,000 tons of clay for the manufacture of draintile at its Union Grove plant.

Rock.—The 49-percent increase in value of mineral production was due chiefly to an increase in production of sand and gravel, which comprised 86 percent of the county mineral value. About 2.4 million tons of sand and gravel was produced, of which 56 percent was for building, 25 percent for road construction, and 19 percent for other purposes (railroad ballast, molding sand, and fill). Major producers, listed in alphabetical order, included: Chicago, Milwaukee, St. Paul & Pacific Railroad Co., near Janesville; Edgerton Sand & Gravel Co. near Edgerton; Janesville Sand & Gravel Co. near Janesville; Wm. J. Kennedy & Son near Beloit and Shopiere; and Lyle T. Manley Co., Inc., near Hanover. The county highway department operated a portable plant and produced paving gravel. Crushed and broken limestone production in the county was about 406,000 tons. Output was used for concrete aggregate, road construction, aglime, and riprap. Footville Lime & Rock Co. operated a fixed plant near Footville, producing aglime. Portable plants were operated by Herb Escher Lime Service near Beloit; Frank Bros. Quarry near Milton; Gilmour Limestone and Little Limestone Co. near Clinton; Peter J. Roth and P. W. Ryan Sons, Inc., near Janesville; Clarence Wealti near Evansville; and Wheeler Limestone Co. near Allens Grove. The county highway department produced crushed limestone for road construction.

St. Croix.—Value of mineral production increased 50 percent as the result of a greater demand for sand and gravel and crushed limestone used in road construction. Sand and gravel was produced for building, road construction, fill, and other purposes by Casey Gravel Works near New Richmond, Leary Construction Co., Inc., near River Falls, and Edward Kraemer & Sons, Inc. The county highway department produced about 518,000 tons of paving sand and gravel. Approximately 279,000 tons of crushed and broken limestone was produced for road construction, aglime, and riprap. Portable plants were operated by Edward Kraemer & Sons, Inc., Leary Construction Co., Inc., near River Falls, and Wilson Rock & Limestone Co., Inc., near Emerald and Springfield. The county highway department produced brushed and broken limestone for road construction and riprap.

Sauk.—The 28-percent increase in value of mineral output resulted chiefly from greater production of sand and gravel and crushed limestone. Sandstone and quartzite represented 52 percent of the county mineral value, compared with 69 percent in 1965. Foley Bros., Inc., produced crushed quartzite for railroad ballast near Rock Springs. Crushed quartzite was produced

for silica brick by General Refractories Co. near Baraboo and Harbison-Walker Refractories Co. near North Freedom. Grinding pebbles were produced by Baraboo Quartzite Co., Inc., from a quartzite deposit near Baraboo. Bloss Stone Co. and Alfred Boyles Flagstone Quarry near Rock Springs and Hildebrandt Stone Co. near Sauk City produced dimension sandstone used as irregular-shaped stone, cut stone, flagging, and rubble.

Crushed limestone production was about 173,000 tons and used for roadstone and aglime. Portable plants were operated by Frederic Bindl near Plain, Davis & Richardson near Spring Green, Holtz & Schulenburg Lime Works near Loganville, and Edward Kraemer & Sons, Inc. About 438,000 tons of sand and gravel was produced by Baraboo Concrete Co., Inc., W. R. DuBois & Son, Inc., Edward Kraemer & Sons, Inc., the county highway department, and the city of Baraboo. Material was used for building, road construction, fill, and ice-control purposes.

Shawano.—Approximately 467,000 tons of sand and gravel was produced for building, road construction, fill, and ice control. Producers included Embarrass Sand & Gravel, near Embarrass; Koepke Sand & Gravel Co., near Wittenberg; Mantin Bros., near Caroline; Murphy Sand & Gravel, Inc., near Bonduel; Rein, Schultz & Dahl, Inc., near Tilleda; A. Riemer Sand & Gravel, near Cecil; Zimmerman Construction Co., near Shawano; and the county highway department. About 15,000 tons of crushed limestone for road construction was also produced by the county highway department. The county agricultural department discontinued its production of limestone.

Sheboygan.—County mineral value increased 21 percent, chiefly because of increased demand for sand and gravel used in building and paving. Five companies, near Cascade, Elkhart Lake, Greenbush, and Plymouth, and the county highway department produced about 900,000 tons of sand and gravel, used for building, road construction, and fill. About 7,000 tons of crushed limestone was produced by the county agricultural department for roadstone and aglime.

Vernon.—Approximately 350,000 tons of crushed limestone was produced chiefly for road construction and aglime. Portable plants were operated by Ellefson Bros., near Viroqua; Edward Kraemer & Sons, Inc.; Ed Muller & Son, Inc., near La Farge and Ontario; Novy Construction Co., near Hillsboro; and Turner Stone Corp., near Genoa. The county highway department produced 29,000 tons of sand for road construction and fill.

Walworth.—Output of sand and gravel, the only mineral produced in the county, was 809,000 tons. Material was used for building, road construction, and fill. Producers included B. R. Amon & Sons, near Elkhorn; Community Sand & Gravel and Thorpe & Madison, near Delavan; Lake Geneva Sand & Gravel Co. and Ernest Nobis, near Fontana; Mann Bros. Sand & Gravel, Inc., at 11 locations throughout the county; and R. W. Miller & Sons, Inc., near Lake Geneva.

Washington.—Mineral production in the county consisted of approximately 1.9 million tons of sand and gravel, valued at $1.4 million. The increase of 16 percent in quantity and 31 percent in value was attributed chiefly to increased demand for building sand and gravel. Production was reported by 10 companies and the county highway department, mainly in the vicinity of Barton, Colgate, Newburg, Richfield, and West Bend. Material was used for building, road construction, fill, and ice control.

Waukesha.—This county advanced from second place to first in value of mineral production. Chief reason for the increase was greater output of sand and gravel and crushed and broken limestone; the county ranked first in production of both. Approximately 6.5 million tons of sand and gravel was produced, of which 31 percent was used for building, 50 percent for road construction, 18 percent for fill, and 1 percent for other purposes. Twenty-eight companies and the county highway department produced sand and gravel. Production was reported from pits near Big Bend, Brookfield, Colgate, Dousman, Eagle, Hartland, Menomonee Falls, Merton, Muskego, New Berlin, Oconomowoc, Okauchee, Pewaukee, Sussex, Wales, and Waukesha, most of which are in the eastern half of the county. Major producers, listed alphabetically, were Hartland Sand & Gravel Co., T. Johnson & Sons, Edward Kraemer & Sons, Inc., Palmer Crushing Co., Richardson Sand & Gravel Co., Inc., State Sand &

Gravel Co., Turner Sand & Gravel Co., Valley Sand & Gravel Co., and Vulcan Materials Co. (Midwest Division).

Twenty-one companies, mostly in the Sussex-Lannon area, produced dimension limestone valued at nearly $1.1 million or 51 percent of the value of dimension limestone produced in the State. Uses of the material, in decreasing order of production, were house stone veneer, rubble, flagging, sawed stone, irregular-shaped stone, and cut stone. Major producers, in alphabetical order, included Halquist Lannon Stone Co., Milwaukee Lannon Stone Co., Inc., R. T. Lannon Stone Co., and Vulcan Materials Co. (Midwest Division). Approximately 1.5 million tons of crushed and broken limestone was produced. Stationary plants were operated by Halquist Lannon Stone Co. near Sussex; Vulcan Materials Co. near Lannon and Sussex; Waukesha Lime & Stone Co. near Waukesha; and Wislanco Lannon Stone Co., Inc., near Lannon. Material was used for concrete aggregate, road construction, aglime, riprap, asphalt filler, filter beds, and metallurgical uses. Humus peat was produced by Demilco, Inc., near Delafield and moss peat was produced near New Berlin by H. Geipel's Custom Soil, Inc. Both types were sold in bulk for general soil improvement; humus peat was also sold in bulk for potting soils and in packaged form for seed inoculant. Sales decreased in quantity but increased in value from that of 1965.

Waupaca.—About 487,000 tons of sand and gravel was produced by four companies and the county highway department. Stationary and portable plants were operated near Clintonville, Marion, and Readfield. Output was used for building, road construction, and fill. Crushed limestone was produced for road construction by the county highway department.

Winnebago.—Value of mineral production increased 29 percent from that of 1965. Chief reason for the increase was a gain of more than $570,000 in value of crushed and broken limestone production. About 1.3 million tons of crushed and broken limestone was produced in 1966, compared with 0.9 million in 1965. Plants were operated by Badger Highways Co., Inc., near Menasha; Courtney & Plummer, Inc., near Neenah; and Vulcan Materials Co. (Midwest Division), near Oshkosh. Output was used for road construction, aglime, asphalt filler, and riprap. Sand and gravel for building, road construction, and fill was produced by Courtney & Plummer, Inc., near Neenah; and Friedrich, Loots & Below, Inc., near Omro. The county highway department produced 3,000 tons of sand for ice control.

Wood.—Dimension sandstone, sold in the form of irregular-shaped stone, rubble, cut architectural stone, and flagging, was produced near Rudolph by Ellis Quarries, Inc., Klesmith Stone Co., and Tony Schmick. Edward Kraemer & Sons, Inc., produced crushed limestone for road construction. The county highway department produced about 398,000 tons of sand and gravel and 153,000 tons of crushed granite for road construction, The city of Wisconsin Rapids produced 57,000 tons of sand for road construction, fill, and ice-control purposes.

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 H. C. Meeves [1] and William C. Henkes [2]

Mineral output in Wyoming increased to $505.8 million in 1966, a slight increase over that of 1965. Mineral fuels comprised $405.0 million or 80 percent of the State total value of minerals produced; nonmetals comprosed $62.4 million or 12 percent; and metals comprised $38.4 million or 8 percent.

Increases in value over those of 1965 were reported for cement, clays, coal, feldspar, lime, LP gases, natural gas, natural gasoline, phosphate rock, sodium carbonate, sodium sulfate, uranium ore, and vanadium. Decreases were noted for gypsum, iron ore, petroleum, sand and gravel, and stone.

Major mineral-industry developments included completion of a clay processing plant by American Colloid Co.; the start of construction on a bentonite processing plant by International Minerals & Chemical Corp. (IMC); expansion of soda ash output by FMC Corp. and Stauffer Chemical Company of Wyoming; and more than 20,000 new uranium claims staked in Wyoming.

[1] Geologist, Bureau of Mines, Denver, Colo.
[2] Petroleum engineer, Bureau of Mines, Denver, Colo.

Table 1.—Mineral production in Wyoming [1]

Mineral	1965		1966	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays—thousand short tons	1,352	$13,633	1,559	$15,874
Coal (bituminous)—do	3,260	10,150	3,670	11,840
Copper (recoverable content of ores, etc.)—short tons	6	4	-----	-----
Gem stones	NA	120	NA	120
Gold (recoverable content of ores, etc.)—troy ounces	3	(2)	-----	-----
Iron ore (usable)—thousand long tons, gross weight	2,087	25,198	1,978	19,700
Natural gas (marketed)—million cubic feet	235,849	31,840	243,381	35,290
Natural gas liquids:				
LP gases—thousand gallons	143,331	6,020	166,080	7,308
Natural gasoline and cycle products—do	95,093	6,195	96,372	6,281
Petroleum (crude)—thousand 42-gallon barrels	138,314	345,785	134,470	344,243
Sand and gravel—thousand short tons	7,996	8,373	7,187	7,496
Silver (recoverable content of ores, etc.) thousand troy ounces	(2)	(2)	-----	-----
Stone—thousand short tons	1,594	2,791	1,393	2,560
Uranium ore—short tons	1,048,176	17,758	1,082,197	18,160
Vanadium—do	W	444	W	555
Value of items that cannot be disclosed: Beryllium concentrate (1965), cement, feldspar, gypsum, lime, phosphate rock, sodium carbonate, and sodium sulfate	XX	30,241	XX	36,379
Total	XX	498,552	XX	505,806

NA Not available. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Less than ½ unit.

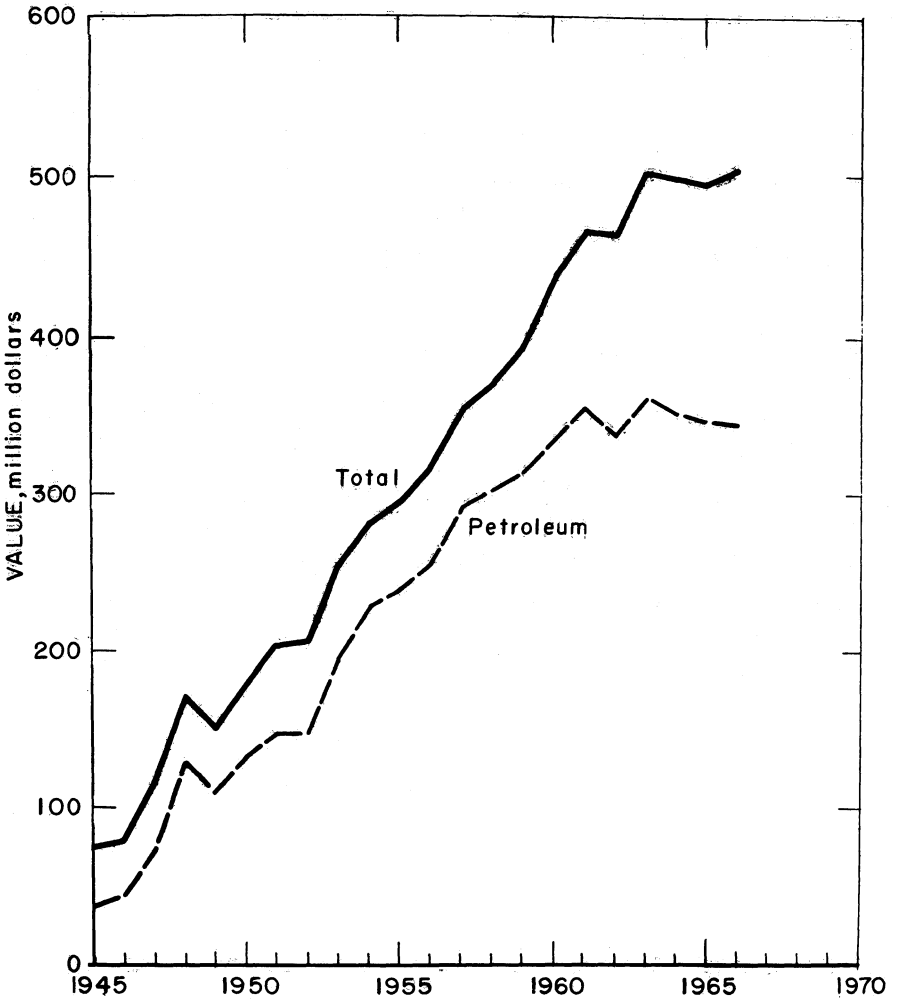

Figure 1.—Value of petroleum, and total value of mineral production in Wyoming.

Table 2.—Value of mineral production in Constant 1957–59 dollars

(Millions)

Year	Value [1]
1957	348
1958	369
1959	400
1960	442
1961	468
1962	459
1963	497
1964	497
1965	493
1966	496

[1] Data for 1957–65 revised.

Employment and Injuries.—Statistics of employment and injuries for 1965 and preliminary data for 1966 in the mineral industries, excluding mineral fuels except coal, are given in table 3.

Government Programs.—Research programs at the Federal Bureau of Mines, Laramie Petroleum Research Center included analysis of core from the 1,279-foot Wyoming Corehole No. 1, which showed that oil shales were not continuous, had highly variable oil yields—from 15 to 56 gallons per ton—and that neither shortite nor trona occurred in the corehole; analysis of oil-stained dolomite core from the Dry Creek area of Wyoming; and continuation of research on in situ extraction of oil from oil shale.

Reports [3] on the mineral resources of Wyoming were published by the Federal Bureau of Mines, the U.S. Geological Survey, and others.

[3] Gill, James R., and William A. Cobban. The Red Bird Section of the Upper Cretaceous Pierre Shale, Wyo. Geol. Survey Prof. Paper 393–A, 1966, p. A1–A73.

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Table 3.—Employment 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
1965:								
Coal	328	226	74	574	---	17	29.60	1,299
Metal	1,421	270	383	3,079	1	72	23.71	3,324
Nonmetal	1,133	312	354	2,860	1	50	17.83	3,546
Sand and gravel	874	171	150	1,197	---	20	16.71	337
Stone	288	242	70	620	---	13	20.97	148
Total	4,044	255	1,031	8,330	2	172	20.89	2,595
1966: [p]								
Coal	330	217	71	546	---	16	29.30	1,289
Metal	1,650	236	389	3,198	1	80	25.33	3,393
Nonmetal	1,200	262	315	2,555	---	39	15.26	577
Sand and gravel	870	163	142	1,138	---	26	22.85	490
Stone	275	242	66	519	---	9	17.34	588
Total	4,325	227	983	7,956	1	170	21.49	1,746

[p] Preliminary.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

The fossil fuels, coal, natural gas, natural gas liquids, and petroleum—were the dominant mineral commodities, comprising 80 percent of the total mineral production value. Petroleum, constituting 68 percent of the total value, was the single most valuable mineral commodity; natural gas, the next most valuable, totaled only 7 percent of the value.

Coal (Bituminous).—Coal production from 14 mines (producing in excess of 1,000 tons each) in seven counties increased 13 percent in quantity and 17 percent in value. The gain was attributed to increased produciton from eight mines; major increases were at the Dave Johnston mine of Pacific Power and Light Co. (PP&L), the Sorensen mine of The Kemmerer Coal Co., and the Rosebud mine of Rosebud Coal Sales Co.

Table 4.—Coal (bituminous) production, by counties

(Short tons)
(Excludes mines producing less than 1,000 short tons)

County	1965	1966
Campbell	490,527	475,170
Carbon	419,310	454,736
Converse	1,250,074	1,565,013
Hot Springs	11,711	9,101
Lincoln	626,706	726,138
Sheridan	349,338	326,037
Sweetwater	112,127	113,942
Total	3,259,793	3,670,137

PP&L scheduled construction of a 250-megawatt, $35 million, single-unit, steam-electric generating plant. Ground breaking at an undetermined site was to be in the spring of 1968, with completion scheduled for late in 1970.

FMC Corp. signed a contract with the Federal Office of Coal Research to develop equipment for processing coal to produce gasoline, a residual char for boiler fuel, and useful gases.

Reynolds Mining Corp., a subsidiary of Reynolds Metal Co., completed a coal-testing laboratory on the shores of Lake Desmet to test the quality of coal under 40,000 acres owned, leased, or under option to Reynolds Mining Corp. The corporation had engaged Stearns-Rogers Corp. of Denver, Colo., to begin engineering and construction on Piney Creek of a multi-million-dollar reservoir and dam to impound 44,000 acre feet of water. The amount of coal, overburden thickness structure, Btu content, and other tests were being studied for the adaptability of the coal deposit to strip mining.

Natural Gas.—The quantity of natural gas marketed increased by 7.5 billion cubic feet and the value by $3.4 million. At yearend, 741 gas wells were active, 6 percent more than at the end of 1965.

The three largest producing gasfields—the same as in 1965—were Greater LaBarge (including LaBarge and East and North LaBarge), 18.5 billion cubic feet; Beaver Creek, 16.9 billion; and Worland, 15.7 billion.

Estimates by the American Petroleum Institute (API) and the American Gas Association (AGA) [4] gave the State gas reserves at yearend of 3.6 trillion cubic feet, a decline of 109 billion cubic feet.

McCulloch Gas Transmission Co., a subsidiary of McCulloch Oil Corporation of California, completed a gas pipeline authorized in 1965. The 4½-inch, 52-mile line was built from facilities in Crook County to Newcastle. The line, to deliver 1.75 million cubic feet per day of gas to the Sioux Oil Co. refinery, was connected to the municipal systems of Moorcroft, Newcastle, and Upton. The gas was supplied from the Rocky Point field, Crook County.

Natural Gas Liquids.—Output of LP gases increased 16 percent, reflecting an increased demand for both natural gas and natural gas liquids. The State had 26 gas-processing plants at yearend; largest in capacity was the El Paso Natural Gas Co. plant at Opal.

The Colorado Interstate Gas Co. (CIG) plant at Rawlins, completed early in the year, was rated as the second largest in capacity in the State. At a cost of $400,000, the Ralston gasoline plant, 23 miles north of Cody, jointly owned by Ralston Processing Associates, Inc., and Husky Oil Co., was expanded to a daily capacity of 16,000 gallons of liquids and 45 long tons of sulfur. Completed in 1965, the plant used natural gas from the Badger Basin, North-

[4] The Oil and Gas Journal. V. 65, No. 14, Apr. 3, 1967, pp. 128–131.

west Elk Basin, Ralston, and Silver Tip fields.

Oil Shale.—Lithologic descriptions and assays of samples from the Federal Bureau of Mines Wyoming Corehole No. 1, Sweetwater County, were completed. Crystals appearing frequently in the core and expected to be shortite, a common crystal in the Wyoming Green River formation, were determined to be calcite. Neither shortite nor trona was detected. Oil shales in the core were not continuous. Although short sections as rich as 55 gallons per ton were found, these were separated by several feet of barren or very low-grade rock. Because of this discontinuity, finding a section 30 feet thick and averaging 25 gallons of oil per ton was expected to be difficult. Detailed study is necessary to determine the suitability of the deposit and its oil shales for underground-combustion experiments.

The Federal Bureau of Mines, in cooperation with PP&L, continued research on in situ extraction of oil from oil shale. Fracturing studies were made on an 80-foot-square area by the use of 190 quarts of nitroglycerin in ten 147- to 150-foot-deep holes. Critical-flow methods using air pressure revealed that additional channeling had developed between 9 of the 10 test wells after detonation of the nitroglycerin. Core drilling was to be attempted to determine the amount of crumbling shattering, and other changes in the Green River formation.

Petroleum.—Crude oil output, amounting to 68 percent of the total value of mineral production, declined 3 percent—the third consecutive annual decline since the peak year, 1963, when 144.4 million barrels of oil was produced. Since 1933 when production was 11.2 million barrels, the State petroleum yield had risen moderately through the war years then grew rapidly to 141.9 million barrels in 1961. Production since 1961 indicated a leveling out or even a decline.

This trend roughly paralleled drilling activity: a high was reached in 1960 when 1,131 wells were drilled (412 were wildcats),[5] followed by a steady decline until 1965 when 963 wells (312 wildcats) were drilled. However, in 1966, this downward trend in drilling was reversed for exploratory wells: the total of 445 wildcats was higher than for the previous record year of 1960.

The first crude oil price changes since 1957 also may have influended the pace of exploratory drilling. Early in the year, posted prices of Wyoming crude oil were raised 5 cents per barrel, bringing the price of 40° to 44.9° API sour crude to $3 per barrel.

At yearend, 8,434 oil wells were active in the State. The Big Horn basin again led in petroleum output with 58.9 million barrels; the Powder River basin ranked second with 47 million barrels. These two basins were the source of 79 percent of the crude oil production. The five leading fields ranked in the same order as in 1965: Elk Basin, Park County, 16.9 million barrels of production; Salt Creek, Natrona County, 12.8 million; Oregon Basin, Park County, 9.0 million; Hamilton Dome, Hot Springs County, 7.0 million; and Grass Creek, Hot Springs County, 5.2 million.

In 1966, 41.9 million barrels of crude oil was processed by the nine refineries in the State, about 400,000 barrels more than in 1965. Out-of-State crude oil shipments amounted to 101.3 million barrels; principal markets included Indiana (31.5 million barrels), Montana (16.7 million), Michigan (11.5 million), and Colorado (11.5 million).

At yearend, API and AGA[6] estimated proved crude oil reserves at 1.1 billion barrels. Additions from discoveries, extensions, and revisions amounted to only 38.6 million barrels, resulting in a decline in reserves of 96.3 million barrels.

Exploratory drilling reached an alltime high of 445 wells, 33 more than in 1960, the previous record year.[7] The Powder River basin had 54.9 percent of total drilling and 56.6 percent of wildcat drilling; the Big Horn basin was ranked second in exploratory drilling with 12.4 percent of the total. The Wind River basin, with 16.4 percent of the development drilling, ranked second in total drilling.

Success ratio for exploratory drilling in the State was 13.7 percent. Johnson County, with seven oil discoveries out of 12 wildcats, had the highest success ratio—58.3 percent. Campbell County had the highest number of successes.

[5] American Association of Petroleum Geologist Bulletin. V. 45, No. 6, June 1961, p. 928.
[6] Work cited in footnote 4.
[7] American Association of Petroleum Geologists, Committee on Drilling Statistics. 1966 data. Also work cited in footnote 5.

Table 5.—Drilling for petroleum in 1966, by counties

County	Oil	Gas	Dry	Total	Footage
Exploratory completions:					
Albany	1	---	9	10	47,657
Big Horn	---	---	17	17	58,205
Campbell	13	---	66	79	663,742
Carbon	1	5	25	31	114,910
Converse	1	---	7	8	53,331
Crook	9	---	58	67	302,127
Fremont	2	2	26	30	157,500
Goshen	---	---	2	2	9,410
Hot Springs	1	---	16	17	65,942
Johnson	7	---	5	12	155,925
Laramie	---	---	2	2	17,170
Lincoln	---	---	3	3	12,546
Natrona	1	---	42	43	163,812
Niobrara	3	1	13	17	72,071
Park	2	---	8	10	46,409
Platte	---	---	2	2	1,910
Sheridan	---	---	1	1	7,140
Sublette	2	2	4	8	43,879
Sweetwater	3	3	21	27	150,606
Teton	---	---	1	1	13,336
Uinta	---	---	1	1	4,700
Washakie	---	---	11	11	53,959
Weston	2	---	44	46	300,785
Total	48	13	384	445	2,517,072
Development completions:					
Albany	2	---	1	3	5,719
Big Horn	6	2	5	13	49,694
Campbell	48	---	37	85	689,573
Carbon	5	8	3	16	70,594
Converse	---	1	3	4	15,904
Crook	26	---	22	48	104,605
Fremont	21	4	9	34	138,042
Hot Springs	13	---	---	13	53,496
Johnson	11	---	2	13	126,634
Laramie	8	---	1	9	64,679
Lincoln	---	4	1	5	36,231
Natrona	78	---	9	87	200,913
Niobrara	3	1	3	7	22,608
Park	24	1	4	29	90,585
Sublette	15	6	6	27	106,484
Sweetwater	5	11	10	26	139,709
Washakie	2	---	---	2	9,230
Weston	32	---	17	49	174,712
Total	299	38	133	470	2,099,412
Total all drilling	347	51	517	915	4,616,484

Source: American Association of Petroleum Geologists Committee on Statistics of Drilling.

The seven oil discoveries in Johnson County included significant developments near the Reno discovery of 1965. In June, Shell Oil Co. completed the East Reno field discovery, 4½ miles east of the first Reno well, for a pump gage of 1,649 barrels of oil per day from the Minnelusa formation (Pennsylvanian). In November, the discovery well at the Pheasant field, 6 miles west of Reno, was completed for a pump gage of 147 barrels of oil per day also from the Minnelusa formation because of collapsed casing, the Pheasant field discovery was not completed until long after the confirmation well had been put on pump for an initial daily potential of 2,013 barrels of oil.

In the eastern Powder River basin, two new field discoveries, both in the Minnelusa formation, had significant initial production. The first, by Davis Oil Co., was completed in June for a pump gage of 610 barrels of oil per day to open the South Wallace field. The second, Little Mitchell Creek field, was found by True Oil Co. and others; the discovery well was completed for a daily initial potential of 614 barrels of oil.

The Stage Stop field in Sweetwater County was an important discovery in the southwestern part of the State. The discovery well, El Paso Products Co. Unit No. 2, was completed in April, initially flowing 601 barrels of oil per day from the Lewis

Table 6.—Crude petroleum production, by counties
(Thousand 42-gallon barrels)

County	1965	1966	Principal fields in 1966 in order of production
Albany	555	559	Quealy.
Big Horn	8,231	7,931	Garland, Byron, Sage Creek, Torchlight, Bonanza.
Campbell	8,349	8,590	Timber Creek, Raven Creek, Rozet, Rozet South.
Carbon	3,325	2,999	Wertz, Rock River.
Converse	4,538	4,758	Glenrock South, Big Muddy.
Crook	7,994	5,755	Coyote Creek, Moorcroft West, Donkey Creek.
Fremont	10,849	10,526	Beaver Creek, Winkleman, Steamboat Butte, Big Sand Draw.
Goshen	8	8	Torrington.
Hot Springs	18,488	17,507	Hamilton Dome, Grass Creek, Little Buffalo Basin, Murphy Dome.
Johnson	7,690	9,208	Sussex, Reno.
Laramie	513	592	Horse Creek, Golden Prairie.
Lincoln	4	-----	
Natrona	16,964	16,798	Salt Creek, Grieve Unit.
Niobrara	1,020	901	Lance Creek, Little Buck Creek.
Park	32,490	31,912	Elk Basin, Oregon Basin, Frannie, Pitchfork.
Sheridan	464	448	Ash Creek, Ash Creek South.
Sublette	4,518	4,140	Birch Creek, Green River Bend, McDonald Draw.
Sweetwater	7,236	7,242	Lost Soldier, Patrick Draw, Arch Unit.
Uinta	-----	[1] 57	Church Buttes.
Washakie	1,451	1,543	Cottonwood Creek, Hidden Dome, Slick Creek Worland.
Weston	3,627	2,996	Fiddler Creek, Mush Creek, Osage.
Total	138,314	134,470	

[1] Represents 90 percent of production from the Church Buttes field; remainder of production included in Sweetwater County.
Source: Wyoming Ad Valorem Tax Division, State Board of Equalization.

formation (Cretaceous). A later well, Unit No. 4, discovered a small quantity of gas in the Almond formation (also Cretaceous).

Frontier Refining Co. sold about 240 miles of products pipeline to Nielson Enterprises, Inc., of Cody. The pipeline extended from Pierce, Colo., through Cheyenne, Wyo., to North Platte, Nebr.

NONMETALS

Value of nonmetallic minerals amounting to 12 percent of the State mineral output value was 13 percent above that of 1965. Production was recorded for cement, clays (bentonite, fire clay, and miscellaneous clays), feldspar, gypsum, lime, phosphate rock, sand and gravel, sodium carbonate, sodium sulfate, stone and sulfur.

Cement.—Monolith Portland Midwest Co., the only cement producer in the State, mined sandstone, coal, and limestone for cement production. Masonry cement declined 44 percent in quantity and 37 percent in value. Portland cement increased 10 percent in quantity and 7 percent in value.

Wyoming Construction Co., a subsidiary of Monolith Portland Midwest Co., mined gypsum and cement rock for manufacturing cement.

Clays.—Clays produced included bentonite, fire clay, and miscellaneous clay. Output of bentonite, the most important of the clays produced, increased 17 percent, from 1.3 million tons valued at $13.5 million in 1965 to 1.5 million tons valued at $15.8 million. Output of fire clay and miscellaneous clay decreased 5 percent and 18 percent, respectively. Of the bentonite produced, 32 percent was used for pelletizing iron-ore concentrates; 30 percent for foundry use; 25 percent for rotary drilling; 5 percent for enameling, chemicals, briquetting, refractories, insecticides, fungicides, filtering, and cements; 3 percent for other uses; and 5 percent was exported.

Producing companies, in order of output, were Dresser Magcobar Division, Dresser Industries, Inc., formerly Magnet Cove Barium Corp.; American Colloid Co.; Archer Daniels Midland Co. (ADM); Baroid Division, National Lead Co.; Wyo-Ben Products, Inc.; IMC; Black Hills Bentonite Co., and Benton Clay Co., Inc.

Table 7.—Oil and gas discoveries in 1966

County and field	Well	Operator	Location			Producing formation	Gross producing interval (feet)	Total depth (feet)	Initial production		Date of completion	Remarks
			Section	Township	Range				Barrels of oil per day	Thousand cubic feet of gas per day		
Campbell County:												
Unnamed	No. A-1 Woolsey	Big Horn-Powder River Corp.	6	50 N	69 W	Muddy	6,668-6,680	8,550	48	-----	Jan. 29	Pumped. Combined with Rozet field.
Gray	No. 1 Gray	Davis Oil Co.-Southland Royalty Co.	14	50 N	69 W	Minnelusa	7,914½-7,922½	8,092	137	-----	June 28	Pumped. New field.
Rozet	No. 2 Federal-Campbell	Sinclair Oil & Gas Co.	11	50 N	70 W	do	8,716-8,719	8,895	116	-----	May 11	Pumped. New pay.
Cardinal	No. 13-3 Simpson	Cardinal Petroleum Co.	3	51 N	69 W	do	7,835-7,847	7,910	77	-----	Oct. 22	Pumped. New field.
Unnamed	No. 1 Hillman-Government.	Davis Oil Co.-Petroleum, Inc.	17	51 N	69 W	do	7,894-7,922½	8,065	235	-----	Nov. 4	Do.
Garner Lake	No. 2-2228 Hamm	Mule Creek Oil Co., Inc.	28	51 N	69 W	do	8,018-8,024	8,201	171	-----	Jan. 27	Do.
Wallace, South	No. 2-White	Davis Oil Co	1	51 N	70 W	do	7,872-7,912	8,050	610	-----	June 7	Do.
Kane	No. 1-K-W	do	15	51 N	70 W	do	8,247-8,249½	8,426	138	-----	June 19	Do.
Little Mitchell Creek Unit	No. 32-14 Federal	Trice Oil Co.-W. B. Osborn, Jr.	14	52 N	69 W	do	7,266-7,300	7,388	614	-----	Dec. 19	Flowed. New field.
Adon Road, North	No. 1 Brehm	Davis Oil Co	14	52 N	70 W	do	7,702-7,719	7,897	45	-----	Sept. 6	Pumped. New field.
Wallace	No. 1 Wallace	do	35	52 N	70 W	do	7,881-7,891	8,075	219	-----	Mar. 6	Do.
Roehrs	No. 1 Roehrs-Federal	do	15	53 N	70 W	do	7,464-7,470	7,645	255	-----	Aug. 26	Do.
Unnamed	No. 1-A Booton	do	34	54 N	70 W	do	7,447-7,449½	7,640	174	-----	Nov. 28	Do.
Carbon County:												
Melton	No. 1 Federal-Melton	Fundamental Oil Corp	26	22 N	86 W	Cloverly	3,168-3,176	3,230	-----	4,000	Nov. 15	Flowed. New field.
Crook County:												
Warbonnet	No. 42-19 Warbonnet Ranch	Arrowhead Exploration Co.-Fundamental Oil Corp.	19	49 N	67 W	Lakota	5,767-5,773	5,845	-----	400	Jan. 8	Flowed. New field.
Coyote Creek	No. F-43-33-Ida Robinson	Mobil Oil Corp	33	49 N	68 W	Turner	5,149-5,153	6,645	10	-----	Mar. 6	Pumped. New pay.
Soap Hole	No. 32-3 Government	Sweco, Inc	32	50 N	65 W	Fall River	341-346	504	5	-----	Jan. 16	Pumped. New field.
Fremont County:												
Golden Goose	No. 1 Federal-MKM	Kimbark Exploration, Ltd.	8	28 N	92 W	Dakota	5,950-5,955	6,120	62	-----	Sept. 24	Do.
Johnson County:												
Hub	No. 33X-8 Government	Shell Oil Co	8	44 N	80 W	Minnelusa	15,206-15,265	15,483	76	-----	Sept. 21	Do.
Reno, East	No. 11X-26A Government	do	26	45 N	79 W	do	14,931-14,945	15,310	1,649	-----	June 27	Do.

Pheasant	No. 32X-13 Pheasant	do	13	45 N	81 W	do	14,990-15,165	15,543	147	-----	Nov. 14	Do.
Niobrara County:												
East Lance Creek Unit	No. 27-1 East Lance Creek Unit	Union Texas Petroleum Corp.	27	36 N	64 W	First Leo	5,840-5,870	6,004	144	-----	Nov. 3	Do.
Redbird, Northeast	No. 1 Pfister	Coronado Oil Co	9	38 N	61 W	Pennsylvanian	3,680-3,735	4,192	6	-----	May 1	Flowed. New field.
Park County:												
Hunt	No. 2-1 Hunt	Amax Petroleum Corp	2	50 N	102 W	Phosphoria	4,069-4,097	4,423	62	-----	July 15	Pumped. New field.
						Tensleep	4,225-4,253					
TE Ranch Area	No. 1 Government	Paul G. Benedum	24	50 N	105 W	Dinwoody	3,619-3,669	3,726	60	-----	Sept. 20	Pumped. New field.
Garland, North	No. 8 Government	Farmers Union Central Exchange, Inc.	11	56 N	98 W	Sundance	3,725-3,730	4,927	65	-----	Aug. 6	Pumped. New pay.
Terry	No. 23-25 NP—Terry Unit	Northern Pacific Railway Co.	25	58 N	103 W	Greybull	9,270-9,274	11,390	225	7,500	Nov. 17	Flowed. New field.
							9,294-9,303					
Sublette County:												
Star Corral, East	No. 10-19 SCU	Belco Petroleum Corp	19	30 N	112 W	Tertiary	3,497-3,510	4,050	127	50	Sept. 17	Do.
Merna	No. 2 Unit	do	20	36 N	112 W	Ft. Union	10,426-10,875	13,525	-----	909	June 11	Do.
Sweetwater County:												
Stage Stop Unit	No. 2 Unit	El Paso Products Co	26	18 N	99 W	Lewis	4,894-4,914	5,900	601	-----	Apr. 25	Do.
Do	No. 4 Unit	do	27	18 N	99 W	Almond	5,309-5,314	5,768	-----	456	Sept. 21	Flowed. New pay.
Weston County:												
Turner	No. 1 Butler	Wind River Drilling Co	33	48 N	68 W	Turner	5,755-5,763	5,827	41	-----	Mar. 15	Pumped. New field.

Source: Petroleum Information Corp. Oil and Gas Operations in the Rocky Mountain Region, 1966 Resume.

Late in the summer, American Colloid Co. put on stream a new bentonite processing plant east of Lovell. IMC began construction of a bentonite processing plant near Colony. This plant, between the ADM and Baroid plants, was rated at twice the bentonite output capacity of the firm's old Belle Fourche, S. Dak., plant. The latter was to be closed and all facilities sold when the Colony plant is completed, tentatively in July 1967. Benton Clay Co., Inc., installed dust collectors to control air pollution in its mill west of Casper.

The Wyoming Land Board established a new policy for bentonite leases. New leases, starting with the second anniversary date of the lease, would have a fee of 25 cents per acre. This replaced the old policy of $50 per year regardless of acreage.

Fire clay was produced by International Pipe and Ceramics Corp. (Interpace) and miscellaneous clays were produced by The Lovell Clay Products Co., Sheridan Block, Brick, & Tile Co., and Interstate Brick Co.

Feldspar.—Feldspar production, by IMC and Rocky Mountain Aggregates, Inc., increased elevenfold.

Gem Stones.—Black jade from a deposit 62 miles southwest of Douglas was shipped to Japan for cutting and carving and to West Germany for jewelry.

Commercial dealers, hobbyists, and gem societies collected agate, petrified wood, and other varieties of gem materials.

Gypsum.—Construction of the Gysum Products of America plant near Lovell was 99 percent complete at yearend. Ore for the plant will come from a mine near Himes. Big Horn Gypsum Co. produced and used gypsum in manufacturing plasterboard at Cody. Wyoming Construction Co. mined gypsum near Woods Landing for Monolith Portland Midwest Co. at Laramie. Cody Sulphur Products Co. continued milling and shipping from the 1955 Wyoming Gulf Sulfur Co. stockpile. Recorded total gypsum output declined 23 percent.

Lime.—The output and value of lime (quicklime), manufactured by The Great Western Sugar Co. at Lovell and Holly Sugar Co. at Torrington and Worland, was greater than that for 1965.

Port Landing, Inc., began construction of a $2.5 million lime plant southeast of Lovell. Rated capacity of the plant was to be 52,000 tons per year of hydrated lime with an excess of 17,000 tons per year of quicklime.

Phosphate Rock.—From its Leefe operations, San Francisco Chemical Co., the only producer of phosphate rock in the State, increased output 13 percent. Ore from Utah was also processed at the plant.

Sand and Gravel.—Sand and gravel output and value decreased 10 percent; average value per ton decreased to $1.04. Output was reported from 71 commercial operations in 19 counties and 89 Government-and-contractor operations representing every county. According to reports, 98 percent of the sand and gravel was prepared for use by washing, crushing, or screening; the remainder was used as pit run. Use distribution was 88 percent for paving, 9 percent building, 2 percent fill, and 1 percent miscellaneous. Output was highest in Laramie, Albany, Sweetwater, and Natrona Counties. Major commercial firms reporting output in order of quantity, were Rissler & McMurry Co., Inc., Big Horn Construction Co., Wilbur Christensen, Gilpatrick Construction Co., Inc., and Casper Concrete Co.

Sand and gravel was used predominantly in road construction. Under the 1966 Wyoming highway program,[8] road-construc-

[8] Engineering News-Record. State Highway Department's Construction Contracting Plans for 1967 . . . and Budgets for Maintenance: Highway Construction Spending Will Reach For a Record This Year. V. 178, No. 12, Mar. 23, 1967, pp. 24–25.

Table 8.—Sand and gravel production in 1966, by counties

(Thousand short tons and thousand dollars)

County	Quantity	Value
Albany	1,097	$1,097
Big Horn	272	294
Campbell	23	26
Carbon	306	314
Converse	466	468
Crook	82	82
Fremont	163	165
Goshen	137	137
Hot Springs	161	189
Johnson	171	182
Laramie	1,258	1,330
Lincoln	49	56
Natrona	663	763
Niobrara	220	228
Park	316	309
Platte	6	4
Sheridan	232	259
Sublette	51	49
Sweetwater	943	977
Teton	155	149
Uinta	188	188
Washakie	29	31
Weston	41	41
Yellowstone	158	158
Total	7,187	7,496

Table 9.—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	1965		1966	
	Quantity	Value	Quantity	Value
Commercial operations:				
Sand:				
Construction:				
Building	294	$336	201	$258
Paving	368	434	105	130
Fill	[1] 10	[1] 13	27	34
Other	(1)	(1)	-----	-----
Total	672	783	333	422
Gravel:				
Construction:				
Building	413	496	416	511
Paving	2,131	2,483	580	715
Railroad ballast	[2] 191	[2] 187	-----	-----
Fill	(2)	(2)	115	123
Miscellaneous	41	29	78	84
Total	2,776	3,195	1,189	1,433
Total sand and gravel	3,448	3,978	1,522	1,855
Government-and-contractor operations:				
Sand:				
Building	-----	-----	3	3
Paving	1,882	1,878	2,716	2,716
Total	1,882	1,878	2,719	2,719
Gravel:				
Building	2	2	-----	-----
Paving	2,662	2,514	2,936	2,912
Fill	2	1	10	10
Total	2,666	2,517	2,946	2,922
Total sand and gravel	4,548	4,395	5,665	5,641
All operations:				
Sand	2,554	2,661	3,052	3,141
Gravel	5,442	5,712	4,135	4,355
Total	7,996	8,373	7,187	7,496

[1] Fill sand and "Other" sand combined to avoid disclosing individual company confidential data.
[2] Railroad ballast and fill gravel combined to avoid disclosing individual company confidential data.

tion contracts awarded totaled $44.3 million: $30.3 million for the Interstate Highway System, $7.9 million for roads in the Federal-Aid Primary and Secondary (ABC) program, and $6.1 million for roads financed by the State. Under the 1966 Interstate program,[9] 35.6 miles of road was opened to traffic, bringing the total of road opened since the program was begun July 1, 1956 to 536.5 miles. Total designated mileage for the State was adjusted to 913.5 miles.

Sodium Carbonate and Sulfate.—Output of soda ash (sodium carbonate), processed from trona, increased 22 percent in quantity and 23 percent in value because of increased production capacity at the Westvaco plant of the Inorganic Chemical Division of FMC Corp. FMC completed expansion of facilities by 350,000 tons per year raising total annual output to 1.2 million tons. New facilities included a line of crystallizers, addition of filters and centrifuges, and a boiler and cooling towers complex. The corporation filled a $146,000 foreign-aid-financed order for a Columbian firm under an Alliance for Progress loan.

Stauffer Chemical Company of Wyoming put a third refinery unit on stream during the year to raise annual production capacity to 800,000 tons. In support of the unit, additional steam- and power-generating facilities and increased water-pumping and water-treating abilities were added.

Industrial Chemicals Division, Allied Chemical Corp., began sinking a second

[9] Bureau of Public Roads. Quarterly Report on The Federal-Aid Highway Program, Dec. 31, 1966. Press Release BPR 67-5, Feb. 1, 1967, 8 pp.

shaft under a newly announced expansion program to bring the total investment in Al-Chem, a new mining operation, to $20 million. The new shaft was to be used for air and materials and as a manway. Under the expansion, the company planned to put the new 600,000-ton-per-year soda-ash complex on stream in late 1968.

Adjacent to the Allied Chemical plant, Church & Dwight Co. began construction of a $5 million, 50,000-ton-per-year complex to produce washing and baking soda and borax; the raw material was to be obtained from Allied.

Texas Gulf Sulphur Co. (TGS) announced plans for a trona mine and mill complex on leased land near Green River. In mid-1967, a 16-foot-inside-diameter, concrete-lined, circular shaft was to be sunk 1,400 feet, to reach the ore body for initial development and mining. Capacity of production facilities was not announced.

Output of natural sodium sulfate by William E. Pratt increased.

Stone.—Stone production and value decreased 13 percent and 8 percent, respectively. Forty-nine percent of the stone output was crushed and broken limestone; 41 percent was crushed and broken granite; the remaining 10 percent included crushed and broken miscellaneous stone, crushed basalt, crushed marble, crushed and broken sandstone, and dimension limestone, sandstone, and miscellaneous stone. Limestone was used for producing cement and lime and for road construction, railroad ballast, riprap, mineral food, building construction, and flux; granite for railroad ballast, road construction, and riprap; miscellaneous stone for riprap, railroad ballast, road construction, building construction and decoration, and rubble; basalt for road construction; marble for landscaping and building construction and decoration; sandstone for manufacturing cement and for building construction and decoration, riprap, and rubble.

Sulfur.—Shipments of sulfur, recovered from hydrogen sulfide-bearing natural gas, increased from 57,100 tons in 1965 to 105,500 tons valued at $1.6 million in 1966. The increased shipments occasioned by the national sulfur shortage were drawn from stockpiles. Production of elemental sulfur increased only 3,500 tons.

Table 10.—Stone production in 1966, by counties

County	Short tons	Value
Albany	271,967	$493,425
Big Horn	517	1,034
Campbell	1,400	2,800
Carbon	100	500
Converse	1,611	3,222
Crook	14,400	21,000
Fremont	6,773	13,546
Johnson	5,252	10,504
Laramie	740,532	1,297,571
Natrona	1,464	5,430
Park	95	190
Platte	225,221	455,602
Sheridan	W	W
Sublette	120	2,400
Sweetwater	W	W
Teton	85,108	194,846
Uinta	1,685	3,370
Washakie	1,197	2,394
Weston	1,400	2,800
Yellowstone National Park	7,875	16,500
Undistributed	26,569	32,578
Total	1,393,286	2,559,712

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

Sulfur was recovered by the modified Claus process in plants operated by Pan American Petroleum Corp., TGS, Ralston Processing Associates, Inc., and Sinclair Refining Co. Purvin & Gertz, Inc., and Atlantic Richfield Co., formerly Atlantic Refining Co., recovered sulfur by the Claus method.

METALS

The value of combined metals production—iron ore, uranium ore, and vanadium—decreased 12 percent, from $43.4 million in 1965 to $38.4 in 1966. Although no production of beryllium, copper, gold, or silver, was recorded some exploration and development work was carried on for these metals.

Iron Ore.—The quantity of iron ore shipments from four operations decreased 5 percent because of decreased production at Atlantic City Ore Operations, United States Steel Corp. (USS), and at Sunrise operations of CF&I Steel Corp. Plicoflex, Inc., and U.S. Aggregate Co. (formerly Peterson, Anderson & Knisely) shipped titaniferous magnetite ore for use as a heavy aggregate.

Uranium Ore.—Production and value of uranium ore increased 3 percent and 2 percent, respectively. Output, from 52 operations in nine counties, was processed at 5

mills in Wyoming and 1 mill in South Dakota. Recoverable uranium oxide from ores produced in the State was 4.6 million pounds valued at $36.8 million. Wyoming continued to be second in the Nation in production of uranium oxide concentrates.

Utah Construction & Mining Co. signed letters of intent with Nordostschweizersche Kraftwerke AG (NOK) and Oskarsharnsverkets Kraftgrupp Aktiebolag (OKG) for uranium concentrate. These letters called for delivery of 750,000 pounds of contained uranium oxide in concentrate to NOK starting late in 1967 and 765,000 to 840,000 pounds to OKG starting in 1968. The company also signed an agreement with General Electric Co. (GE) to deliver 1.7 to 2 million pounds of uranium concentrate in 1969–70. The company mine and mill were to be operated at accelerated rates indefinitely to fufill the contracts.

Two private electric companies contracted with Western Nuclear, Inc., for 1.5 million pounds of uranium concentrate for delivery in 1969–70, which was to be used in nuclear-powered, electric-generating plants. The company also contracted to supply 800,000 pounds of uranium concentrate to Central Atlantic Utility Group headed by Philadelphia Electric Co.

Ener-Chemco, Inc., a Cities Service Co. subsidiary, acquired an option to 27,000 acres of uranium leases in Carbon, Fremont, and Natrona Counties from Preston Oil Co. and Wolf Exploration Co., both of Denver, Colo.

Rio Algom Corp., United States subsidiary of Rio Algon Mines, Ltd., of Canada, signed an agreement with Mitsubishi Mining and Smelting Co., a subsidiary of Mitsubishi Metal Mining Co. of Japan, for a joint uranium exploration program on 14,000-acres in the Shirley basin which was under lease to Rio Algom. The agreement was subject to final approval of the Japanese Government. Mitsubishi Shoji Kaisha, Ltd., of Tokyo, the uranium agent for Rio Tinto in Japan since 1960, was to have first right of refusal on up to 50 percent of the uranium developed under the agreement for sale in Japan. The remainder was to be available to Rio Algom for sale in the United States and world markets.

More than 20,000 new uranium claims were staked in Wyoming; most of these were staked after March 1966 in blocks of 300 to 500 claims by the major uranium companies active in the State. In addition, 500,000 acres of State land was leased since March 1966.

American Nuclear Corp., formerly Gas Hills Uranium Co., conducted a drilling program in the Beaver Rim area. Active in the Conant Creek anticline area, particularly Sand Draw, were Homestake Mining Co., The Shoni Corp., and Utah Construction & Mining Co. Active staking had been done in the Copper Mountain area by Federal-American Nuclear Partners, Kerr-McGee Corp., T & T Oil Co. (a subsidiary of Union Pacific Railroad Co.), Teton Exploration Drilling Co., Inc., and Western States Mining & Contracting, Inc. In the

Table 11.—Mine production of uranium ore, by counties [1]

County	1965				1966			
	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]	Number of operations	Ore (short tons)	U_3O_8 contained (pounds)	F.o.b. mine value [2]
Big Horn	2	W	W	W	1	W	W	W
Campbell	---	-----	-----	-----	1	W	W	W
Carbon	8	253,001	r 1,301,596	$5,212,721	5	89,748	413,785	$1,024,039
Converse	9	28,340	109,845	419,009	7	11,668	41,027	145,260
Crook	5	92,355	385,571	1,548,714	5	84,386	393,650	1,593,884
Fremont	37	663,940	r 2,734,772	10,478,514	27	878,823	3,927,384	15,210,918
Natrona	4	W	W	W	4	W	W	W
Sublette	---	-----	-----	-----	1	W	W	W
Sweetwater	1	W	W	W	1	W	W	W
Undistributed	---	10,540	30,883	99,436	---	17,572	56,688	185,966
Total	66	1,048,176	4,562,667	17,758,394	52	1,082,197	4,832,534	18,160,067

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Receipts at mills based on data supplied to the Bureau of Mines by AEC.
[2] F.o.b. mine value; base price, grade premiums, and exploration allowances. Calculated according to AEC Circular 5, revised, price schedule.

Hat Creek area, Homestake Mining Co., Ralph Schauss, and other independents were active. The Powder River area was reported to have been staked solid from Douglas to Pumpkin Buttes and from the Powder River to Lusk by The Cleveland-Cliffs Iron Co., Humble Oil Co., Jenkins & Wold, Kerr-McGee, T & T Oil, and Teton Exploration. Deep drilling by the major uranium companies was unsuccessful in the Pumpkin Buttes area. Large blocks of claims were staked in the Red Desert area by Homestake, Newmont Exploration, Ltd., Utah Construction, and Western Nuclear, Inc. Claim staking and drilling in the Shirley basin was by Kerr-McGee, Petrotomics Co., Tidewater Oil Co., Union Carbide Corp., Utah Construction, and Western Nuclear. In west Shirley basin, Four Corners Exploration Co. and Western Nuclear were active on a new mineralized trend. Rio Algom and Mitsubishi Metal were active in the northwest section of Shirley basin. State leases in the South Pass area were obtained by Federal Resources Corp., T & T Oil, United Nuclear Corp., Utah Construction, and many independent operators.

Rio Algom and Union Carbide were active in the Sweetwater Valley area, particularly in Kohler Draw. Homestake Mining and Western Nuclear had staked numerous claims in the Poison Spider area.

Vanadium.—The quantity and value of vanadium, recovered as a byproduct of Wyoming uranium ores processed in the mill of Mines Development, Inc., at Edgemont, S. Dak., increased 2 and 25 percent, respectively.

REVIEW BY COUNTIES

Of the 24 counties in Wyoming, 10 counties—collectively producing 84 percent of the State total mineral value—reported mineral production in excess of $20 million.

Albany.—Monolith Portland Midwest Co., the only cement producer in Wyoming, accounted for more than half of the county mineral production value through manufacturing cement and mining cement rock, gypsum, limestone, and sandstone as raw materials.

Output of crude oil increased by 4,000 barrels; although production from older fields—Quealy Dome, Rex Lake, Little Laramie, and Herrick—declined, the yield from the reactivated Big Hollow and Seven Mile fields more than offset the decline. Seven Mile field had production of 28,200 barrels and Big Hollow 2,760 barrels.

Output of sand and gravel, from seven operations, increased 31 percent; 92 percent of the output was used for road construction, the remainder for building. The University of Wyoming mined 640 tons of dimension sandstone for use in its campus building program. Plicoflex, Inc., and U.S. Aggregate Co. increased output of iron ore for use as heavy aggregate from the Iron Mountain, west of Farthing, and Shanton deposits, respectively. Feldspar produced by Rocky Mountain Aggregates, Inc., was used in precast stone.

Big Horn.—With a production of $26.7 million the county ranked sixth in value of mineral output in the State.

Petroleum, again the most valuable mineral commodity, generated 76 percent of the mineral output value. Although petroleum production decreased 300,000 barrels, the value dropped only 1 percent. Garland field was again the largest in the county with a yield of 3.9 million barrels. Sixteen fields yielded crude oil, and five, natural gas.

Bentonite was second to petroleum in value of minerals produced. Dresser Magcobar, operating the largest bentonite plant in the State, increased shipments 29 percent over those of 1965; Wyo-Ben Products Co., Inc., shipped 3 percent less; and American Colloid Co. began production late in the summer at its new bentonite plant near Lovell. Output of a local clay by Lovell Clay Products Co. for use in manufacturing building brick, heavy clay pipe, tile products, and fire brick declined.

Sand and gravel production, from seven operations, increased 186,000 tons; 95 percent was used for road construction, the remainder for building. The Great Western Sugar Co. processed and used 19 percent more lime at its beet-sugar refinery at Lovell. Titan Mining Co. produced uranium ore from the Tri Pacer mine. Stone output was 31,000 tons less than in 1965.

Table 12.—Value of mineral production in Wyoming, by counties

County	1965	1966	Minerals produced in 1966 in order of value
Albany	$6,139,715	$6,614,616	Cement, petroleum, sand and gravel, stone, iron ore, gypsum, feldspar.
Big Horn	25,770,587	26,713,572	Petroleum, clays, natural gas, sand and gravel, lime, uranium ore, stone.
Campbell	22,038,639	23,232,574	Petroleum, coal, natural gas, natural gasoline, LP gases, sand and gravel, stone, uranium ore.
Carbon	16,388,541	12,296,362	Petroleum, coal, natural gas, uranium ore, LP gases, sand and gravel, natural gasoline, stone.
Converse	16,520,258	18,861,296	Petroleum, coal, sand and gravel, LP gases, natural gas, uranium ore, natural gasoline, vanadium, stone.
Crook	27,697,287	23,588,110	Petroleum, clays, uranium ore, vanadium, natural gas, sand and gravel, stone.
Fremont	67,799,836	66,841,339	Petroleum, iron ore, uranium ore, natural gas, natural gasoline, LP gases, sand and gravel, stone.
Goshen	240,478	W	Sand and gravel, lime, petroleum.
Hot Springs	46,579,263	45,303,166	Petroleum, sand and gravel, natural gas, coal, natural gasoline.
Johnson	20,963,000	25,599,698	Petroleum, clays, natural gas, LP gases, sand and gravel, natural gasoline, stone.
Laramie	3,479,968	4,144,571	Petroleum, sand and gravel, stone, natural gas.
Lincoln	8,104,433	8,307,666	Natural gasoline, coal, phosphate rock, LP gases, sand and gravel.
Natrona	46,913,507	47,697,578	Petroleum, natural gas, LP gases, sand and gravel, natural gasoline, clays, uranium ore sodium sulfate, stone, feldspar.
Niobrara	2,832,916	2,637,000	Petroleum, sand and gravel, natural gas, LP gases.
Park	85,347,899	86,371,753	Petroleum, natural gas, LP gases, natural gasoline, gypsum, sand and gravel, stone.
Platte	W	W	Iron ore, stone, sand and gravel.
Sheridan	2,898,731	2,528,674	Petroleum, coal, sand and gravel, stone, clays.
Sublette	22,423,870	21,400,915	Natural gas, petroleum, sand and gravel, LP gases, stone, uranium ore.
Sweetwater	52,125,089	59,560,460	Sodium carbonate, petroleum, natural gas, sand and gravel, coal, LP gases, natural gasoline, stone, uranium ore.
Teton	W	343,846	Stone, sand and gravel.
Uinta	1,212,508	1,446,610	Natural gas, sand and gravel, petroleum, clays, natural gasoline, stone.
Washakie	6,864,809	7,135,422	Petroleum, natural gas, LP gases, lime, sand and gravel, stone.
Weston	12,051,195	10,880,659	Petroleum, clays, LP gases, natural gas, sand and gravel, stone.
Yellowstone National Park	28,610	174,500	Sand and gravel, stone.
Undistributed [1]	4,131,314	5,552,064	
Total	498,552,000	505,806,000	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes gem stones that cannot be assigned to specific counties and values indicated by symbol W.

Campbell.—With a mineral production value of $23.2 million, the county was ranked ninth.

Except for $29,000, mineral fuels accounted for all the value. Petroleum output, comprising 95 percent of the total, was 5 percent higher than in 1965, as a result of production from new fields. The county had 13 oil discoveries for a success ratio of 16.5 percent; it ranked first in exploratory and second in development drilling.

A 3-percent decrease in coal output was reported by Wyodak Resources Development Corp. Production of sand and gravel increased 19,000 tons. Gilpatrick Construction Co. mined and processed miscellaneous stone for use in road construction for the Wyoming Highway Department. A small amount of uranium ore was mined by Western Uranium Co. from the Pete 17 mine.

Carbon.—Petroleum was the most valuable mineral commodity, and the 19 oilfields in the county had production amounting to 3 million barrels. Wertz field accounted for 74 percent of the petroleum output. Marketed natural gas was 37 percent

higher than in 1965. Completion of the Rawlins gasoline plant of CIG increased output of natural gas liquids sevenfold.

Overall coal production in the county increased 8 percent. A decrease in coal output by Monolith Portland Midwest Co. from the Hanna 2 strip mine was offset by an increase from the Rosebud strip by Rosebud Coal Sales Co. Uranium ore production was 163,000 tons under that of 1965. Output from four mines, one less than in 1965, was by Utah Construction & Mining Co., Petrotomics Co., Shirley Basin Joint Venture, and Western Nuclear, Inc. The Petrotomics Co. uranium mill, scheduled to close September 1966, was to continue operations indefinitely to allow stockpiling of uranium oxide concentrate for sale to private industry. The company removed 5.5 million cubic yards of overburden from the Dave pit. The top of the 90-foot, intermittent ore body lay 139 feet below the surface, making the pit 220 feet deep.

Sand and gravel output from eight operations, compared with 15 in 1965, was 263,000 tons below that of 1965. Rawlins Redstone Development Co. produced a small amount of dimension sandstone.

Converse.—Mineral fuels accounted for 97 percent of the total value of mineral production; petroleum led in value, followed by coal, natural gas liquids, and natural gas.

Petroleum output increased 220,000 barrels because of higher production from the South Glenrock field. Because of increased demand, natural gas and natural gas liquids were produced at higher levels.

Coal output from the Dave Johnston strip (PP&L) and the East Antelope strip (Best Coal Co.) increased 25 percent in quantity.

Seven operators reported an increase of 370,000 tons in sand and gravel production; 98 percent was used for road construction.

Production of uranium ore in the Dry Fork area from seven operations, two less than in 1965, decreased 16,700 tons. Vanadium output was 50 percent less than in 1965.

Stone production increased 1,000 tons and was used by Big Horn Construction Co. and Brasel & Sims Construction Co., contractors for the Wyoming Highway Department.

Crook.—With a mineral output value of $23.6 million, the county ranked eighth among mineral producing counties of the State. Petroleum comprised 62 percent, clay 26 percent, and uranium ore 7 percent of the total.

Although output of petroleum declined 28 percent, the county shared in the high level of drilling activity in the Powder River basin; 67 wildcat wells resulted in nine discoveries. Depletion of the reservoir reduced production at the West Moorcroft field by 50 percent; Coyote Creek field, second in rank in 1965, moved to first position in county petroleum output even though it also had a decline in yield.

Output of bentonite increased 16 percent. Producers, in order of output, were American Colloid Co., ADM, Baroid, and IMC.

Uranium output, 9 percent less than 1965, was by Homestake Mining Co. and Susquehanna-Western, Inc. The production, all from the Hulett area, was processed at the Mines Development, Inc. mill, Edgemont, S. Dak. Vanadium, recovered from the uranium ores, was 3 percent greater than that of 1965. Sand and gravel output, from one operation, increased 29,000 tons. Storm Construction Co., and Gilpatrick Construction Co., respectively contractors for the U.S. Forest Service, and the Wyoming Highway Department, increased stone output threefold.

Fremont.—Ranked second in mineral output value. Fremont had a total mineral value of $66.8 million; mineral fuels accounted for 53 percent.

The county ranked third in the State, in marketed natural gas and fourth in petroleum production. Yield of gas from the East Riverton field increased fourfold, to 2.5 billion cubic feet. Beaver Creek and Riverton Dome fields again ranked first and second in gas production, with outputs of 16.9 billion and 9.5 billion cubic feet, respectively. Beaver Creek also ranked first in crude oil output with 2.5 million barrels, followed by Winkleman with 2.4 million barrels.

Iron ore output by USS decreased slightly. The county continued to lead the State in uranium ore output, accounting for 81 percent of the total; production in the

Table 13.—Uranium operators in Fremont County in 1966

Operator	Locality	Type of mine
Atlas Corp., Atlas Mineral Div	Gas Hills	Underground.
Continental Uranium Company of Wyoming	Green Mountain and Crooks Gap.	Do.
Federal-Gas Hills Partners	Gas Hills	Open pit.
Green Mountain Uranium Corp	Green Mountain and Crooks Gap.	Underground.
Union Carbide Corp., Gas Hills Operations	Gas Hills	Open pit.
Utah Construction & Mining Co., Lucky Mc Operation.	do	Open pit and underground.
Western Nuclear, Inc	do	Do.

county increased 32 percent. Western Nuclear, Inc., accepted the 3-compartment, 875-foot-deep, Golden Goose shaft from Centennial Development Co. in March 1966. Development work continued during the remainder of 1966, with full-scale production planned for mid-1967. The company's Jeffery City mill was shut down 3 months for a $250,000 modernization and remodeling project. Mine output was crushed and stockpiled for the mill.

Federal-American Nuclear Partners began mining at the Sagebrush 3, Tablestakes 1, and Loco C pits. Approximately 4 million cubic yards of overburden was removed from the Sagebrush-Tablestakes area. The main ore body, encountered at 180 feet, was a better grade than drilling had indicated. Approximately 2.8 million cubic yards of overburden was to be removed from the Loco C pit to reach the ore body at 190 feet.

Sand and gravel output from six operations, two less than in 1965, was 582,000 tons below that of 1965. Stone production, by Teton Construction Co., contractor for the Wyoming Highway Department, and Midvale Irrigation District, was 3,000 tons less than that produced in 1965.

Goshen.—The value of mineral production increased in 1966. Although three operators produced less sand and gravel, the value was higher than that of 1965. Holly Sugar Co. used 17 percent more lime in its Torrington beet-sugar refinery. Petroleum production at the Torrington oilfield continued at about the same level as in 1965.

Hot Springs.—The county ranked fifth in mineral production value in the State; mineral fuels accounted for all except $189,000. Petroleum accounted for 99 percent of the total.

With 17.5 million barrels, 5 percent less than in 1965, the county ranked second in the State in petroleum output. The 18 oilfields included four which had an output of more than 1 million barrels each and which accounted for 89 percent of the county yield. These were Hamilton Dome, 7 million barrels (fourth largest in the State); Grass Creek, 5.2 million (fifth largest in the State); Little Buffalo Basin, 2.1 million; and Murphy Dome, 1.3 million barrels.

Output from seven operations, five more than in 1965, increased production of sand and gravel 91,000 tons; 55 percent was used for road construction and 45 percent for building.

Coal output by Dusky Diamond Coal Co., Roncco Coal Co., and T-K Coal Co. was 22 percent less than that of 1965.

Johnson.—A total mineral production value of $25.6 million gave Johnson County a ranking of seventh among the counties; petroleum comprised 93 percent of the total.

The 20-percent increase in crude oil yield was the result of new fields (East Reno and Pheasant), rapid development of the Reno field, and expanded output in the Meadow Creek and North Fork fields. Sussex was the largest oilfield in the county with production of 3.3 million barrels and the 1965 discovery, the Reno field, had moved up to second rank with a yield of 2.5 million barrels.

Black Hills Bentonite Co., the only bentonite producer in the county, increased output substantially. Sand and gravel production, from 11 operations, increased 10 percent; 82 percent was for road construction, 7 percent for building, 6 percent for miscellaneous use, and 5 percent for fill. Gilpatrick Construction Co. and Art Schimkat Construction Co. mined and

processed miscellaneous stone for use as contractors for the Wyoming Highway Department.

Laramie.—Mineral output value was divided among petroleum with 36.5 percent, up 15 percent in output; sand and gravel 32.1 percent, up 78 percent in output; crushed stone 31.3 percent, down 14 percent in output; and natural gas less than 0.1 percent, up 40 percent in output.

Crude oil was the most valuable mineral commodity. From six fields, petroleum output increased 79,000 barrels, with most of the increase occurring in the Golden Prairie, Horse Creek, and Pine Bluffs fields.

Wycon Chemical Co., a subsidiary of CIG, announced plans for a $5 million addition to its facilities near Cheyenne for production of an additional 300 tons of ammonia per day. Construction by Fish Engineering & Construction Co. of Houston, Tex., was scheduled for completion in April 1967.

Output of sand and gravel, from 12 operations, was divided among road construction with 86 percent, building with 13 percent, and 1 percent for fill and miscellaneous uses.

Teton Construction Co. produced crushed granite for road construction. Morrison-Knudsen Co., Inc., under contract to Union Pacific Railroad Co., produced crushed and broken granite for use as riprap and railroad ballast. The Great Western Sugar Co. produced crushed and broken limestone for railroad ballast, road construction, riprap, mineral food, and for manufacturing lime for use in its beet-sugar refineries. Brasel & Sims Construction Co., Wilbur Christensen, and Rissler & McMurry Co., Inc., contractors for the Wyoming Highway Department, used miscellaneous stone for riprap.

Lincoln.—In order of value, mineral commodities produced were natural gas liquids, coal, phosphate rock, and sand and gravel.

Natural gas liquids, extracted from natural gas from the Big Piney-La Barge area at the Opal gasoline plant of El Paso Natural Gas Co., totaled 51 percent of the value of mineral output.

With production from the Elkol and Sorensen strips, operated by The Kemmerer Coal Co., increasing 16 percent, the county was again second in the State in coal yield. At the Elkol strip, two diesel-electric power shovels, one 5 and one 7 cubic yards, moved over 300,000 cubic yards of overburden to reach coal seams totaling 150 feet in thickness. At the Sorensen strip, one 7-cubic-yard-capacity diesel-electric power shovel, one 18-cubic-yard-capacity diesel-electric dragline, and one 5-cubic-yard-capacity diesel dragline removed 2.4 million cubic yards to reach coal seams totaling 80 feet in thickness. Production from the Elkol strip was for commercial markets; that from the Sorensen strip was for the Naughton plant of Utah Power & Light Co. The Kemmerer Coal Co. continued experimentation with a continuous-boring machine which was to recover coal from under the high wall of the pits through a 7- by 12-foot bore.

At the San Francisco Chemical Co. open pit output of phosphate rock increased 13 percent. Concentrates from the processing plant near Sage were shipped out-of-State for use in manufacturing fertilizers and phosphoric acid. Sand and gravel production, from three operations, declined 115,000 tons.

Natrona.—With a mineral value of $47.7 million, the county ranked fourth in production. Mineral fuels accounted for 98 percent of the total: Crude petroleum led with 90 percent, followed by marketed natural gas, and natural gas liquids with 4 percent each.

The county was ranked third in the State in petroleum production with an output of 16.8 million barrels. Although crude oil yield declined slightly, natural gas and natural gas liquids gained substantially; the new gas plant near Casper, owned by Kansas-Nebraska Natural Gas Co., contributed to this increase. Only one field in the county produced more than 1 million barrels of oil; this field, Salt Creek, accounted for 76 percent of the oil production and 68 percent of the total value of mineral production.

Although nearly 10 percent of the State exploratory drilling activity was in the county, only one discovery was made. Of the 87 development wells drilled, 78 were completed as oil wells.

Output of sand and gravel from 16 operations, compared with seven in 1965, decreased 44 percent; 72 percent of the production was used for road construction, 15 percent for building, 12 percent for fill, and 1 percent for miscellaneous use.

Shipments of bentonite by the Benton Clay Co., Inc., from mines near Midwest, decreased 6 percent.

Union Carbide produced uranium ore at its three East Gas Hills operations, and Federal-American Nuclear produced from one operation; total output increased 68 percent. William E. Pratt, from saline deposits near Natrona, increased output of sodium sulfate, 26 percent. Crews of the Federal Bureau of Land Management mined and processed limestone for use in building; sandstone for rubble and as riprap; and miscellaneous stone for riprap. IMC produced feldspar from the Morning Dew mine for porcelain and dental uses.

Niobrara.—Of the total value of mineral production, which declined 7 percent, petroleum accounted for 87 percent; sand and gravel 9 percent; marketed natural gas 3 percent, and LP gases 1 percent.

The 13 oil- and gas-fields in the county produced 901,000 barrels of oil and 645 million cubic feet of gas. Depletion of reservoirs caused a 12-percent decrease in oil output.

On March 29, the Sioux Oil Co. crude oil-treatment plant at Mule Creek field was destroyed by fire; damage estimates ran from $35,000 to $50,000. Company executives indicated the plant, built in 1941, would be rebuilt.

Sand and gravel output, increasing twofold, was used in road construction.

Park.—With a mineral output valued at $86.4 million, the county ranked first in production in the State. Petroleum comprised 95 percent of the total value, followed by marketed natural gas and natural gas liquids; the remainder was divided among gypsum, sand and gravel, and crushed stone.

The county also ranked first in crude oil output; third in natural gas liquids; and fourth in marketed natural gas. The largest oilfield in the State, Elk Basin, with output of 16.9 million barrels, was one of four fields in the county which yielded more than 1 million barrels of oil; the other three were Oregon Basin 9 million barrels, Frannie 1.6 million barrels, and Pitchfork 1.2 million barrels of oil. Because of greater demand, marketed natural gas, from 11 fields, increased by 3.3 billion cubic feet.

Pan American Petroleum Corp. completed its fieldwide, automatic crude-oil handling facilities at Elk Basin field. Capacity of the gasoline plant at Ralston was expanded at a cost of $400,000.

Exploratory drilling activity was at the same level; development drilling, however, was down by 16 wells from the 45 drilled in 1965.

Big Horn Gypsum Co. mined less gypsum than in 1965 for its plasterboard plant at Cody. Cody Sulphur Products milled and shipped 42 percent less gypsum from the Wyoming Gulf Sulphur Co. stockpile. Production of sand and gravel from seven operations, four less than in 1965, decreased 30 percent compared with 1965; 75 percent was used for road construction, 16 percent for miscellaneous use, and 9 percent for building. C. J. Abbott, Inc., produced miscellaneous stone as a contractor for the Wyoming Highway Department.

Platte.—Iron ore output from the Sunrise mine of CF&I Steel Corp., although 13 percent below that of 1965, comprised the major portion of the county's mineral value.

Guernsey Stone Co., a subsidiary of Peter Kiewit Sons' Co., produced crushed and broken limestone for use as riprap, road construction material, railroad ballast, and dimension limestone for building. Basins Engineering Co., Inc., mined and processed marble for use in roofing, exposed panels, and landscaping. Rocky Mountain Aggregates, Inc., mined marble for use in manufacturing precast products. Brasel & Sims Construction Co. used miscellaneous stone on a project for the Wyoming Highway Department. Overall, stone output increased 9 percent. Two operations yielded 75 percent less sand and gravel than that recorded in 1965; 67 percent of the output was used in road construction and 33 percent in building.

Sheridan.—Of the total value of mineral production, petroleum provided 45 percent, coal 43 percent, sand and gravel 10 percent, and miscellaneous clay and stone 2 percent. Although output from the Ash Creek oilfield increased slightly, the decline at South Ash Creek reduced the county total by 16,000 barrels.

Output of coal from strip mines operated by Big Horn Coal Co. and Welch Coal Co. decreased 23,000 tons. Sand and gravel production from 11 operations, two more than in 1965, decreased 184,000 tons; distribution was 76 percent for road construction, 13 percent for building, and 11 per-

cent for fill. Tongue River Stone Co. mined and processed miscellaneous stone for use in road construction and as railroad ballast. Miscellaneous stone also was produced, under contract to the Wyoming Highway Department, by Wilbur Christensen, Gilpatrick Construction Co., Husman Brothers, Inc., and Reiman-Weurth, Inc.

Sublette.—With a mineral production valued at $21.4 million, the county ranked tenth. Although petroleum and marketed natural gas decreased both in quantity and value, they provided all except $79,000 of the total mineral value. The county ranked first in marketed natural gas. The largest gasfield in the State, Greater La Barge, yielded 18.5 billion cubic feet of gas, 25 percent of the county output. Three other fields had gas yields of more than 10 billion cubic feet: Tip Top, 14.3 billion; Big Piney, 12.3 billion; and Hogsback, 10.3 billion.

Total drilling decreased 56 percent. Development drilling decreased by 36 wells compared with the number drilled in 1965; wildcat wells decreased from 16 to eight. The success ratio for the exploratory wells was 50 percent.

Sand and gravel output from five operations, two more than in 1965, decreased 105,000 tons; 86 percent of the output was for road construction, 10 percent for miscellaneous uses, and 4 percent for building. Sunset Rock Quarry, Inc., produced dimension sandstone for building from a quarry near La Barge. Federal-American Nuclear Partners mined uranium ore from the Pard 4 mine.

Sweetwater.—With a mineral production valued at $59.6 million, $7.4 million over that of 1965, the county ranked third. Sodium carbonate was the principal commodity.

To supply the enlarged processing plants of FMC and Stauffer Chemical, trona output increased over that of 1965. Kern County Land Co. was the successful bidder at $56.50 per acre for 650 acres of trona-producing land in Sweetwater County; one-half of the acreage was to be assigned to Duval Corp. Of additional interest, Buttes Gas & Oil Co. drilled trona deposits adjacent to those held by TGS; Phillips Petroleum Co. conducted feasibility studies on land drilled in 1965; and Diamond Alkali conducted a drilling program.

The county again ranked second in marketed natural gas, with 54.1 billion cubic feet—10 percent higher than in 1965. Of the 26 productive gasfields, the largest was the Greater Patrick Draw-Arch Unit area with output of 15.6 billion cubic feet. Other fields with large production were Canyon Creek, 10.3 billion cubic feet; Tablerock 7.6 billion; and Desert Springs, 5.8 billion cubic feet.

Petroleum output, from 22 fields, was virtually unchanged. Lost Soldier, the largest field, yielded 4.3 million barrels—389,000 barrels more than in 1965. Much of this increase was attributed to new, pressurized crude-handling facilities and a water-injection program in each of the three producing formations. The waterflood program was estimated to add 34 million barrels to the recoverable oil in the field.

Wildcat drilling in the county almost doubled—from 16 wells in 1965 to 27 wells in 1966. This exploration resulted in three oil and three gas discoveries; the Stage Stop field was one of the significant oil discoveries of the year.

Combined coal production from the underground mines of Gunn-Quealy Coal Co. and Edwin L. Swanson Brothers increased 2 percent; production from the former increased 3 percent and more than offset the decreased production of the latter firm.

Output of sand and gravel from 11 operations, three more than 1965, decreased 153,000 tons or 14 percent; 96 percent of the output was for road construction and 4 percent for building. Big Horn Construction Co. produced crushed miscellaneous stone for the Wyoming Highway Department. Western Aggregates produced miscellaneous stone for building. Industrial Uranium Co. shipped uranium ore from stockpiles at the Golden Arrow.

Teton.—Fifty-seven percent of the mineral production value came from stone and 43 percent from sand and gravel. Utah-Idaho Sugar Co. mined and crushed limestone at the Fox Creek quarry for use in beet-sugar refineries in Idaho. Kimberly Construction Co. mined, crushed, and screened basalt for road construction in Yellowstone National Park. Under contracts with the Wyoming Highway Department, C. J. Abbott, Inc., Ellingford Brothers, and Etlin Peterson produced miscellaneous stone for use as riprap.

Output of sand and gravel, from nine operations, decreased 9,000 tons; 78 percent was used for road construction, 12 percent for fill, and 10 percent for building.

Uinta.—Mineral fuels—marketed natural gas, natural gasoline, and petroleum—from the Uinta County part of the Church Buttes field comprised 79 percent of the county mineral production value.

Output of sand and gravel, from seven operations, two more than in 1965, increased 42 percent; 90 percent was used for road construction and 10 percent for building.

Interstate Brick Co. and Interpace, mining clay near Evanston for use in their Salt Lake City, Utah, plants, reported decreases in clay output. Brasel & Sims Construction Co. used miscellaneous stone for riprap as a contractor for the Wyoming Highway Department.

Washakie.—Production of petroleum, natural gas, and LP gases comprised 97 percent of the mineral production value. Petroleum output with a 92,000-barrel increase came from 10 fields; Cottonwood Creek, with an output of 1 million barrels, was the largest. Increased production from Cottonwood Creek and Slick Creek more than offset the drop in yield from other fields.

The Worland field accounted for 98 percent of the gas production; this was sulfur-bearing gas from which elemental sulfur was recovered. Eleven unsuccessful wildcat wells and two development oil wells were drilled during the year.

Holly Sugar Co. processed lime for use in beet-sugar refining at Worland. Sand and gravel output, from six operations, was only 29,000 tons, compared with 606,000 tons in 1965; 69 percent of the output was for road construction, 28 percent for building, and 3 percent for miscellaneous uses.

Weston.—Mineral fuels—crude oil, LP gases, and marketed natural gas—comprised 72 percent of the value of mineral output, followed by clay with 27 percent. Petroleum with a $1.4 million decrease in output was again the most valuable mineral commodity. Of the 23 oilfields, only 1, Fiddler Creek, yielded more than 1 million barrels. Continued depletion of the reservoirs at Fiddler Creek and Osage caused most of the decline in output. Exploratory drilling increased from the 31 wells drilled in 1965; development drilling was also higher—49 compared with 34 wells in 1965.

Bentonite output by American Colloid Co., ADM, and Baroid increased 6 percent. Sand and gravel output, from three operations, increased 8 percent; all was used for road construction. Gilpatrick Construction Co., under contract to the Wyoming Highway Department, mined crushed, and screened miscellaneous stone.

Yellowstone National Park.—Sand and gravel production, 158,000 tons, from two operations was used for road construction. Crews of the Yellowstone National Park Service produced basalt and granite for road construction.

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